BLM

U.S. Department of the Interior
Bureau of Land Management

Draft Environmental Assessment

Three Fingers and Jackies Butte Herd Management Areas
Wild Horse
Population Management Plan

U.S. Department of the Interior
Bureau of Land Management
Vale District/Malheur Field Office
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ENVIRONMENTAL ASSESSMENT DOI-BLM-ORWA-V000-2021-0023-EA

1.0 INTRODUCTION, PURPOSE OF, AND NEED FOR ACTION

1.1 Introduction

The Vale District Bureau of Land Management (BLM) proposes to gather and remove excess wild horses and implement fertility control measures on wild horses from the Three Fingers and Jackies Butte Herd Management Areas (HMAs) in order to achieve and maintain a thriving natural ecological balance and manage the wild horse population within Appropriate Management Levels (AMLs) over a ten-year time frame. Various methods of gathering and removal of wild horses are available (i.e. helicopter drive trapping, bait/water trapping, and horseback drive trapping). The method(s) to be used would be determined by the authorized officer.

This Environmental Assessment (EA) is a site-specific analysis of the potential impacts that could result with the implementation of the Proposed Action or alternatives to the Proposed Action. Preparation of an EA assists the BLM authorized officer to determine whether to prepare an Environmental Impact Statement (EIS) if significant impacts could result, or a Finding of No Significant Impact (FONSI) if no significant impacts are expected.

1.2 Background

The Three Fingers HMA comprises about 62,508 acres of public land. The HMA is located in Malheur County, about 25 miles N from Jordan Valley, Oregon (Map 1). The AML for wild horses within the HMA is 75-150 wild horses. The AML was established in Southern Malheur Management Framework Plan (MFP) (1975) and reaffirmed in the Southeast Oregon Resource Management Plan Record of Decision (SEORMP/ROD, 2002). The HMA was last gathered in 2016 with a partial emergency gather due to a wildfire. Based on the July 2019 aerial survey of the Three Fingers HMA, there were a total of 166 adult horses and 32 foals. Assuming a 20% population growth rate per year (NAS Report, 2013), the expected wild horse population by summer 2022 will be over 280 adult wild horses.

The Jackies Butte Herd Management Area (HMA) comprises about 65,211 acres of public land in the Dry Creek Pasture of the Jackies Butte Summer Allotment. The HMA is located in Malheur County, about 12 miles SE from Rome, Oregon (Map 1). The AML for wild horses within the HMA is 75-150 wild horses. The AML was established in Southern Malheur Management Framework Plan (MFP) (March, 1983) and reaffirmed in the Southeast Oregon Resource Management Plan Record of Decision (SEORMP/ROD, 2002). The HMA was last gathered in 2012 due to an emergency created by wildfires. The majority of the wild horses were removed from the HMA at that time. In 2014, horses were returned to the HMA to bring the population back up to a total of 75. All of the released mares (23) had been primered and boostered with PZP-22. Based on the July 2019 aerial survey of the Jackies Butte HMA, there were a total of 127 adult horses and 16 foals. Assuming a 20% population growth rate per year (NAS Report, 2013), the expected wild horse population by summer 2022 will be over 200 adult wild horses.

The two HMAs whose management is addressed in this EA have spatially separated, discrete wild horse herds.

1.3 Purpose of and Need for Action

The purpose of the action is to return the wild horse herds to levels that are within the established AML in both the Three Fingers and Jackies Butee HMAs, to maintain the herds within those levels, to protect rangeland resources from deterioration associated with overpopulation, and to restore a natural ecological balance and multiple use relationship on public lands in the area consistent with the provisions of Section 1333(b) of the Wild Free-Roaming Horse and Burro Act (WFRHBA) of 1971.

The need for action is to achieve a thriving natural ecological balance on public lands; manage wild horses in a manner that assures significant progress is made toward achieving Rangeland Health Standards for upland vegetation and riparian plant communities, watershed function, and habitat quality for animal populations, as well as other site-specific or landscape-level objectives (discussed below), including those necessary to protect and manage Threatened, Endangered, and Sensitive Species (H-4700-1, 4.1.5). Wild horse herd health is promoted by achieving and maintaining a thriving natural ecological balance.

1.4 Land Use Plan Conformance

The Proposed Action and all action alternatives are tiered to the goals, objectives, and management directions set forth in the SEORMP/FEIS (2001, Chapter 3 242-246). They are also in conformance with decisions made in the SEORMP/ROD (2002, 55-57. Objectives identified for wild horse herds in these documents include (1) maintaining and managing HMAs at AMLs to ensure a thriving natural ecological balance between wild horse populations, wildlife, livestock, vegetation resources, and other resource values, and (2) enhancing and perpetuating special and unique characteristics that distinguish the herd.

1.5 Relationship to Laws, Regulations, and Other Plans

The Proposed Action and all action alternatives have been designed to conform to State, Tribal, Federal and local land use plans, regulations, consultation requirements, and other authorities, which direct and provide the framework and official guidance for management of BLM lands within the Vale District:

- Wild Free-Roaming Horses and Burros Act of 1971 (Public Law 92-195) as amended.
- Wild Free-Roaming Horse and Burro Management (43 Code of Federal Regulations [CFR] 4700).
- BLM Wild Horses and Burros Management Handbook, H-4700-1 (June, 2010).
- National Environmental Policy Act (NEPA) (42 U.S.C. 4321-4347, 1970).
- BLM NEPA Handbook, H-1790-1 (January, 2008).

- Federal Land Policy and Management Act (FLPMA) (43 U.S.C. 1701, 1976), Section 302(b) of FLPMA, states "all public lands are to be managed so as to prevent unnecessary or undue degradation of the lands."
- Public Rangelands Improvement Act (43 U.S.C. 1901. 1978).
- Standards for Rangeland Health and Guidelines (S&Gs) for Livestock Grazing Management for Public Lands Administered by the BLM in the States of Oregon and Washington (1997).
- Greater Sage-grouse and Sagebrush-steppe Ecosystems Management Guidelines BLM (2001).
- BLM National Sage-grouse Habitat Conservation Strategy (2004).
- Greater Sage-grouse Conservation Assessment and Strategy for Oregon (Hagen, 2011).
- Oregon Greater Sage-Grouse Approved Resource Management Plan Amendment and Record of Decision (September, 2015a)
- Revised Integrated Invasive Plant Management for the Vale District (DOI-BLM-ORWA-V000-2011-047-EA), 2016.
- Vegetation Treatment Using Aminopyralid, Fluroxypyr, and Rimsulfuron Programmatic Final Environmental Impact Statement (2016).
- Vegetation Treatment Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Final Environmental Impact Statement (2010) and Record of Decision (2010).
- Oregon Department of Environmental Quality (ODEQ) Laws and Regulations
- State, local, and Tribal laws, regulations, and land use plans
- All other Federal laws that are relevant to this document, even if not specifically identified

1.6 Decision to be Made

The BLM Authorized Officer will decide whether or not to gather and remove excess wild horses, implement fertility control measures and what method(s) to use for each. The decision would affect wild horses within, and those that have strayed outside of, the Three Fingers HMA and Jackies Butte HMA. The BLM Authorized Officer's decision would not set or adjust AML nor would it adjust livestock use, as these were set through previous decisions.

1.7 Scoping and Identification of Issues

In keeping with Section 8.3.3 of BLM NEPA Handbook H-1790-1, Vale District evaluated the need for scoping on this EA. External scoping was conducted for the South Steens HMA Population Management Plan in 2013, the Cold Springs HMA Population Management Plan EA (USDI, 2015c), the Stinkingwater HMA Population Management Plan EA in 2017, and the Warm Springs HMA Population Management Plan in 2018. In those cases, scoping resulted in no new substantive issues being raised for the proposed actions. Because the Three Fingers and Jackies Butte Herd Management Areas Wild Horse Population Management Plan EA is a similar project, Vale BLM has determined that there is no need to conduct further external scoping.

1.8 Issues Considered but not Analyzed

Issues considered but not analyzed can be found in Appendix C.

2.0 PROPOSED ACTION AND ALTERNATIVES

This section of the EA describes the Proposed Action and reasonable alternatives, including alternatives that were considered but eliminated from detailed analysis. Reasonable alternatives are practical or feasible from the technical and economic standpoint and using common sense. The Proposed Action and alternatives represent a reasonable range to cover the full spectrum of alternatives which meet the purpose and need. Five alternatives are considered in detail.

- Alternative 1. Over a Ten Year Timeframe, Remove Excess Wild Horses and Implement Intensive Fertility Control Management (*Proposed Action*).
- Alternative 2. Same as Alternative 1 and Include a Non-reproducing Portion of the Population.
- Alternative 3. Alternative 1 *without* Gathers and Removals
- Alternative 4. Gate Cut Removal
- Alternative 5. No Action – Defer Gather and Removal

All Action Alternatives (1 through 4) were developed to respond to the identified resource issues and the Purpose and Need to differing degrees. Alternative 5, No Action, would not achieve the identified Purpose and Need. However, it is analyzed in this EA to provide a basis for comparison with all Action Alternatives, and to assess the effects of not conducting a gather. Alternative 5, the No Action Alternative, does not conform to the WFRHBA which requires the BLM to immediately remove excess wild horses.

2.1 Management Actions Common to Alternatives 1-4

2.1.1 Project Design Features

The following design features would be used for all action alternatives (1-4).

- Time frame for comparison of all action alternatives is 10 years. Implementation would begin in 2022 and would continue over the next 10 years unless environmental conditions change enough to require analysis of additional management actions.
- Helicopter drive gather and remove operations in Three Fingers HMA would take approximately 7 days to complete. Helicopter drive gather and removal operations in Jackies Butte HMA would take approximately 3 days to complete. Several factors such as animal condition, herd health, weather conditions, or other considerations could result in operations requiring more or less time.
- Helicopter gather operations would be scheduled any time between July 1st through February 28th in any year and would be conducted under contract.
- Trap sites would be selected within the pastures and areas where horses are known to be frequently located, to the greatest extent possible.
- Trap sites and temporary holding facilities, made of portable panels, would be located in previously used sites or other disturbed areas whenever possible. These areas would be seeded with a seed mix appropriate to the specific site if bare soil exceeds more than ten square yards per location.
- Undisturbed areas identified as trap sites or holding facilities would be inventoried, prior to being used, for cultural, wildlife, and botanical resources. If cultural, wildlife, or

botanical resources are encountered, these locations would not be utilized unless the trap location could be modified to avoid effects to the resources present.

- Trap sites and temporary holding facilities would be surveyed for noxious weeds prior to gather activities. Any weeds found would be treated using the most appropriate methods. All gather activity sites would be monitored for at least 2 years post-gather. Any weeds found would be treated using the most appropriate methods, as outlined in the 2016 Vale District Weed Management EA, or subsequent documents.
- All vehicles and equipment used during gather operations would be cleaned before and following implementation to guard against spreading of noxious weeds.
- Efforts would be made to keep trap and holding locations away from areas with noxious weed infestations.
- Gather sites would be noted and reported to range and weed personnel for monitoring and/or treatment of new and existing infestations.
- Maintenance may be conducted along roads accessing trap sites and holding facilities prior to the start of gather operations to ensure safe passage for vehicles hauling equipment and horses to and from these sites. Any gravel required for road maintenance is to be certified weed-free gravel. Road maintenance would be done in accordance with Vale District road maintenance policy.
- Gather and trapping operations would be conducted in accordance with the SOPs described in the Wild Horse and Burro Comprehensive Animal Welfare Program (CAWP) (refer to Appendix D for PIM No. 2021-002; Attachment 1) which was created to establish policy and procedures to enable safe, efficient, and successful wild horse gather operations while ensuring humane care and treatment of all animals gathered (Appendix D).
- An Animal and Plant Health Inspection Service (APHIS) veterinarian would be onsite during helicopter drive gathers, as needed, to examine animals and make recommendations to BLM for care and treatment of the wild horses.
- Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy (Washington Office (WO) Permanent Instruction Memorandum (IM) 2021-007, Euthanasia of Wild Horses and Burros Related to Acts of Mercy, Health or Safety) (USDI, 2021).
- On all horses gathered (removed and returned), data including sex and age distribution would be recorded. Additional information such as color, condition class information (using the Henneke, 1983, rating system), size, individual identification, RFID chips implanted, disposition of the animal and other information may also be recorded.
- Excess animals would be transported to an off-range corral facility via semi-truck and trailer where they would be prepared (freeze marked, microchipped, vaccinated and dewormed) for adoption, sale (with limitations) or off-range pasture.
- Hair samples would be collected to assess genetic diversity of the herd, as outlined in WO IM 2009-062 (Wild Horse and Burro Genetic Baseline Sampling). Hair samples would be collected from a minimum of 25 percent of the post gather population.
- Public and Media Management during helicopter gather and bait trapping operations would be conducted in accordance with WO IM 2013-058 (Wild Horse and Burro Gather/s (WH&B): Public and Media Management). This IM establishes policy and procedures for safe and transparent visitation by the public and media at WH&B gather operations, while ensuring the humane treatment of wild horses and burros.

- Emergency gathers: BLM Manual 4720.22 defines emergency situations as an unexpected event that threatens the health and welfare of a wild horse or burro population, its habitat, wildlife habitat or rangeland resources and health. Emergency gathers may be necessary during this ten-year time frame for reasons including disease, fire, insect infestation, or other events of catastrophic and unanticipated natural events that affect forage and water availability for wild horses. Emergency gather operations would follow the project design elements described in this section.

2.1.2 Monitoring

The BLM Contracting Officer's Representative (COR) and Project Inspectors (PIs) assigned to the gather would be responsible for ensuring contract personnel abide by the contract specifications and the Gather SOPs outlined in the CAWP (Appendix D). (Applies to all action alternatives 1-4).

Ongoing monitoring of forage condition and utilization, water availability, aerial population surveys as required in WO IM 2010-057, Wild Horse and Burro Population Inventory and Estimation, and animal health would continue in the Three Fingers and Jackies Butte HMAs. (Applies to all alternatives).

Genetic monitoring would also continue following gathers and/or trapping. If the results of genetic monitoring indicate that levels of genetic diversity (as measured in terms of observed heterozygosity) become unacceptably low, the BLM would consider introduction of horses from HMAs in similar environments to maintain the projected genetic diversity, in keeping with suggestions from the BLM Wild Horse and Burro Herd Management handbook (BLM 2010-4700-1). (Applies to all action alternatives 1-4).

Fertility control monitoring would be conducted in accordance with the Population-level Fertility Control Treatments SOPs (Appendix E). (Applies to Alternatives 1 and 3).

2.2 Description of Alternatives Considered in Detail

2.2.1 Alternative 1. Proposed Action - Remove Excess Wild Horses and Implement Intensive Fertility Control Management

Alternative 1 is designed to manage wild horse populations with intensive, available, fertility control treatments over a ten-year time frame and with wild horse removals which would most likely include one to three gather operations in each of the HMAs. If agency funding and logistics allow for it, implementation of the Proposed Action fertility control would begin in 2022 and implementation of the gather portion of the Proposed Action would begin as soon as BLM's Washington D.C. Headquarters (HQ) gives authorization for a gather.

regardless of population size. All other project design features would be the same irrespective of the number of animals gathered and removed.

After the completion of any gather and fertility control operations during this ten year plan, at least seventy-five wild horses would remain in the Three Fingers HMA; of these, approximately 37 would be mares treated with fertility control vaccine and 38 would be studs. Similarly, at least seventy-five wild horses would remain in the Jackies Butte HMA after the completion of gather and fertility control operations; of these, approximately 37 would be mares treated with fertility control and 38 would be studs. Adjustments to the actual number of mares treated with fertility control and returned to the range would be made in response to the actual number of animals captured during a gather event.

Vale District has not been authorized for a normal scheduled gather in either HMA since 2011 so the immediate implementation of the Proposed Action would begin with initiating the remote field darting fertility control portion of the alternative if the opportunity arises. Currently the available fertility control vaccines to be used in this project include Zonastat-H, PZP-22, and GonaCon Equine. The number of mares treated annually would fluctuate depending on the number of mares darted or caught and/or identified for treatment, the type of fertility control vaccine being used and its effectiveness, and the population within the HMAs. Vaccination with immunocontraceptives is the primary fertility control method considered under this alternative. A limited number of mares could be treated with intrauterine devices (IUDs), but IUD application is not under consideration as the main method for planned fertility control application in these two HMAs at this time. Analysis of the effects of IUDs is included in this EA for comparison to the vaccines, including in Appendix G,

Bait, water, horseback, helicopter drive trapping could also be used to intensively apply available fertility control to reduce the population growth rates between gathers. Data sheets would be prepared and updated, and individual mare's previous records would be reviewed prior to any fertility control application activity. Mares would be individually marked and/or be individually recognizable without error. No mare would be treated unless she has been identified for treatment.

Vaccine primer inoculations would be administered to selected mares. Flexibility in determining which mares are selected for treatment is vital to the success of the fertility control program. Adjustments would be made if it is found that there is a severe physiological reaction by an individual mare (which would be unexpected). This information would be documented in the data. If timing or funding constraints arise such that a more limited number of vaccine doses can be administered, then a treatment priority would consider the existing band or herd composition, such thatmares would be prioritized for vaccination if it is known that they already had one or more offspring in the herd. However, it is not a requirement of the WFRHBA, the SEORMP/ROD (2002), this alternative, or any action alternative, that each mare in the herd give birth to a foal.

Application of fertility control would continue through 2032. If monitoring shows successful applications, no negative reactions and reduction in foaling rates, the fertility control treatments could continue beyond 2032 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 rate and extent of fertility control applications would also partially depend on annual funding, the presence of qualified fertility control applicators, and realized annual herd growth rates.

If a gather is authorized by BLM HQ, the proposed action would be to gather as close to 100% of the total wild horse population as possible and remove excess horses down to the low end of AML. As much of the herd as possible would be gathered in order to (1) select horses to return to the HMA to re-establish the low end of AML, (2) remove excess wild horses that would be prepared for the adoption and/or sale program, and (3) apply the initial or booster doses of fertility control treatment to the mares that will be returned to the HMA. This would mean if horses were gathered in both HMAs in the summer/fall of 2022, approximately 445 adult horses and 100 foals, roughly 90 percent of the estimated herd sizes based on current estimates, would be gathered using the helicopter-drive method. In that hypothetical example, approximately 345 excess wild horses would be removed from both of the HMAs, including those that have strayed outside the HMA boundaries, to re-establish the herd sizes at the low end of AML (75-150 animals, in each HMA). For gathers and removals authorized for only a portion of either HMA, the numbers would be adjusted according to the number of horses present. For future helicopter gathers under this 10-year plan, the number of horses to be gathered and the number of excess horses removed would be adjusted based upon the estimated herd size at the time of the gather.

Each helicopter gather would take approximately one week or less. BLM would plan to gather as soon as holding space and funding become available and BLM's HQ gives authorization. The gather would be initiated following public notice on the BLM Press Releases webpage https://www.blm.gov/news/oregon-washington. No horses found outside of the HMA would be returned to the range.

Bait, water, horseback, and helicopter drive trapping would be used as tools to remove excess horses in areas where concentrations of wild horses are detrimental to habitat conditions or other resources within the HMAs, to remove wild horses from private lands or public lands outside the HMA boundaries, to selectively remove a portion of excess horses for placement into the adoption program, or to capture, treat, and release horses for application of different types of fertility control including field darting. Bait, water, horseback, or helicopter drive trapping would be conducted as needed between normal helicopter drive gather cycles. Bait, water trapping, horseback, and helicopter drive trapping operations could take anywhere from one week to several months depending on the amount of animals to trap, weather conditions, or other considerations. Operations would be conducted either by contract or BLM personnel.

Site-specific removal criteria were never set for the HMAs, therefore, animals removed from the HMAs would be chosen based on a selective removal strategy set forth in BLM Manual Section 4720.33. Wild horses would be removed in the following order: (1) First Priority: Age Class – Four Years and Younger; (2) Second Priority: Age Class – Eleven to Nineteen Years; (3) Third Priority: Age Class Five to Ten Years; and (4) Fourth Priority: Age Class Twenty Years and Older should not be permanently removed from the HMA unless specific exceptions prevent them from being turned back to the range. In general, this age group can survive in the HMAs, but may have relatively lower fecundity on the range and greater difficulty adapting to captivity and the stress of handling and shipping if removed. BLM Manual Section 4720.33 further specifies some animals that should be removed irrespective of their age class. These animals include, but are not limited to, nuisance animals and animals residing outside the HMAs or in an area of an inactive HA. One exception to these selective removal criteria would be the release of existing wild geldings back to the HMAs. If recaptured during future gather operations, any wild geldings would be returned to the range regardless of age.

Captured wild horses would be released back into the HMAs under the following criteria.

- If a gather/removal is conducted, released horses would be selected to maintain a diverse age structure of horses at low AML and approximately a 50/50 sex ratio.
- Released horses would be selected to maintain herd characteristics identified for each HMA.
- Post-gather, every effort would be made to disperse released horses evenly throughout the HMAs.
- If a gather/removal is conducted, mares ages two or older, would be selected to be returned to the HMA after receiving fertility control treatment. GonaCon-Equine vaccine is the primary form of immunocontraception that Vale BLM is currently using in the field. The specific type and method of fertility control treatment may be be adjusted as advancements are made with available fertility control treatments and methods. All fertility control treatments would be administered in a manner consistent with guidelines and protocols set forth in IM No. 2009-090, Population-Level Fertility Control Field Trials: Herd Management Area (HMA) Selection, Vaccine Application, Monitoring and Reporting Requirements (but in keeping with guidelines for application of GonaCon-Equine).

During the 10-year timeframe of the Proposed Action, BLM anticipates that there may be the need for one to two future gathers, 4 to 5 years following the initial proposed gather, over a period of the next ten years, following the date on the Decision Record for this document. This ten-year timeframe enables BLM to refer to the results of future monitoring, to determine the effectiveness of the proposed action at successfully maintaining population levels within AML in the Three Fingers and Jackies Butte HMAs. During the ten-year time frame helicopter gathers would be carried out under the same (or updated) (Standard Operating Procedures (SOP) as Appendix D and the same selective removal criteria, population control measures, release criteria and sex ratio adjustment strategies would be applied as described in the section above.

Adaptive management would be employed that incorporates the use of the most promising methods of fertility control; for example: a fertility control vaccine would be used in the initial gather but may be substituted as advancements are made with safe but more effective and longer lasting fertility control treatments and methods. If IUDs are used, their use would follow SOPs (Appendix E). If a new vaccine type became available during the 10-year timeframe of this analysis, adequate NEPA would be completed to determine its use. Future determinations that "excess" horses exist within the next ten years in the HMAs, would be based on the results of future population surveys and would trigger future gather dates and target removal numbers for gathers. Unless immediate removal is required (e.g. from private land, for public safety, or due to an emergency situation), a notice to the public would be sent out 30 days prior to any future gather.

2.2.2 Alternative 2: Gather and Removal ***including*** a Non-reproducing Portion of the Population

Alternative 2 would follow the same gather/removal actions proposed in Alternative 1 (*Proposed Action*) with the additional inclusion of managing a component of the wild horse population of both the Three Fingers HMA and Jackies Butte HMAs as non-reproducing. This alternative would include an initial ~90% gather/removal of either HMA followed by the release into the HMA of selected returns of fertility control treated mares (as in Alternative 1), but also including a limited number of non-reproducing horses. If gather success allows for it, then the starting herd size after animals are returned to the range would be at the low end of AML (75). This EA does not propose creating entirely non-reproducing HMAs out either Three Fingers or Jackies Butte HMA, but it proposes including a component of the herd to be sterile horses, composed of no more than 50% of each herd. Including some sterile animals in the herd would be expected to reduce population growth rates for a longer duration and to a lower level than immunocontraceptives alone, and would extend the duration between gathers as a result. When at low AML, the herd population of the either HMA would be made up of approximately 75 wild horses with a minimum of 19 unsterilized mares and 19 unsterilized studs, and the remainder of the 37 horses being any combination of geldings or sterilized mares.

Ongoing management practices mean that it would not be problematic, from a population genetics point of view, to manage these relatively small herds in a way that includes a component of non-reproducing individuals. At the broader level of the herd, the potentially breeding animals in the herd are likely to produe enough foals to offset mortality. BLM recognizes that the wild horses in these two relatively small HMAs are not truly isolated populations; rather they are parts of larger metapopulation that includes multiple BLM-managed (and USFS-managed) wild horse herds in Oregon, and in other states. BLM will use the results of genetic monitoring to determine whether and when additional, fertile wild horses from other herds should be periodically introduced, to augment levels of observed heterozygosity and to reduce the risk of negative effects of inbreeding.

2.2.3 Alternative 3: Fertility Control Vaccines Only

Alternative 3 would follow the same intensive fertility control actions proposed in Alternative 1 (*Proposed Action*), but without removing any wild horses. The only action under this alternative that directly influences the size of the wild horse herds is to apply available fertility control vaccines.

2.2.4 Alternative 4: Gather and Removal Only

Alternative 4 would follow the same gather and removal actions proposed in Alternative 1 (*Proposed Action*), but without applying any fertility control treatments. The only action under this alternative that directly influences the size of the wild horse herds is to gather and remove excess horses.

2.2.5 Alternative 5: No Action – Defer Gather and Removal

Under Alternative 5, No Action Alternative, no gather would occur and no additional management actions would be undertaken to control the size or sex ratio of the wild horse population at this time. Estimates of the number of wild horses on the range indicate there will be over 280 adult horses within Three Fingers HMA and over 200 adult wild horses within Jackies Butte by summer 2022, with an increase of roughly 20% more per year expected over time. Within 4 years, wild horse numbers would be expected to increase to approximately 600 adult horses in Three Fingers HMA and approximately 425 adult wild horses in Jackies Butt HMA by fall 2026 under the no action alternative. Within 10 years, wild horse numbers could increase to approximately 3050 adult horses combined in the two HMAs by fall 2032 under the no action alternative, barring a catastrophic mortality event. Wild horses ranging outside the HMAs would remain in areas not designated for their management.

2.3 Alternatives Considered but Eliminated from Detailed Analysis

The reasons for not considering the following alternatives have all been discussed in previous EAs with HMAs that are similar to Three Fingers and Jackies Butte HMAs. For the discussions, refer to the Cold Springs HMA Population Management Plan (USDI, 2015c), Hog Creek Population Management Plan (USDI, 2017), and Barren Valley Complex Wild Horse Population Management Plan (USDI, 2020).

A) Closure of HMA to Livestock Use

B) Complete Removal of Wild Horses from the HMA

C) Removal of Wild Horses from the HMA Using Bait and Water Trapping Only

D) Gather by Horseback Only

E) Wild Horse Numbers Controlled by Natural Means

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 General Description

This section of the EA describes the current state of the environment which includes the effects of past actions. The following environmental consequences discussions describe all expected effects including direct, indirect and cumulative on resources from enacting the alternatives.

3.2 Description of Affected Resources/Issues

The Interdisciplinary Team (IDT) reviewed the elements of the human environment, as required by law, regulation, Executive Order, and policy, to determine if they would be affected by any of the alternatives. An IDT also reviewed and identified issues and resources affected by the alternatives. The results are summarized in Table 1.

Table 1: Supplemental Authorities and Other Elements Potentially Affected by Action

Supplemental Authorities			
ACECs	**YES**	**NO**	No ACECs present in Jackies Butte HMA. Honeycombs Research Natural Area and Owyhee Views ACEC in Three Fingers HMA. To prevent any impacts to ACECs, trap sites and temporary holding facilities would be located in previously disturbed areas. Use of trap sites or holding facilities outside existing areas of disturbance would not be located in areas with existing ACECs.
Air Quality	**YES**	**NO**	The planning area is outside a non-attainment area. Implementation of the Proposed Action would result in small and temporary areas of disturbance.
Cultural Resources	**YES**	**NO**	To prevent any impacts to cultural resources, trap sites and temporary holding facilities would be located in previously disturbed areas where a cultural specialist has determined disturbances not likely to affect known or undetected cultural resources. Cultural resource surveys would be conducted prior to using trap sites or holding facilities outside existing areas of disturbance.
Environmental Justice	**NO**	**NO**	Not present.
Fish Habitat	**NO**	**NO**	Not present.
Floodplains	**NO**	**NO**	Not present.
Forest and Rangelands	**YES**	**YES**	Discussed below.
Human Safety	**YES**	**NO**	Implementing the road closures identified in Section 2.2 would eliminate the impacts to human safety created by the proposed action.
Migratory Birds	**YES**	**YES**	Discussed below.
Native American Religious Concerns	**NO**	**NO**	There are no known Native American Religious Concerns regarding this project.
Noxious Weeds	**YES**	**NO**	To prevent the risk for spread, any noxious weeds or non-native invasive weeds would be avoided when establishing and accessing trap sites and holding facilities.
Prime or Unique Farmlands	**NO**	**NO**	Not present.
Riparian-Wetland Zones	**YES**	**YES**	Discussed below.
Special Status Species	**YES**	**YES**	Discussed below.
Water Quality	**YES**	**NO**	Locate trap sites and temporary holding facilities away from any riparian areas to avoid impacts to water quality.
Waste (Hazardous or Solid)	**NO**	**NO**	Not present.
Wilderness Characteristics	**NO**	**NO**	Not present.
Wild and Scenic Rivers	**NO**	**NO**	Not present.
Wilderness and Wilderness Study Area	**YES**	**NO**	No Wilderness Study Areas are located within Jackies Butte HMA. Wilderness Study Areas Wild Horse Basin and Honeycombs WSAs OR-034-047, 061, 067 and 068 are within the Three Fingers HMA. To prevent any impacts to wilderness characteristics, trap sites and temporary holding facilities would be located in previously disturbed areas. Use of trap sites or holding facilities outside existing areas of disturbance would not be located in areas with existing wilderness characteristics.

In addition to the critical elements listed in Table 1, the following resources may be affected by the Action Alternatives and/or the No Action Alternative. The existing situation (affected environment) relative to these resources is described below.

3.2.1 Wild Horses

Affected Environment

Three Fingers HMA

The Three Fingers HMA is comprised of the Wildhorse Basin Pasture/Board Corral Allotment and Riverside Pasture/Three Fingers Allotment. The topography of the HMA varies from isolated flats and slightly rolling hills to steep mountainous country. There are several high, steep ridges in the area with rims and rocky outcrops. The central portion of the Riverside pasture is made up of steep, highly dissected sediments referred to as the canyon lands. The southern portion of the Riverside pasture is made up of the Shadscale Flat area and surrounding ridges. Elevation varies from approximately 2,600 to 5,000 feet. Precipitation averages 8 inches at lower elevations to 10 inches at the highest elevations. Most of this precipitation comes during the winter and spring months in the form of snow, supplemented by localized thunderstorms during the summer months.

Appropriate Management Level is established at a population range of 75 - 150 wild horses. Forage is allocated for a maximum of 1800 animal unit months (AUMs) (SEORMP/ROD, 2002). Forage is allocated to ensure enough feed exists within the HMA to sustain high AML of 150 horses throughout the year. Inventory data show that horses have historically concentrated in areas near Wildhorse Basin and Shadscale Flat during the summer and fall. As the HMA approaches or goes over the high end of the AML, wild horses concentrate on the southernmost ridge in the Riverside Pasture throughout the spring and summer. During the winter and early spring, the horses can graze the canyon lands in both pastures if there is sufficient precipitation to provide seasonal surface water.

The summer 2022 estimated population of at least 280 or more adult wild horses is based on the number of animals seen (the ‘direct count’) during an aerial population survey completed in July 2019 (USDI, 2019). Direct counts are almost always underestimates of the true numbers of animals present in a surveyed area (Lubow and Ransom 2016), so the estimated herd size here should be considered a lower limit of actual herd size. As the herd is expected to grow by approximately another 57 horses in 2022, by late summer 2022 the population size is expected to be at least roughly 270 horses (adults and foals) over the AML lower limit.

In the early 1970’s, wild horses within the Three Fingers HMA were predominantly sorrel, bay, roan, black, pinto, dun, and brown. Most have saddle horse type conformation. Some of the horses in the HMA are probably descendants of army remount studs. Characteristics of the herds have remained the same since 1975. Adult horses in the HMA weigh an average of 950 to 1050 pounds and stand between 14.2 and 15.2 hands, with some stallions being slightly larger.

Baseline genetic diversity samples were taken in 2002 and again in 2011 (Cothran, 2012a). These samples indicate that genetic variability within the Three Fingers HMA is similar to the feral horse and domestic horse mean. Refer to Appendix F for detailed genetics information.

Jackies Butte HMA

The Jackies Butte HMA is comprised of the Dry Creek Native Pasture of the Jackies Butte Summer Allotment. The topography of the HMA is relatively flat to gently undulating. Elevation varies from approximately 3,800 to 4,650 feet, with Jackies Butte being the highest prominent landmark. Precipitation averages 8 inches at lower elevations to 10 inches. Most of this precipitation comes during the winter and spring months in the form of snow, supplemented by localized thunderstorms during the summer months. Approximately 75% of this HMA has burned multiple times in 13 of the last 27 years. Due to the multitude of wildfires that have occurred, there has been an invasion of annual grasses and weeds in the uplands.

Appropriate Management Level is established at a population range of 75-150 wild horses. Forage for wild horses is allocated for a maximum of 1800 AUMs (SEORMP/ROD, 2002). Inventory data show that horses have historically concentrated along Dry Creek throughout the spring, summer, and fall as water sources become scarce. The wild horses tend to concentrate their upland use on Jackies Butte.

The summer 2022 estimated population of at least 206 adult horses is based on the 'direct count' of animals seen during an aerial population survey completed in July 2019 (USDI, 2019). Because 'direct counts' are nearly always underestimates of true number of animals present in a surveyed area, this number should be considered a lower limit of actual herd size. As the herd is expected to grow by approximately another 41 horses in 2022, by late summer 2022 population in this HMA is expected to be roughly 172 horses (adults and foals) over the AML lower limit.

In the early 1970's, wild horses within the Jackies Butte HMA were varied in color and characteristics. All colors of horses were observed with a few appaloosa colored. Adult horses in the HMA weigh an average of 950 to 1150 pounds and stand between 14.2 and 15.2 hands, with some stallions being slightly larger.

Baseline genetic diversity samples were taken in 2000 and again in 2011 (Cothran, 2012b). These samples indicate that genetic variability within the Jackies Butte HMA is higher than the feral horse and domestic horse mean. Refer to Appendix F for detailed genetics information.

Affected Environment Common to both HMAs

The most common management actions that have occurred within the project area for wild horses have been horse gathers, which have taken place when monitoring data indicates that the maximum established AML number is exceeded. Depending on reproductive rates, results of rangeland monitoring data, funding, and management considerations, horses within the HMAs have typically been gathered and removed on a four- to five-year cycle (Tables 2 & 3). Aerial inventories are typically conducted every 2-3 years for each HMA on Vale District. Population estimates for both HMAs will be updated as inventories are conducted in the future. The tables below reflect the gather history for the Three Fingers and Jackies Butte HMAs, respectively.

Table 2: Three Fingers HMA - Gather History since 1974

Year	Captured	Removed	Released	Died/Euthanized
2016	155	154	0	1
2011	190	144	45	1
2006	180	180	0	2
2002	324	285	38	1
1996	124	111	13	0
1991	78	70	8	0
1983	95	95	0	3
1982	79	65	13	1
1978	340	340	0	0
1975	254	250	0	3
1974	2	2	0	0

Following the 2016 emergency gather, the estimated post-gather population in Three Fingers HMA was 80 adult wild horses. A population inventory was completed in 2019 for a total of 166 adult wild horses in the Three Fingers HMA. This equates to an estimated 27% annual population increase, which is within the range of values recorded in a recent metaanalsis of wild equid demographic rates (Ransom et al. 2016). The summer 2022 estimated population of >280 adult wild horses in the HMA is based on the raw count of wild horses seen during the aerial population survey completed in June 2019, and population projections using an average annual growth rate of approximately 20% per year since that time.

Table 3: Jackies Butte HMA - Gather History since 1976

Year	Captured	Removed	Released	Died/Euthanized
2012	84	77	0	7
2011	193	148	42	3
2007	148	122	26	0
2000	134	114	20	1
1994		68		
1991		78		
1988		79		
1983	186	186	0	0
1978	135	135	0	0
1976	136	134	0	2

Following the 2012 emergency gather and subsequent 2014 release, the estimated post-release population in Jackies Butte HMA was 75 wild horses. All of the mares released in 2014 were given PZP-22 fertility control vaccine. A population inventory was completed in July 2019, during which a raw count of 143 adult wild horses was observed in the HMA. These two values suggest that the average annual growth rate between the last gather and 2019 was approximately 14% per year. The summer 2022 estimated population of >180 adult wild horses is based on those estimates, and population projections since that time using a 20% approximate annual growth rate as the effects of the fertility control application have faded.

Within the Great Basin, drought conditions are common, and water is the main limiting factor within both HMAs. Precipitation averages 5 inches at lower elevations to 8 inches at the highest elevations. Most of this precipitation comes during the winter and spring months in the form of snow, supplemented by localized thunderstorms during the summer months. Extreme water scarcity does not happen each year but is an annual concern. The four essential habitat components (water, forage, cover, and space) for wild horse and burros "must be present within the HMA in sufficient amounts to sustain healthy wild horse and burro populations and healthy rangelands over the long term" (H-4700-1, p. 12, 2010). Escalating problems are defined as conditions that deteriorate over time (4700 Handbook, 4.7.7). The key indicator of an escalating problem is a decline in the amount of forage or water available for wild horse use, which result in negative impacts to animal condition and rangeland health. Causal factors are normally drought or animal numbers in excess of AML (4700 WHB Handbook, 4.7.1).

There are large areas of the Three Fingers HMA that remain ungrazed by both livestock and horses due to their distance from water sources. When adequate water is available, wild horses have been observed to be well dispersed across the HMA. With the severe drought the region has seen in recent years and the over-population of the herd, the wild horse use areas became more concentrated around the limited water sources that remained. This was the same for the use areas of livestock and native ungulates.

Limited resources and an overpopulation of wild horses can lead to competition for available resources with other users of the land (such as wildlife and permitted livestock, as summarized by Chambers et al. 2017 and Crist et al. 2019). McInnis and Vavra (1987) found at least 88 percent of the mean annual diets of horses and cattle consisted of grasses; therefore, there is potential for direct competition for forage. However, dietary overlap is not sufficient evidence for exploitative competitions (Colwell and Futuyma 1971), and consequences of overlap partially depend upon availability of the resource (McInnis and Vavra 1987). Site observations indicate wild horses will typically use range farther from water than cattle and that adequate forage remains available in the major wild horse use areas. Miller (1983) found that wild horses generally stay within 4.8 km (2.98 miles) of a water source during the summer, while Pellegrini (1971) found wild horses will roam up to seven miles from water before returning, and Hampson et al. (2010) found that horses may move back and forth 10 miles per day between forage and water. Green and Green (1977) found wild horses range from three to seven miles from a water source, but the distance is related to forage availability. When water and forage are available together the range will be smaller, and when they are not available together wild horses concentrate in areas of ample forage and travel further distances to water (Green and Green 1977, as cited in Miller 1983). Nevertheless, horses can only travel so far before their condition or the condition of their young is affected.

Research has also shown when wild horses have to share water sources with cattle and antelope, there can be direct competition (Miller 1983, Crist et a. 2019). When resources become scarce, whether due to drought or overpopulation, resource concentration can create an aggregation of animals where direct contact between competing species is more common, increasing the likelihood of interference behavior (Valeix et al. 2007, Atwood et al. 2011, Gooch et al. 2017). "Feral horses have been found to be typically dominant in their social interactions with native Great Basin ungulates, due to their large size… and often aggressive behavior (Gooch et al. 2017, Berger 1986)." Work by Perry et al. (2015) and Hall et al. (2016) confirms this. In a study of interactions with desert bighorn sheep (*Ovis canadensis nelsoni*), domestic horses were experimentally placed near water sources, which resulted in no direct aggression; however, the mere presence of horses resulted in a 76 percent decline in bighorn use of water holes at those locations (Ostermann-Kelm et al. 2008, Gooch et al. 2017). Gooch and others (2017) investigated the interference competition between pronghorn antelope and feral horses at water sources within the Great Basin, particularly the Sheldon National Wildlife Refuge (NWR). They found that nearly half of the pronghorn/horse interactions observed were negative and resulted in pronghorn being excluded from the water source as a result of horse activity (Gooch et al. 2017). Although they did not measure the consequences of these interactions on pronghorn antelope water consumption and fitness, since about 40 percent of interactions resulted in pronghorn antelope exclusion from water, these pronghorn/horse interactions are likely associated with some costs of fleeing (the cost of leaving the water source prematurely and the energy expended on departure; Frid and Dill, 2002) for pronghorn antelope (Gooch et al. 2017). These effects could have detrimental impacts on pronghorn fitness and population dynamics, particularly under adverse conditions when surface water availability is limited and monopolized by horses (Gooch et al. 2017).

With the current estimated wild horse populations in the HMAs, interference competition and the indirect consequences are more likely to occur and impact other species sharing the HMAs.
As the wild horse population continues to grow well above the AML, there is cause for concern regarding the potential for degradation of rangeland resources in typical home ranges surrounding the limited reliable water sources. Unlike managed livestock grazing, wild horse grazing occurs year-round. If there are ample, well distributed resources then there is little to no concern for resource degradation. However, when resources are limited and habitat use is concentrated into a small number of areas, desirable key forage species receive heavier levels of use during the growing season. This type of use is acceptable if it occurs only on a periodic basis, but not throughout the year. Repetitive use during the growing season that prevents key forage species from completing their growth and reproductive cycles tends to reduce plant vigor as carbohydrate reserves are spent on regrowth, as opposed to seed production. Maintaining the herd sizes of wild horses within AML would decrease this concern.

Herbaceous forage utilization monitoring documents heavy (61-80%) to severe (>81%) utilization levels in portions of the Three Fingers HMA experiencing concentrated wild horse use. Use in Jackies Butte HMA is not quite as severe yet as horse numbers have recently been within AML until this year, but with continued increase there will heavy and severe utilizations starting to occur.

Environmental Consequences – Wild Horses

The cumulative effect analysis areas (CEAA) for wild horses are the HMA boundaries for all action alternatives (Alternatives 1 – 4) as they aim to maintain wild horse populations within AML which should provide adequate resources for the horses within the HMAs. The No Action Alternative would have a CEAA for wild horses of an estimated ten miles outside the HMA boundaries in all directions. This area was chosen because the AMLs are currently exceeded. If no action is taken to maintain populations within AML, that often causes horses to drift outside of an HMA as resources inside the HMA become limited.

Impacts Common to Action Alternatives (1, 2, and 4)
For over 40 years, various impacts to wild horses as a result of gather activities have been observed. Under the actions proposing gathers, effects to wild horses would be both direct and indirect, occurring to both individual horses and the population as a whole.

In any given BLM-administered gather, gather-related mortality averages about 0.5 percent (Government Accountability Office, GAO-09-77, Scasta 2019), which is considered very low compared to the acute mortality rates that other agencies and researchers cause when trapping and handling wild animals (Scasta 2019). An average of about 0.7 percent of the captured animals are humanely euthanized in accordance with BLM policy IM 2021-007 (USDI, 2021) due to pre-existing conditions (Government Accountability Office, GAO-09-77, Scasta 2019). These data affirm that use of helicopters and motorized vehicles has proven to be a safe, humane, effective, and practical means for the gather and removal of excess wild horses (and burros) from public lands. BLM Manual 4720.41 prohibits the capture of wild horses by using a helicopter during the foaling period (generally March 1 to June 30), which is defined as 6 weeks on either side of the expected peak foaling period. However, IM 2015-152 (USDI, 2015d) allows for the use of helicopter gathers during peak foaling season due to emergency conditions and escalating problems.

The BLM has been conducting wild horse gathers since the mid-1970s. During this time, methods and procedures have been identified and refined to minimize stress and impacts to wild horses during gather implementation. There is policy in place for gathers (both helicopter and bait/water) to enable efficient and successful gather operations while ensuring humane care and treatment of the animals gathered (PIM 2021-002, Appendix D). This policy includes standard operating procedures such as time of year and temperature ranges for helicopter gathers to reduce physical stress while being herded toward a trap; maximum distances to herd horses based on climatic conditions, topography and condition of horses; and handling procedures once the animals are in the trap.

Impacts due to gathers have been analyzed in many previous documents. To see this analysis refer to Cold Springs HMA Population Management Plan (USDI, 2015c), Hog Creek Population Management Plan (USDI, 2017), Barren Valley Complex Wild Horse Population Plan (USDI, 2020), and Appendix G.

<u>*Results of WinEquus Population Modeling*</u>
The WinEquus Wild Horse Population Model was designed for and used in this analysis for comparing fertility control and removal as management strategies. The fertility control portion of the model uses effectiveness results from applications of PZP in the field. This analysis was modified with the best available information for GonaCon in the predictions run for this document. Appendix H provides the comparison of alternatives resulting from the WinEquus Population Model. Population modeling using Version 1.4 of the WinEquus population model (Jenkins 2002) was completed to analyze possible differences that could occur to wild horse populations between alternatives. The purpose of the modeling was to analyze and compare effects of Action Alternatives on population size, average population growth rate, and average removal number. Table 3 summarizes the results. It is important to note that the model is not accurately capable of projecting the rusults of fertility control methods specified in that Alternative 2; however, it is generally expected that the numbers removed and treated under

Alternative 2 would be slightly less than under Alternative 1 due to a smaller breeding population.

Table 4 shows the results of population projections for Three Fingers and Jackies Butte HMAs separately, but the summary of analyses is the same. Under no alternative was the lowest projected growth rate below 2.9% in either HMA (i.e., populations were projected to continue to grow). Because the WinEquus model is not parameterized for field darting fertility control, it is likely that in actual application of Alternative 1 the numbers of animals treated would be slightly higher, average growth rate would be slightly lower (but still above zero), and number of animals removed would be lower than those calculated according to the WinEquus model. Alternative 1 resulted in the smallest population growth rates, with Alternative 1 having a population closer to AML in 11 years. Alternative 4 resulted in the most horses gathered and removed over a ten year timeframe. Alternatives 3 and 5 resulted in the least number of horses gathered as compared to the proposed action, but neither alternative keeps the population of the HMAs within AML. The minimum number of years for projections in the WinEquus program is 10 years. The 10 year projection gives results on growth rate (in 10 years) and population (gather needs) on year 11. The 10 year projection fits with the 10 year timeframe of this EA.

Table 4: Projected average population size after 11 years, agrowth rates, number of mares treated, and number of animals to be removed, based on population modeling with the WinEquus software (Jenkins 1996; Appendix H).

Alternative				
Three Fingers Alt. 1: Proposed Action	146	12.5	58	284
Three Fingers Alt. 3: Proposed Action without gather – fertility control only	805	17.4	963	0
Three Fingers Alt. 4: Gather and Removal Only	138	17.5	0	328
Three Fingers Alt. 5: No Action	767	17.1	0	NA
Jackies Butte Alt. 1: Proposed Action	129	9.9	660	186
Jackies Butte Alt. 3: Proposed Action without gather – fertility control only	546	16.9	70	0
Jackies Butte Alt. 4: Gather and Removal Only	129	17.3	0	285
Jackies Butte Alt. 5: No Action	547	16.8	NA	NA

This modeling was used to identify if any of the alternatives would eliminate the population or cause numbers or growth rates to reach a point where there was no new recruitment to the population. Modeling data indicate that population levels would continue to be above low AML, and growth rates would not approach zero, such that any adverse effects to the population would be unlikely.

Impacts of Alternative 1 (Removal and Intensive Fertility Control)

Alternative 1 would result in the wild horse herds on the two HMAs to remain within AML levels, which is expected to foster a thriving natural ecological balance on those lands.

Maintaining horse herd levels at densities that are proportionate to available natural resources is an important element of the SEORMP ROD (2002). The effects of climate change may include prolonged and more frequent drought conditions and maintaining wild horse herds at levels within AML should help BLM managers to ensure that adequate water and forage resources are available for the wild horses living on these HMAs, into the future.

Gathering every 4 to 5 years allows BLM to collect Deoxyribonucleic acid (DNA) samples, closely monitor the genetic diversity (observed heterozygosity) of the herd, and make appropriate changes when the results of monitoring indicate that would be necessary. For example, introducing new animals to the herd in the event that observed heterozygosity becomes undesirably low is a management action that could happen under this or any of the action alternatives. A consistent gather cycle also enables the maintenance and improvement of desirable physical traits within the herd.

BLMs Use of Contraception in Wild Horse Management
Fertility control vaccines (also known as (immunocontraceptives) meet BLM requirements for safety to mares and the environment (EPA 2009, 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. The BLM has begun to use soft, flexible, Y-shaped silicone intrauterine devices (IUDs) for mares in some other HMAs (see DOI-BLM-UT-W020-2020-0002-EA or DOI-BLM-WY-D040-2020-0005-EA). IUDs are not expected to be a main method of fertility control in these herds, but IUD use is analyzed in this EA for comparison.

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). 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 or closer (BLM 2010). Booster doses can be safely administered by hand or by dart.

Expanding the use of population growth suppression to slow population growth rates and reduce the number of animals removed from the range and sent to off-range pastures (ORPs) is a BLM priority. The WFRHBA of 1971 specifically provides for contraception and sterilization (section 3.b.1). No finding of excess animals is required for BLM to pursue contraception in wild horses or wild burros. Contraception has been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used with other techniques, to reduce horse population size (Bartholow 2004, de Seve and Boyles-Griffin 2013). All fertility control methods in wild animals 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 by itself does not remove excess horses from an HMA's population, so if a wild horse population is in excess of AML, then contraception alone would result in some continuing environmental effects of horse overpopulation. Successful contraception reduces future reproduction. Limiting future population increases of horses could limit increases in environmental damage from higher densities of horses than currently exist.

Successful contraception would be expected to reduce the frequency of horse gather activities on the environment, as well as wild horse management costs to taxpayers. Bartholow (2007) concluded that the application of 2 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. He also concluded that contraceptive treatment would likely reduce the number of horses that must be removed in total, with associated cost reductions in the number of adoptions and total holding costs. If applying contraception to horses requires capturing and handling horses, 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. Selectively applying contraception to older animals and returning them to the HMA could reduce long-term holding costs for such horses, which are difficult to adopt, and could reduce the compensatory reproduction that often follows removals (Kirkpatrick and Turner 1991). Although contraceptive treatments are associated with a number of potential physiological, behavioral, demographic, and genetic effects, detailed below and in Appendix G, those concerns 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). In principle, it is possible that mares treated repeatedly with fertility control vaccines may not return to fertility, becoming effectively sterile (Nuñez et al. 2017). For the purposes of this analysis, though, such long-lasting effects are not expected to be common and so vaccines will not be considered, generally, to cause a non-reproducing component of the herd in the same sense as purposeful sterilization considered under Alternative 2.

It is prudent for sterilized animals to be readily identifiable, either via freeze marks or in a record system that can identify horses by 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 the capture and animal welfare program (CAWP) to reduce the sources of handling stress in captured animals (BLM 2021). 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

Under the Proposed Action, the BLM would return to the HMA as needed to re-apply available fertility control vaccines/drugs, such as PZP and GonaCon-Equine, and initiate new treatments in order to maintain contraceptive effectiveness in controlling population growth rates. Once the population is at AML and population growth seems to be stabilized, BLM could use population planning software (PopEquus, currently in development by USGS Fort Collins Science Center) to determine the required frequency of re-treating mares with the available fertility control vaccine/drug.

The effects of PZP antigen vaccines, GnRH (GonaCon) vaccines, and IUDs have been previously discussed in other NEPA analyses for wild horse management; a literature review with a more complete discussion of those potential effects is also attached in Appendix G.

Population Management Impacts
Reducing and then maintaining wild horse numbers within AML during the ten-year time frame of the proposed action using available fertility control vaccines along with gathers when horses are found to be in excess of the high end of AML would reduce the risk of horses experiencing periods of diminished available forage and/or water (e.g. during drought). Having a plan in place allows BLM staff to monitor and take appropriate action when needed before an emergency situation arises. Using adaptive management that involves incorporating the use of the most promising methods of fertility control (as long as it is available for use) may allow BLM to extend the number of years between gather cycles while continuing to maintain numbers within AML and providing for a thriving natural ecological balance. Successful management of many species often relies on actions that involve intensive handling of individuals (Ashley and Holcombe 2001). Nevertheless, extending a gather cycle based upon a slowing of the population growth would reduce the frequency of stressful events, such as gathers.

The objectives set forth in the SEORMP ROD (2002) to maintain or improve riparian condition, upland health, forage and water resources, and wilderness characteristics would be most likely achieved under Alternative 1 (Proposed Action) because this alternative combines the best tools and actions to maintain wild horse populations within AML and therefore achieve a thriving natural ecological balance.

Impacts of Alternative 2 (Removal and Non-reproducing Portion of Population)
As with Alternative 1, Alternative 2 would result in the numbers of wild horses in each HMA being maintained within AML. This is expected to foster a thriving natural ecological balance and long-term maintenance of high-quality wild horse habitat, resulting in healthy wild horse individuals and herds. In including some non-reproducing animals in the herd, this alternative reflects a recommendation made in the WHB Handbook (BLM 2010). Section 4.5.3 states "During gather or herd management area planning, the authorized officer should consider a range of alternatives to reduce population growth rates and extend the gather cycle for all wild horse herds with annual growth rates greater than or equal to 5 percent. Alternatives may include but are not limited to: …..management of selected HMAs for non-reproducing wild horses."

Sterile wild horses (whether geldings or sterilized mares) would continue to have the legal protections of the WFRHBA, and it is not expected that sterilization would change their free-roaming behavior. Analysis of effects in this section of the EA is limited to an overview of the effects of neutering of males, and of the minimally invasive forms of mare sterilization.

Appendix G has a more complete literature review of the effects of these methods. In Appendix G, that review is also complemented with an analysis and literature review of surgical ovariectomy methods of mare sterilization, for comparative purposes. However, ovariectomy would not be used under this or any alternative considered here.

Effects of Sterilzation, Including Spaying and Gelding
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 sterilizing mares and gelding stallions. Sterilizing a female horse (mare) or burro (jenny) can be accomplished by several methods, some of which are surgical and others of which are non-surgical. The humane mare sterilization methods considered for use under this alternative would be limited to those that are minimally invasive, pharmacological, or immunocontraceptive, and would not include surgical removal of the ovaries. Here, 'neutering' is defined to be the sterilization of a male horse (stallion), 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. Gelding 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 – this may reduce female fertility rates (Garrott and Siniff 1992). 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 (other than the sterility itself), 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 (reviewed in Appendix G) details the expected impacts of sterilization methods on wild horses. No finding of excess animals is required for BLM to pursue sterilization in wild horses, but NEPA analysis has been required. 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 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-sustaining 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 (e.g., NAS 2013, Appendix F), and BLM routinely moves animals from one to another to improve local herd traits and maintain adequate 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. Over 70,000 adult wild horses and nearly 15,000 adult wild burros roamed BLM lands as of March 1, 2021, and those numbers do not include approximately 10,000 WH&B on US Forest Service lands, and at least 100,000 feral horses on tribal lands in the Western United States (Schoenecker et al. 2021).

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 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), mare sterilization and gelding alone would not be 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 sterilizing some mares or gelding some stallions 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.

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 or minimally-invasive mare sterilization, other than the direct consequence of becoming infertile.

Observations of the long-term outcomes of sterilization could be recorded during routine resource monitoring work, but use of sterilization in the Three Fingers HMA or Jackies Butte HMA would not necessarily be part of any scientific research. 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.

Gelding Males

Castration (the surgical removal of the testicles, also called gelding or gelding) is a surgical procedure for 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 have a relatively low complication rate. As noted in the review of scientific literature In Appendix G, 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 gelded males in a herd can lead to a reduced population-level per-capita growth rate if they cause a marginal decrease in female fertility (Garrott and Siniff 1992) or if the gelded males take some of the places that would otherwise be occupied by fertile females. Including gelded males in herd management would not be 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). However, BLM is not pursuing the chemical vasectomy method. The NAS panel noted that, even though chemical vasectomy had been used in dogs and cats up to that time, "There are no published reports on chemical vasectomy in horses..." and that, "Only surgical vasectomy has been studied in horses, so side effects of the chemical agent are unknown." The only known use of chemical vasectomy in horses was subsequently published by

Scully et al. (2015); this was part of a study cited in the EA (Collins and Kasbohm 2016). Scully et al. (2015) found that the method was not effective.

Collins and Kasbohm (2016) suggested that there was a reduced mare fertility rate due to inclusion of some sterile males, in a feral horse herd with both surgically sterilized mares and vasectomized horses. Unpublished USGS results from a study at Conger HMA indicate that a non-zero fraction of geldings that were returned to the range with their social band did continue to associate with fertile females, apparently excluding fertile stallions, for at least 2 years (King et al. 2020).

Direct Effects of Gelding

No animals which appear to be distressed, injured, or in poor health or condition would be selected for gelding. Stallions would not typically be gelded 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 gelding in the Antelope / Triple B gather EA, DOI-BLM-NV-E030-2017-010-EA).

Though gelding 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). 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). 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 Gelding

Other than the short-term outcomes of surgery, gelding 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). 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 than 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. The question of whether or not a given gelded 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. Gelding 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.

The effect of castration on aggression in horses has not often been quantified, though preliminary results from the Conger HMA suggest that the frequency of agonistic behaviors in recently-gelded males was not significantly different from that of fertile stallions (King et al. 2020). 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).

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, but preliminary results from the Conger HMA indicate that gelded wild horses had habitat use and movement patterns that were comparable to those of fertile stallions (King et al. 2020).

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. Unpublished USGS results from the Conger study herd indicate that geldings' movement patterns were not qualitatively different from those of fertile stallions, when controlling for social status as bachelor or harem stallion (King et al. 2020). 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).

There is further analysis of potential effects of male neutering in Appendix G.

Mare Sterilization

Herd-level birth rate (i.e., foals per female) is expected to decline in direct proportion to the fraction of sterilized mares in the herd because sterilized mares cannot become pregnant. Sterilizing 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

The mare sterilization methods whose effects are analyzed here are limited to minimally invasive physical sterilization, and pharmacological or immunocontraceptive sterilization. A more detailed analysis of mare sterilization, which includes inferences that can be made from analysis of surgical ovariectomy methods, is included in Appendix G. The anticipated effects of any mare sterilization method could be both physical and behavioral.

Physical effects of surgical methods would be due to post-treatment healing and the possibility for complications. Minimally invasive, physical sterilization would include any physical form of sterilization that does not involve extensive incision, or removal of the ovaries. 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). Another form involves using a laser to cause scarring of less than about 1 cm^2 at the uterotubal junctions. Treated mares would need to be screened by a veterinarian (i.e., via transrectal ultrasonography) 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. However, additional NEPA analysis would be required before such a method is used in the areas considered here.

Effects of Mare Sterilization on Pregnancy and Foal
The minimally invasive sterilization techniques noted above require a trans-cervical technique, so those mares would have been screened for pregnancy ahead of time, and no pregnant mares would be treated with those minimally-invasive sterilization methods. If a mare treated with those methods were to become pregnant (i.e., because scarring of the oviduct or oviduct papilla did not permanently block eggs from reaching the uterus) then it is expected that pregnancies and foal development would proceed normally throughout the duration of the pregnacy, because the ovaries would still be functional.

Direct Effects of Mare Sterilization
Minimally invasive sterilization methods are expected to have only minor and transient physical effects on treated mares, other than the blockage of the oviduct and prevention of pregnancy. In the case of the use of surgical grade cyanoacrylate use to cause oviduct occlusion, some scarring of the oviduct is the desired result, but that effect is localized and not anticipated to cause long-term discomfort. Similarly, laser ablation of the oviduct papilla is expected to cause scarring on a very small portion of uterine tissue (the papilla and a few square millimeters of tissue nearby), and to not cause long-term discomfort. The attending veterinarian would be responsible to provide appropriate analgesics for any animal treated, to alleviate short-term discomfort. Mortality due to either form of minimally-invasive sterilization method described here is not expected to take place.

Behavioral Effects of Mare Sterilization
Behavioral effects of mare sterilization can be inferred from studies in which mares were sterilized by other methods, and in which ovarian function continued despite contraception being effective. 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 sterilizing wild horse mares that live with other fertile and infertile wild horses has not been well documented, but the literature review summarized briefly here, and in more depth in Appendix G, provides evidence that 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 removal of the ovaries (Hart and Eckstein 1997). However, mares may continue to demonstrate estrus behavior during the anovulatory period (Asa et al. 1980). 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 ovariectomy usually greatly reduces female sexual behavior in companion animals (Hart and Eckstein 1997).

The likely effects of sterilization on mares' social interactions and group membership can be inferred from available literature, even though wild horses have rarely been sterilized and released back into the wild, resulting in relatively few studies that have investigated their behavior in free-roaming populations. Wild horses and burros are instinctually herdbound and this behavior is expected to continue. Overall, the BLM anticipates that some or all mares treated with miminally invasive sterilization would continue to exhibit estrus behavior, which could foster band cohesion. This outcome would be consistent with research that demonstrated continuing estrus behavior in ovariectomized mares, comparable to the leves seen in the anovulatory (non-breeding) season in intact mares (Asa et al. 1980). Insofar as minimally invasive mare sterilization techniques considered here would not remove the ovaries, it is likely that the the behavior of such treated mares may be comparable to the behavior of mares treated with PZP vaccine; that is, the continuation of estrus behavior at roughly 21 day cyclicity throughout the breeding season. As noted by the NAS (2013), the ideal fertility control method would not eliminate sexual behavior or change social structure substantially, and it appears that the various forms of mare sterilization noted here would most likely allow for the continuation of such behaviors. The complexity of social behaviors among free-roaming horses is not entirely centered on reproductive receptivity, and fertility control treatments that suppress fertility may not cause substantial 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 sterilizing 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 sterilized 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.

Because mares treated with minimally-invasive sterilization methods may accrue greater fat reserves than pregnant and nursing foals, they may attain higher body condition scores and survive longer – as has been observed in mares treated with immunocontraceptive vaccines. 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 sterilized mares.

The likely effects of sterilization 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 sterilized mares will change their spatial use patterns, but not having energetic 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). These results would be consistent with the conclusion that movement patterns and distances moved by sterile mares may be essentially unchanged.

Sterilizing wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether sterilized mares would continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that sterilized 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 sterilized 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 sterilizing wild horses will cause them to lose their free-roaming nature.
In this sense, a sterilized 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).

Sterilization 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). The long-term survival rate of sterile wild mares at the Sheldon NWR appeared 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.

There is further analysis of potential effects of mare sterilization in Appendix G.

Genetic Effects of Mare Sterilization and Gelding

It is true that sterilized females and gelded 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.

Under Alternative 2, the HMAs under consideration in this EA would retain at least half of each herd as potentially breeding. In reproducing herds with high levels of genetic diversity, which will be monitored for loss of genetic diversity, and into which additional animals can be introduced should there be indication of need, sterilizing some mares and / or gelding some stallions is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. 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 fertile animals every generation (about every 10 years) is a standard management technique that can alleviate potential inbreeding concerns (BLM 2010).
In these HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. 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. The starting level of genetic diversity in both Three Fingers HMA and Jackies Butte HMA was relatively high, and the fraction of sterile animals in this case would not be more than 50%. Roelle and Oyler-McCance (2015) concluded that nothing in their results indicate wild horse managers should steer away from permanent contraceptive techniques, as long as results are monitored, and adjustments are made if necessary. Vale BLM would be meeting WFRHBA, the WHB Handbook, and SEORMP and all other objectives by continuing to monitor the herd population and releasing horses to keep the numbers within AML.

Impacts of Alternative 3 (Fertility Control Vaccines Only)
Because wild horse population size would remain well over AML, there would be a higher density of wild horses across the HMAs, increasing competition for resources and habitat among horses, and with other species. By exceeding population size within the established AMLs, it would be expected to decrease forage quantity and quality and put wild horse health at risk. The overpopulation of wild horses would increase the potential for individual animals or the herd to be affected by climatic fluctuations causing drought and reductions in available forage. This would lead to an increased probability for the need for emergency gathers and decrease success of the herd over the long term.

The objectives set forth in the SEORMP ROD (2002) would become more difficult to achieve under this alternative as solely using fertility treatment to slow population growth in wild horses would take much longer than in Alternative 1. It is not expected to be logistically possible that a high enough fraction of the mares in the HMAs could be treated, with a great enough frequency, to cause the herd to decline. Even if efforts to vaccinate the majority of mares in the HMAs are somehow successful, the long lifespan of wild horses is expected to cause the population to continue to grow in proportion to the fraction of mares still breeding in any given year, and to not diminish to any great extent due to mortality for at least a 10-year duration (Appendix H). The impacts related to overpopulation would continue to occur, and would worsen over time, as the results from WinEquus indicates in 11 years there would be approximately 805 horses in the Three Fingers HMA and 546 horses in the Jackies Butte HMA. This means that although fertility control could slow reproduction rates, it would not be successful in causing herd sizes to attain or stay within AML. The effects on the animals' required habitat, and on their behaviors, would be expected to reflect a high degree of competition between individuals for limited resources. Horse herd sizes over AML can also be considered in light of expected effects of climate change. Severe drought conditions may worsen and become more frequent. High herd densities using limited water supplies could reasonably be expected to exacerbate behavioral conflict at water sources, and to cause even greater levels of habitat degradation because of excessive habitat use near those water sources.

Impacts of Alternative 4 (Gather and Removal Only)
Under this alternative, effects to wild horses and to the habitats they rely on would be comparable to the proposed action, with the exception of the use of fertility treatment. With no fertility treatment applied, wild horse numbers are expected to increase by approximately 20 percent annually (NAS 2013, Ransom et al. 2016). Therefore, if the post-gather population in 2022 is 75 horses (low AML) in either HMA, then within 4 years the expected herd size would

be approximately 150 animals. As predicted under the WinEquus model over an 11 year period approximately 45-60 additional horses would be removed from the range and put into the adoption and/or sale program or off-range pastures, as compared to Alternative 1. However, as mentioned in the section addressing the WinEquus analysis, this number would most likely be higher as the number of horses removed under Alternative 1 would most likely be lower than the model prediction.

Insofar as a higher number of animals is expected to be removed under Alternative 4 than under Alternative 1, it is expected that the loss of observed heterozygosity could occur at a greater rate under Alternative 4 (i.e., Gross 2000). An alternative that omits fertility control treatment as an action item has the potential to maintain higher levels of genetic diversity than an alternative that removes the same number of animals *and* uses some fertility treatment, because the number of breeding mares would be maximized following gathers as mares would not skip 1 to 2 years of breeding contribution to the genetic diversity of the population. As discussed in Alternative 1, any potential decline in the genetic diversity of the herd, when applying fertility control with removals, is an identified impact that can be managed and mitigated through consistent gathers with genetic monitoring and translocation of horses from other HMAs to boost genetic diversity, when necessary. This aspect of monitoring and managing genetic diversity would be the same as under Alternative 1.

The objectives set forth in the SEORMP ROD (2002) would become more difficult to achieve under this alternative as fertility treatment to slow population growth in wild horses would not be applied.

Impacts of Alternative 5 (No Action)
Based upon the apparent 20% annual growth rate observed in Three Fingers HMA, there are expected to be more than 280 adult horses in the HMA in 2022. Results from WinEquus using the no action alternative indicate that in 11 years there would be approximately 767 horses (over 500% greater than high AML) with a maximum of about 1,525 horses (over 1000% greater than high AML) in the HMA, unless thre is a catastrophic mortality event (e.g. NAS 2013). It would be expected that wild horses may roam more widely, occupying a larger area than the designated HMA acreage.

The lower apparent growth rate in Jackies Butte (14% between 2014 and 2019) was attributed to the PZP-22 applications given from 2012-2014 while the wild horses were being held in the corrals. It is expected that Jackies Butte HMA has more than 200 adult horses in the HMA in 2022. Results from WinEquus (Appendix H) using the no action alternative indicates in 11 years there would be approximately 547 (about 350% more than high AML) horses, with a maximum of approximately 1,110 horses (that would be about 800% higher than high AML) unless thre is a catastrophic mortality event. It would be expected that wild horses may roam more widely, occupying a larger area than the designated HMA acreage.

If horses are not gathered in either HMA, water would be an increasingly limiting factor for all uses (horses, wildlife, and livestock). To maintain a thriving natural ecological balance "an adequate year round quantity of water must be present within the HMA to sustain wild horse and burro numbers within AML" (4700 WHB Handbook). The Merck Veterinary Manual (Kahn

2005) states that “[w]ater requirements depend largely on environment, amount of work or physical activity being performed, nature of the feed and physiologic status of the horse.” The manual suggests the minimum daily water requirement is 0.4 gallon per 100 pounds of weight, with the average daily intake being closer to 0.65 gallon per 100 pounds. The manual also recognizes this would increase under specific conditions, such as sweat loss, increased activity, and lactation, with the increase being as much as 200%, up to 1.3 gallons per 100 pounds per day. Wild horses within the HMAs range from 950 to 1,250 pounds. Assuming an average weight of 1,100 pounds, horses within the HMAs require a minimum daily water intake of 4.2 gallons, with an average daily intake of 6.8 gallons, but the requirement may be as high as 13.65 gallons. This calculates out to a very minimum of about 510 gallons per day when either HMA is at the low end of the AML (75 animals) and using only the minimum amount of water, to anywhere from 1245 to 1625 gallons per day when either HMA is at the 2022 populations.

BLM has observed impacts from horses on riparian and upland use areas within both HMAs with current horse numbers. Taking no action on reducing horse numbers or applying fertility control would only exacerbate the problem. Not only would horses cause increasing levels of competition for forage and water with wildlife and livestock, but amongst themselves as well. Horses usually occupy home ranges (undefended, nonexclusive areas), however, when resources are limited, mutual avoidance occurs but can intensify into increased aggression for territory (defended, exclusive areas). In a wild horse behavior study in Grand Canyon, Berger (1976) summarized home ranges for all bands decreased in size in successive warm months, probably due to increased ambient temperature and drought, resulting in greater utilization of spring areas that led to increased interband confrontation and agonistic display. Miller and Denniston (1979) reported that even females participated along with male group mates when threatening another group of horses at water. Increased occurrences of aggressive activities, caused by a lack of necessary resources, and the consequent acute injuries or effects to the health and wellbeing of wild horses would not follow BLM’s objective of managing for a thriving natural ecological balance within an HMA. The co-occurring effects of climate change and high herd desnities over AML noted for Alternative 3 would also be expected under the no-action alternative, but to an even greater degree.

Non-achievement of the objectives in the 2002 SEORMP ROD, specifically the riparian, upland and forage and water resources objectives, would be realized more rapidly under the No Action Alternative as compared to the action Alternatives which aim to maintain wild horse populations within AML. If no action were taken to reduce the population size, initially there would be no effect to wild horses and forage/water availability. Livestock would be moved from the pasture if adequate forage/water was not available for wild horses present. However, as the population grew increased competition for forage, water and home ranges between wild horse bands would become apparent disrupting social behavior and increasing risk to herd health as forage quantity and quality becomes more limited.

3.2.2 Livestock Grazing Management

Affected Environment

The BLM allocated forage for livestock (AUMs[1]) use most recently, in the 2002 record of decision for the Southeastern Oregon Resource Management Plan (SEORMP). The allocation was carried forward from the Southern Malheur Rangeland Program Summary (January 1984), and will be revisited during activity planning associated with evaluation and assessment within Succor Creek and Jackies Butte Geographic Management Areas as described in the SEORMP.

Three Fingers HMA

The Three Fingers HMA is located within the Riverside pasture of the Three Fingers Allotment (#10503) and the Wildhorse Basin pasture of the Board Corrlas Allotment (# 10507). The Riverside pasture is 53,933 acres (39% of the allotment) and is the only pasture in the Three Fingers Allotment within the boundary of the Three Fingers HMA.The Three Fingers Allotment as a whole has been managed under a deferred grazing system with a yearround season of use with the exception of the Riverside pasture. There are five permittees that graze the Riverside pasture from March 1st to May 1st every year.

The Wildhorse Basin Pasture is 17,568 acres (29% of the allotment) and is the only pasture in the Board Corral Allotment in the Three Fingers HMA. Yearround use is authorized for Board Corrals Allotment. The grazing system in Wildhorse Basin Pasture is a three-year rotation of spring/early summer one year, summer/fall the next year, and late fall/winter the third year. There are two permittees authorized to graze livestock in Wildhorse Basin pasture.

Table 5 summarizes information about livestock grazing and its relationship to wild horse management within the Three Fingers HMA.

Table 5: Livestock Use Information

Allotment								
Three Fingers Riverside	122,506 PD* 23,033 Pvt 2,534 State	39.2%	48,112 PD 4,812 BOR 456 State	6	1,311 Cattle	3/1 – 10/31	9,981	2,098 Average 6,671 Minimum 10,157 Maximum
Board Corral Wildhorse Basin	55,675 PD* 1,725 Pvt 0 State	28%	14,207 PD 38 Pvt 3,073 BOR 249 water	5	335 Cattle 8 Horses	3/1-2/28	Cattle 4,077 Horses 105	306 Average 89 Minimum 612 Maximum

* PD means Public Domain and PVT means private lands.

[1] An AUM is the amount of forage needed to sustain one cow, five sheep, or five goats for one month.

Jackies Butte HMA

The Jackies Butte HMA is located within the Dry Creek Native pasture of the Jackies Butte Summer Allotment (#01101).

The Dry Creek Native pasture is 65,260 acres (29% of the allotment) and is the only pasture in the Jackies Butte HMA. There are a total of seven livestock operators authorized to graze cattle between April 1 and October 31. Jackies Butte Allotment as a whole has been grazed using a deferred rotation grazing system. The Jackies Butte Summer Allotment Management Plan (AMP) specifies that the three native pastures within the allotment are grazed on a three-year rotation with one pasture being deferred until after seed ripe of key grass species each year.

Table 6 summarizes information about livestock grazing and its relationship to wild horse management within the Jackies Butte HMA.

Table 6: Livestock Use Information

Allotment								
Jackies Butte Summer Dry Creek Native	208,536 PD* 21,803 Pvt 379 State	28.5%	65,218 PD 42 Pvt	7	1,977 Cattle	4/1 – 10/31	14,274	2,339 minimum 2,730 average 3,229 maximum

* PD means Public Domain and PVT means private lands.

Environmental Consequences – Livestock Grazing Management

Effects Common to All Alternatives

The current overpopulation of wild horses is continuing to contribute to areas of heavy vegetation utilization, trailing and trampling damage and is preventing the BLM from managing for rangeland health and a thriving natural ecological balance and multiple-use relationships on the public lands in the area.

Livestock grazing would be expected to continue to occur in a manner consistent with grazing permit terms and conditions. Utilization of the available vegetation (forage) would also be expected to continue at similar levels (up to 50%). In some years, this may result in livestock being removed from the area prior to utilizing all of their permitted AUMs.

Impacts Common to Action Alternatives (1, 2, and 4)

Direct impacts to livestock and management practices from activity associated with gathering, including disturbance resulting from moving horses with a helicopter, would be minimal.

Removal of horses to the lower end of AML within the HMA would reduce competition between livestock and wild horses for the available forage and water resources. This benefit would decrease as wild horse numbers increased until the next gather. Indirect impacts would include an increase in the quality and quantity of the available forage in the short-term. Over the longer-term, improved vegetation resources would lead to a thriving natural ecological condition.

Impacts of Alternative 1 (Removal and Intensive Fertility Control)
This alternative would result in a slower increase in wild horse population than with the other alternatives. This would allow wild horse use to remain within their allocated AUMs for a longer period of time, increasing the availability of forage for livestock up to their full permitted use dependent on annual rangeland conditions. The ability to continue gathers, as needed, over the next 10 years would decrease the risk of wild horse numbers interfering with the ability of livestock to utilize permitted AUMs while also maintaining an ecological balance by maintaining livestock and wild horse use at allocated levels.

Impacts of Alternative 2 (Removal and Non-reproducing Portion of Population)
Under this alternative, the effects would be similar as under Alternative 1. Under this alternative, by reducing the breeding population, wild horse numbers would increase at a slightly lower rate, resulting in the need for fewer gathers in the long term and fewer animals receiving fertility control treatments. This would result in keeping the wild horse populations within AML and would decrease the risk of wild horse numbers interfering with the ability of livestock to utilize permitted AUMs while also maintaining an ecological balance by maintaining livestock and wild horse use at allocated levels.

Impacts of Alternative 3 (Fertility Control Vaccines Only)
Under this alternative, the effects would be the similar to the No Action Alternative with the exception of slightly lower long-term wild horse populations. Under this alternative, without the initial gather, wild horse reproduction rates would be gradually decreased. As horse numbers naturally decreased through attrition, the grazing impacts due to wild horses would decrease, but would not attain AML in the next decade. This would increase the likelihood that livestock use may have to be reduced due to wild horse populations exceeding the high end of AML and the associated forage competition.

Impacts of Alternative 4 (Gather and Removal Only)
Under this alternative, the effects would initially be the same as the proposed action. Without the use of fertility control, the population would continue to increase by approximately 20% per year resulting in numbers above high AML in approximately 4-5 years from the initial gather. Under this alternative, without any fertility treatment, wild horse numbers would increase at a quicker rate, resulting in the need for more gathers in the long term or increasing the likelihood that livestock use may have to be reduced prior to future gathers due to wild horse populations exceeding the high end of AML and the associated forage competition.

Impacts of Alternative 5 (No Action)
Utilization of native perennial forage species by authorized livestock has been directly affected due to the current excess of wild horses above the AML. Wild horse numbers above the AML result in wild horses utilizing more AUMs than they were allocated in the 2002 SEORMP/ROD.

In order to meet annual utilization targets and allow for management that would meet or make progress towards Rangeland Health Standards in the future, permitted livestock grazing would continue to be reduced below full permitted use, as wild horse numbers continue to exceed AML. Apparent heavy to severe utilization is occurring in areas used by livestock, wild horses, and wildlife, specifically around water sources, as indicated by field observations. These areas are currently receiving heavy use even when livestock are not present. The indirect effects of the No Action (Defer Gather and Removal) Alternative would be continued damage to the range as would be seen in S&Gs not being achieved in the future, continued competition between livestock, wild horses, and wildlife for the available forage and water, reduced quantity and quality of forage and water, and undue hardship on the livestock operators who would continue to be unable to fully use the forage they are authorized.

3.2.3 Upland Vegetation

Affected Environment

Three Fingers HMA

Shrub steppe vegetation communities in the area result from cold winters and hot dry summers. Historically, the project area supported a wide variety of sagebrush/perennial grassland cover types. Disturbance factors such as wildfires, wild horse grazing use, historic domestic livestock grazing use, and invasive plants have converted large areas of shrub and perennial grass rangeland to annual grasses including cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae)*. Stands of bluebunch wheatgrass (*Pseudorogneria spicata*) occupy many north-facing slopes that have not been impacted by horses or fire. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) stands are common, generally associated with bluebunch wheatgrass, Thurber's needlegrass (*Stipa thurburiana*), Indian rice grass (*Achnatherum hymenoides*), needle and thread (*Stipa comata*), basin wildrye *(Leymus cinereus*), bottlebrush squirreltail (*Elymus elymoides*), and Sandberg bluegrass (*Poa secunda*). Pockets of low sagebrush (*Artemisia arbuscula*), primarily associated with Sandberg bluegrass and bluebunch wheatgrass are common on ridgetops along the fence route. Both gray rabbitbrush (*Ericameria nauseosa*) and green rabbitbrush (*Chrysothamnus viscidiflorus*) are scattered throughout the area. Broom snakeweed (*Guterrizea sarothrae*) is ubiquitous. Forbs on areas in mid to late seral conditions include, but are not limited to, hermit milkvetch (*Astragalus erimiticus*), Pursh's milkvetch (*Astragalus purshii*), Hood's phlox (*Phlox hoodii*), arrowleaf balsamroot (*Balsamorhiza sagitatta*), and showy penstemon (*Penstemon speciosus*). A number of volcanic ash pockets occur in and near the proposed project location. Associated with these unusual soils are bare-stemmed buckwheat (*Eriogonum novonudum*), yellow phacelia (*Phacelia lutea*), and an annual atriplex (*Atriplex* sp).

A variety of noxious weeds and invasive annual plants of varying significance are scattered throughout Steamboat Ridge/Leslie Gulch area. As mentioned above, disturbed areas support extensive blocks of annual non-native grasses. Invasive non-native annual forbs including clasping pepperweed (*Lepidium perfoliatum*), blue mustard (*Chorispora tenella*), tumble mustard (*Sisymbrium* ssp.), Russian thistle (*Salsola iberica*) and kochia (*Kochia scoparia*) are common. Halogeton (*Halogeton glomeratus*) is becoming established in the Shadscale Flat area just north of the proposed project. Scotch thistle (*Onopordum acanthium*), bull thistle (*Cirsium vulgare*) and Canada thistle (*Cirsium arvense*) are scattered about the Steamboat Ridge/Leslie Gulch area as well.

Several noxious, perennial weeds can be found in isolated patches at or within a ten mile radius of the project area. They consist of: Whitetop, or hoary cress, (*Lepidium ssp.),* saltcedar (*Tamarix ramossissima*), perennial pepperweed (*Lepidium latifolium*), Russian knapweed (*Acroptilon repens*), rush skeletonweed (*Chondrilla juncea),* dalmation toadflax (*Linaria genistifolia ssp. dalmatica*), diffuse knapweed (*Centaurea diffusa*), and yellow starthistle (*Centaurea solstitialis*). These noxious species are a particularly serious threat to the area because (1) they are easily moved about by various means including wind, water, human activities, livestock, wildlife, and wild horses and (2) they are often very difficult to kill in rangeland situations, and (3) they may entirely replace native plants including special status species.

Jackies Butte HMA

Similar conditions exist in this HMA as in Three Fingers HMA. But wildfire has been a regular occurrence over the past thirty five years converting large areas of shrub and perennial grass rangeland to cheatgrass (*Bromus tectorum*) and in some areas crested wheatgrass (*Agropyron cristatum)* as a result of seeding post fire. Outside of seedings and cheatgrass, the current vegetation in the HMA primarily consists of Wyoming big sagebrush (*Artemisia tridentate ssp. wyomingensis*), Sandberg bluegrass (*Poa sandbergii*), bluebunch wheatgrass (*Pseudorogneria spictata*), and Thurber's needlegrass (*Stipa thurberiana*).

Portions of Jackie's Butte area are infested with a conglomerate of mostly annual weeds or weedy species. Following the Long Draw Fire, rush skeletonweed *(Chondrilla juncea)* was discovered in the Caviatta Ridge area. In the years since the fire, rush skeletonweed and Scotch thistle have expanded in the area. The area's other more invasive noxious weeds are mostly confined to strips along vehicle travel routes. Perennial pepperweed (*Lepidium latifolium*), whitetop (*Lepidium spp.),* Russian knapweed (*Acroptilon repens*) and Scotch thistle (*Onapordum acanthium*) are known to occur within the area outside of Caviatta Ridge.

In both HMAs, areas where wild horses and livestock congregate, as well as trailing routes, are heavily utilized with some areas having all vegetation removed. Annual grasses are an issue within both HMAs. The five year average wild horse utilization is slightly less than 50%, which is the high end of moderate use, in their preferred areas. Desired perennials weakened by overgrazing allow cheatgrass and medusahead to increase. Cheatgrass is becoming more predominant in both HMAs, especially along horse trailing routes and waterholes. As grazing pressure increases, so will cheatgrass. In the Three Fingers HMA where medusahead is present, it readily moves into cheatgrass stands and becomes the dominant grass. While livestock will commonly eat cheatgrass, medusahead is much less palatable and seldom foraged.

High wild horse utilizations may contribute to conversion of native plant communities to invasive annual grass monocultures that serve little to no purpose on the landscape.

Environmental Consequences – Upland Vegetation

Impacts Common to Action Alternatives (1, 2, and 4)
Due to the hoof action and vehicle use around trap sites, upland vegetation is often trampled and/or uprooted. Because of these effects, trap sites would be located in areas previously used or those which have been disturbed in the past. The trap sites would be approximately 0.5 acres in size which would have a minimal effect on upland vegetation in the HMA. However, keeping gather sites in previously used areas or areas previously disturbed would minimize or reduce potential new effects to upland vegetation since vegetation will already have been impacted.

Reducing wild horse numbers to AML would reduce the potential for heavy, annual utilization levels in wild horse use areas. Reductions in horse numbers would result in decreased demand for forage thus providing opportunity for some plants in use areas to have a full growing season of no use to restore vigor and complete a reproductive cycle. Removal of excess horses would allow native vegetation to improve in areas where they have received continuous moderate to heavy growing season use. Annual utilization of herbaceous plants during the growing season is widely known to reduce plant vigor, reproduction and productivity.

Impacts of Alternative 1 (Removal and Intensive Fertility Control)
Applying the fertility vaccine would slow down the reproductive rate reducing the grazing pressure over a longer period of time, disperse wild horse use areas and give native vegetation a greater stronghold. Healthy, diverse and productive plant communities promote improved resiliency, reducing the threat of noxious and invasive weed establishment and spread.

Impacts of Alternative 2 (Removal and Non-reproducing Portion of Population)
The environmental consequences on upland vegetation would be similar to Alternative 1 although the growth rate would not slow down as much as in Alternative 1 due to less aggressive fertility control applications. Vegetation would be impacted by increased horse numbers sooner which would decrease native vegetative recovery rates post gather.

Impacts of Alternative 3 (Fertility Control Vaccines Only)
The environmental consequences on upland vegetation would be similar to the No Action Alternative with the exception of slowing down the growth rate slightly as a result of applying fertility treatment. Over time the numbers would slightly decrease as compared to the No Action Alternative, but not significantly enough to reach AML.

Impacts of Alternative 4 (Gather and Removal Only)
The environmental consequences on upland vegetation would be the same as Alternative 1 as long as a regular gather cycle would be followed. However, if a regular gather cycle is not followed, increases in horse numbers would adversely affect upland vegetation with impacts resembling current conditions.

Impacts of Alternative 5 (No Action)
Under the No Action Alternative, wild horses in excess of the AML would not be removed. The increased number of horses on the range would increase the amount of utilization and decrease the amount of available forage. Rangeland Health Standards would not be achieved with the continued increase in the wild horse population. Consistent overutilization in wild horse use areas could lead to Rangeland Health Standards not being achieved in the future. If native,

perennial vegetation is degraded, the potential for the continued expansion of annual grasses would occur. Currently there are large acres of medusahead known to exist in the Three Fingers HMA. Plant communities consisting of tall tussock perennial grasses are critical in preventing medusahead invasion and increasing tall tussock perennial grass density would reduce the susceptibility of a site to medusahead invasion (Davies, 2008).

No action to maintain the wild horse population within AML is expected to reduce the vigor and resiliency of perennial grasses in the HMA as utilization levels increase, therefore increasing the potential for annual grass invasion ande expansion. Annual grass communities lack the plant community structure, root occupancy of the soil profile, ability to provide the amount and distribution of plant litter that native perennial communities provide. Annual grass communities, as compared to the potential and capability of native perennial communities, lack the ability to protect the soil surface from raindrop impact; do not provide detention of overland flow; and do not provide maintenance of infiltration and permeability, and protect the soil surface form erosion (Rangeland Health Standards, 1997). Under this alternative, increases in annual grasses would occur and the condition of the range would deteriorate. The loss of native vegetation would lead to soil loss due to exposure to wind and water erosion and would expose previously uninfested areas to noxious and invasive weeds. Increases in erosion directly influence the potential to achieve Rangeland Health Standards 1 – Uplands and 3 – Ecological Processes.

3.2.4 Special Status Species and Habitat

Affected Environment

Three Fingers HMA

No federally listed threatened or endangered species are known or suspected to occur within the HMA.

Six Bureau sensitive plant species are known to occur in the HMA. These include Ertters senecio (*Senecio ertterae*), Mentzelia packardiae (*Packard's mentzelia*), Owyhee clover (*Trifolium owyheense*), Hooker's buckwheat (*Eriogonum hookeri*), sterile milkvetch (*Astragalus cusickii* var. *sterilis*), and Grimy ivesia (*Ivesia rhypara* var. *rhypara*). None of these are listed under the federal Endangered Species Act. Owyhee clover and grimy ivesia are listed by the state of Oregon as Endangered, Mentzelia packardiae and sterile milkvetch are listed by the state as Threatened and Ertters senecio is a state Candidate. The senecio, mentzelia and ivesia occupy highly specific ash sites, with the senecio and mentzelia on loose talus rubble at few sites in Malheur County only, and the ivesia on six sites of shallow, more compacted ash in this area and with limited sites in Lake County, Oregon. Owyhee clover and sterile milkvetch grow in less definitive habitat within the Wyoming big sagebrush type, but are restricted globally to the ash soils of the Owyhee River canyon area between Birch Creek and Owyhee Dam. Although the milkvetch has been found both east and west of Owyhee River, the clover has not yet been found west of the river. Several sites of these two species are known in Idaho just to the east at the edge of their eastern range. While incidental surveys for the six species have located new occurrences of the species within their extent, overall inventory has been incomplete within the area due to the extremely rugged topography. It is anticipated that more sites would be found, particularly of the clover and milkvetch, with additional inventory.

BLM sensitive species that may be affected by the Proposed Action and alternatives include greater sage-grouse, grasshopper sparrow, bighorn sheep, spotted bat, pallid bat, Townsend's big-eared bat, and fringed myotis. There are two greater sage-grouse leks adjacent to the HMA, one to the northeast and one to the southeast. The two leks are approximately two miles from the eastern boundary of the HMA. Although there have been greater sage-grouse observed within the HMA in the past, overall greater sage-grouse numbers in this area have declined over the last decade, most likely due to loss of habitat from large wildfires resulting in loss of sagebrush cover and associated forbs and an increase in cheatgrass and other non-natives. Bighorn sheep were once common in the Three Fingers HMA. However, in 2015-2016 there was a mortality event in this bighorn sheep herd when members of the herd contracted and transmitted a respiratory disease caused by *Mycoplasma ovipneumoniae (M. Ovi)* (Oregon Department of Fish and Wildlife, 2017). *M. Ovi* is a bacterium that causes respiratory disease and pneumonia in domestic and wild sheep and goats. *M. ovi* within bighorn sheep herds can lead to large-scale mortality events (Cassirer et al. 2018). While a few sheep remain in the herd, the sheep are unlikely to travel into the HMA where they would have to compete with wild horses when they can access the rockier slopes and abundant habitat along the Owyhee River below.

Jackies Butte HMA

No federally listed threatened or endangered species are known or suspected to occur within the HMA. There are no known sites of BLM Sensitive plant species within the Jackies Butte HMA. BLM sensitive animal species that may be affected by the proposed action and alternatives include greater sage-grouse, grasshopper sparrow, kit fox, spotted bat, pallid bat, Townsend's big-eared bat, fringed myotis, and pygmy rabbit. There is one greater sage-grouse lek within the HMA. It has not been recorded as being active since 1999, although it was not surveyed for many years. The last few years it has been surveyed no birds were found. The lek burned in 1995 and again in 2001. Vegetation consists of an annual grassland. While kit fox range is mapped to include part of the HMA, their presence should be limited. Kit foxes prefer shrubby habitat, which is missing through most of the HMA. The small portion of the HMA that has shrubs, while not currently known to be within kit fox range, could potentially become part of their range in the future.

The species mentioned in this section are sagebrush obligates or associated with sagebrush steppe ecosystems. As such, greater sage-grouse will serve as a focal species. The focal species concept provides a link between single- and multi-species methods of wildlife conservation and management (Mills 2007). Focal species serve as a set of species which define the characteristics of different spatial and compositional landscape attributes necessary for functional and healthy ecosystems (Lambeck 1997; Caro and O'Doherty 1999). In short, because they are sagebrush obligates, greater sage-grouse function as surrogates for sagebrush communities and associated vertebrates (Rowland et al. 2006). Conserving greater sage-grouse habitat also benefits other wildlife species, particularly sagebrush-obligate bird species (Hanser and Knick 2011; Donnelly et al. 2017), small mammals (Rowland et al. 2006), and big game (Copeland et al. 2014). Potential project impacts for many wildlife species would be similar to those anticipated for sage-grouse.

The "Greater Sage-Grouse Conservation Assessment and Strategy for Oregon" (Hagen 2011), contains guidelines for wild horse management as it relates to sagebrush habitat management

(Pg. 104), it states, “The management goals for wild horses are to manage them as components of the public lands in a manner that preserves and maintains a thriving natural ecological balance in a multiple use relationship. Wild horses are managed in HMAs that involve 2.8 million acres of public land, primarily in Southeastern OR.” The Oregon Sage-Grouse Action Plan (Sage-Grouse Conservation Partnership, 2015), adopted through Governor Kate Brown’s Executive Order (EO 15-18), further builds upon the foundational work of Strategy.

The recommended conservation actions for wild horses from the Action Plan include:

- *Action FRE-1) Develop, implement, and enforce adequate regulatory mechanisms that ensure that free-roaming horse and burro populations do not exceed AMLs in HMAs, particularly those that overlap with sage-grouse Priority Areas of Conservation (PAC).*
- *Action FRE-1-2) Prioritize funding for free-roaming horse gathers in PACs that exceed AML unless removals are necessary in other areas to prevent catastrophic environmental impacts.*
- *Action FRE-1-4) Use permanent sterilization as a method to suppress population growth rates.*

In addition, the Oregon Greater Sage-Grouse Approved Resource Management Plan Amendment (ARMPA) (September 2015a) outlines the following objectives for wild horse and burro management:

1) *Manage wild horses and burros as components of BLM-administered lands in a manner that preserves and maintains a thriving natural ecological balance in a multiple use relationship.*
2) *Manage wild horse and burro population levels within established appropriate management levels (AML).*
3) *Complete assessments of Greater Sage-grouse habitat indicators for HMAs containing PHMA and GHMA*[2].

Within Three Fingers HMA, approximately 95.1% is designated as GHMA and 4.9% is not designated as sage-grouse habitat (Table 7). There are no acres designated as PHMA in the Three Fingers HMA. A small portion of the HMA, 1.0%, is within 4 miles of an occupied or pending lek. More than 80% of nests are located within four miles of a lek (Hagen 2011).

Within Jackies Butte HMA approximately 1.9% is designated PHMA, approximately 24.4% is designated as GHMA, and 73.7% is not designated as sage-grouse habitat (Table 7). In addition, the 1.9% acres of the Jackies Butte HMA in PHMA also intersects with the Soldier Creek Priority Area of Concern (PAC). According to the 2020 population estimates, this PAC has approximately 136 males. This is a 51.6% decline in birds from the previous year when the

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[2] Priority Habitat Management Area (PHMA): BLM-administered lands identified as having the highest value to maintaining sustainable GRSG populations. These areas include breeding, late brood-rearing, winter concentration areas, and migration or connectivity corridors. General Habitat Management Area (GHMA): BLM-administered lands where some special management will apply to sustain GRSG populations; areas of occupied seasonal or year-round habitat outside of PHMA.

population estimate was 273 birds. As stated in the ARMPA, a greater than 40% decline of population in one year causes a soft population trigger to be tripped. Even though the population estimate declined 51.6% in 2020, the 5-year average population estimate is still 117 males above the regular soft threshold of 222. It is not yet known what caused the population estimate to decline so rapidly in 2020. Populations naturally fluctuate, and it is possible that the population could bounce back during the 2022 population survey. It is also possible that the birds are there but they have simply moved to unknown leks.

Table 7: Acres and percentage of PHMA, GHMA, and areas within four miles of occupied and pending sage-grouse leks within the HMAs

HMA				
Three Fingers	0 ac (0%)	59,283 ac (95.1%)	3,024 ac (4.9%)	598 ac (1.0%)
Jackies Butte	1,253 ac (1.9%)	15,910 ac (24.4%)	48,048 ac (73.7%)	31,839 ac (48.8%)
Total	**1,253 ac (0.1%)**	**75,193 ac (58.9%)**	**51,072 (40%)**	**410,617 ac (25%)**

*Areas within four miles of a lek overlap with PHMA and GHMA and the three should not be added cumulatively.

In the Three Fingers HMA, approximately 19,552 acres (31%) are designated spring nesting and winter habitat for Greater Sage-Grouse. None of the HMA is considered summer habitat, although birds may be found during this time period. There are no leks within the HMA.

The area where the Jackie's Butte HMA is located has not yet been mapped for seasonal habitat. Normally it can be assumed that areas within 4 miles of a pending or occcupied lek can be considered spring breeding and nesting habitat, however the majority of this area within Jackies Butte has little to no sagebrush habitat due to fires. Approximaely 2,300 acres in the southeast corner that did not burn is within the 4 miles of a lek. This area still has a sagebrush overstory and therefore could be nesting habitat. There is one lek within the Jackies Butte HMA which is classified as "pending". "Pending" as defined by Oregon Department of Fish and Wildlife is a lek not counted regularly in the last 7 years, but birds were present one or more years of that period. This lek burned in 1985, 1995, and again in 2001 and no longer has sagebrush on site.

Environmental Consequences – Special Status Species and Habitat

Effects Common to All Alternatives

Under all alternatives wild horses would continue to graze within the HMAs. The sagebrush plant communities within the HMAs that support sage-grouse are very complex and successionally dynamic, making it difficult to form large-scale conclusions about the impacts of grazing on sage-grouse populations (Crawford et al. 2004). Grazing effects are not distributed evenly because historic practices, management plans and agreements, and animal behavior all lead to differential use of the range (Manier et al. 2013). However, research suggests it is possible for grazing to be managed in a way that promotes forage quality for sage-grouse since grazing may result in increased forb presence (Vavra 2005).

There is no record of wild horses grazing on the six sensitive plant species within the HMA, this may be due to the sparce vegetation in the habitat where these plants grow. Wild horses could directly impact individuals within occurrences through trampling along trailing routes.

Impacts Common to Action Alternatives (1, 2, and 4)

In these alternatives sage-grouse would have the same resources available as are currently present within the HMAs. Horse numbers would be reduced to AML reducing the occurrence of large areas of uniform utilization at heavy intensities on a year-round basis. Utilization is not expected to exceed 50%. Anderson and McCuistion (2008) found grazing management (including horses), when upland birds are present, should be flexible, but limited to a light to moderate use (30%-50% utilization). They concluded light to moderate use can increase forb quality and quantity since it can delay the maturation of forbs, extending availability throughout the growing season. Adams et al. (2004) suggests that light to moderate grazing encourages the height and cover of sagebrush and other native species during nesting seasons, and light grazing is used to create patches in the vegetation, increasing the herbage of species preferred by sage-grouse, especially during nest and brood rearing. Moderate levels of livestock use are generally considered compatible with maintaining perennial bunchgrass, with the level of sustainable use depending on a number of environmental factors (Hagen 2011).

Under these alternatives, herbaceous cover, as well as riparian vegetation, is expected to increase which will benefit the sage grouse by providing improved thermal cover and protection from predators. This would improve survivability and may increase population over time resulting in numbers at or above management objectives. Areas within the HMAs near water sources would continue to be affected by concentrated grazing uses. Portions of the HMAs away from existing waterholes and springs would have non-grazed areas, which would be expected to provide more suitable nesting sites for sage-grouse due to more residual grass cover. This would be expected to be highest in areas outside of the current use area during drought years and lowest in these areas during wet years since in those years it would be expected that all water sources would have water and attract livestock and wild horses while dispersing their use. Residual grass cover provides horizontal screening at nest sites, in addition to screening from shrubs, which is believed to reduce predation. Maintaining wild horse numbers within AML would aid BLM land managers in their ability to provide quality sage-grouse habitat in the quantities needed for their survival and the growth of populations. This alternative would maintain achievement of, or promote progress toward achieving Rangeland Health Standard 5 with the goal of providing habitats that support healthy, productive and diverse populations and communities of native plants and animals (including special status species and species of local importance) appropriate to soil, climate and landform. This alternative would not contribute to the decline of remaining sagebrush habitat for sage-grouse or the reduction of sage-grouse populations.

Gather and removal sites would not be located within or adjacent to sensitive plant occurrence, thus this activity would have no negative direct impacts to these species. Reducing herd size reduces the amount of trampling along trailing routes, decreasing the risk of trampling sensitive plant sites.

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)
Under these alternatives horse numbers would continue to increase; resulting in greater use of the area and reduction of residual grasses that provide hiding cover for sage-grouse nests. Riparian vegetation browsing and trampling of springs, primarily due to wild horse use, would further degrade habitat conditions for wildlife. Utilization studies in the HMAs are currently showing only localized moderate to heavy (41-60% to 61-80%) use areas around water sources and wild horse home ranges. These alternatives would likely expand those moderate to heavy use areas with an indefinite increase in wild horse numbers. Findings from France et. al. (2008) suggests cattle initially concentrate grazing on plants between shrubs and begin foraging on perennial grasses beneath shrubs as interspace plants are depleted. It can be assumed wild horse use would mimic cattle use of perennial grasses as the more easily accessible plants would be grazed first. France et. al. (2008) found cattle use of understory perennial grass was minimal until standing crop utilization reached about 40%; although this utilization level would likely vary depending on sagebrush density, sagebrush arrangement (e.g., patchy vs. uniform distribution), bunchgrass structure, and accompanying forage production levels. As utilization levels increase across the HMAs with increased wild horse numbers it is expected that horizontal screening cover of sage-grouse nests would decline. An increase in wild horse numbers would also decrease the likelihood that individual perennial plants could receive a full growing season of rest from wild horse use. When perennial plants lack adequate growing season rest periods where they are able to complete a full reproductive cycle the plant community composition, age class distribution, and productivity of healthy habitats is negatively affected thus influencing the ability to achieve Rangeland Health Standard 5 for native, Threatened & Endangered and Locally Important Species. Increases in wild horse numbers beyond AML could also lead to direct competition between horses and sage-grouse for food sources during critical stages of the sage-grouse life cycle (nesting and brood rearing), with less available resources for sage-grouse due to over utilization of the area by horses. This alternative could, and is expected to, result in lower habitat quality for sage-grouse and contribute to the further reduction of sage-grouse habitat and population numbers. Habitat and population management thresholds identified in Table 2-2 in the ARMPA could move toward or meet triggers over time requiring more restrictive action. The impacts to sensitive plant species would be greatest under these alternatives because the impacts of trampling along trailing sites escalates as herd size increases.

The impacts to sensitive plant species would be greatest under these alternatives because the impacts of trampling along trailing sites escalates as herd size increases.

3.2.5 Migratory Birds

Affected Environment
The sagebrush steppe present within the HMAs support several species of sagebrush obligate and facultative migratory birds, including sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), and loggerhead shrike (*Lanius ludovicianus*). Other species commonly occurring in sagebrush habitat in the area include

mountain bluebird (*Sialia currucoides*), vesper sparrow (*Pooecetes gramineus*), horned lark (*Eremophila alpestris*) and western meadowlark (*Sturnella neglecta*). Raptors found in or near the project area include golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), ferruginous hawk (*Buteo regalis*), American kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus*), long-eared owl (*Asio otus*) and short-eared owl (*Asio flammeus*). Species listed by the US Fish and Wildlife Service as Birds of Conservation Concern that occur in the HMAs are golden eagle, ferruginous hawk, long-billed curlew, sage thrasher, Brewer's sparrow, and sage sparrow.

Past and present actions affecting the area include road and fence construction, water developments, livestock and wild horse grazing, and recreation. These actions and events can have mixed effects on migratory birds and their habitat depending on the species. Livestock and wild horse grazing are the most widespread and long-term actions occurring within the affected environment; and are managed and monitored to facilitate sustainable multiple use, including maintenance of migratory bird habitat.

Environmental Consequences – Migratory Birds

Impacts Common to Action Alternatives (1, 2, and 4)
Under these alternatives, herbaceous cover is expected to increase which will benefit migratory birds by providing improved nesting and hiding cover, protection from predators, and forage. Maintaining wild horse numbers within AML would aid BLM land managers in their ability to provide quality migratory bird habitat in the quantities needed for their survival and the growth of populations. This alternative would maintain achievement of or promote progress toward achieving Rangeland Health Standard 5 with the goal of providing habitats that support healthy, productive, and diverse populations and communities of native plants and animals. This alternative would not contribute to the decline of sagebrush habitat for sagebrush obligate species.

Some migratory birds could be temporarily disturbed or displaced by the helicopter or by placement of traps, however the general helicopter gather period would be outside the breeding and nesting period for most birds. Impacts would be short term (<2 weeks) and many species of migratory birds would return to regular use of the areas after the disturbance has passed. Reduction of wild horse numbers to AML would reduce utilization of forage and water resources by horses, reducing competition for these resources and allowing for improvement of habitat conditions for migratory bird species.

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)
Under this alternative horse numbers would continue to increase; resulting in greater use of the area and reduced residual grasses that provide food, hiding cover and nesting habitat for migratory birds. An increase in wild horse numbers would also decrease the likelihood that individual perennial plants could receive a full growing season of rest from wild horse use. When perennial plants lack adequate growing season rest periods where they are able to complete a full reproductive cycle, the plant community composition, age class distribution, and productivity of healthy habitats is negatively affected thus influencing the ability to achieve Rangeland Health Standard 5 for native, T&E and Locally Important Species. Increases in wild horse numbers beyond AML could also lead to direct competition between horses and migratory birds for food

and water sources during critical stages of their life cycle (nesting and brood rearing), with less available resources due to over utilization of the area by horses. This alternative could, and is expected to, result in lower habitat quality for migratory birds and contribute to the further reduction of migratory bird habitat.

3.2.6 Wildlife and Locally Important Species

Affected Environment – Wildlife and Locally Important Species

A variety of wildlife, other than migratory birds and Special Status Species (SSS), include small mammals (black-tailed jackrabbit, cottontails, ground squirrels, pocket gophers, deer mouse, bobcat, yellow-bellied marmot, wood rats, voles, chipmunks, bats) cougar, coyote, amphibians, and reptiles common to southeast Oregon can be found throughout the HMAs. Pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*) use the HMAs to varying extents. Pronghorn and mule deer are present year-long while elk generally migrate into the HMAs during the winter. Chukar partridge (*Alectoris chukar*) are also found in the area.

Wild horses present throughout the HMAs may exclude other wildlife use from water sources, especially in late summer when water sources are limited. Miller (1983) found that when antelope could get to water while being no closer than 3 meters from a wild horse or cow, they were able to water; otherwise, they would only circle the waterhole, leave, and return later to try again.

Cheatgrass has become a permanent component of many Intermountain ecosystems, including within HMAs. It is the focal point for the disruption of many ecosystem processes and functions. Wildfire cycles are shorter and severity and extent of fire impacts are greater with cheatgrass in the ecosystem. Wildlife species are affected both directly by alteration of habitat due to cheatgrass invasion and indirectly by the loss of habitat due to increased wildfires. Wild horses can spread nonnative 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). Also, the diversity and cover of microbiotic crusts are diminished with cheatgrass in the ecosystem allowing additional entry of cheatgrass and other weeds. The rangeland health of cheatgrass infested communities is either at risk or already in the unhealthy category with even more undesirable weeds invading some cheatgrass communities (Pellant 1996).

Environmental Consequences – Wildlife and Locally Important Species

Impacts Common to Action Alternatives (1, 2, and 4)

Some wildlife could be temporarily disturbed or displaced by the helicopter or by placement of traps. Impacts would be short term (<2 weeks) and many species of wildlife would return to regular use of the areas after the disturbance has passed. Reduction of wild horse numbers to AML would reduce utilization of forage and water resources by horses, reducing competition for these resources and allowing for improvement of habitat conditions for wildlife species.

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)

Over time the wild horse population would continue to increase, using more resources and leaving fewer forage species for wildlife to graze upon. Of the big game species present, pronghorn would most likely be more affected by competition for forage with wild horses than mule deer. On an annual basis, dietary overlap between feral horses and pronghorn averaged 16% and ranged from 7 to 26% (McInnis and Vavra 1987); wheras a study by Hansen et al. (1977) found that mule deer food habits appear to be complementary rather than conflicting with diets of wild horses. The no action alternative and the subsequent increase in wild horse numbers would also cause increased competition, between horses and some wildlife, for water. As wild horse numbers increase, they may exclude wildlife from using water sources, especially in late summer when water sources are limited and horse concentrations are high around the remaining water sources. Both mule deer and pronghorn used water sources less often where horse activity was high (Hall et al 2018). As horse numbers increase, wildlife numbers in the HMAs could decrease due to lack of forage base support and accessible water sources.

3.2.7 Invasive Species

Affected Environment – Invasive Species

Invasive species are non-native plants. Noxious weeds are a subset of invasive species that are listed by county or state as injurious to human or animal safety and health and have a legal classification as noxious. Unlisted invasives include a suite of annual mustard species, chenopods and other nuisance annual species. The most troublesome and problematic of the unlisted species are invasive annual grasses, collectively referred to as IAGs, which account for the preponderance of acres of invasive species in both HMAs. Several species are known to exist within each of the HMAs. Ground surveys of the areas are conducted randomly. An aerial survey of South Malheur County in 2018 to detect saltcedar, Scotch thistle, whitetop and perennial pepperweed included Jackies Butte HMA. Table 8 shows species and known locations, including those found in the aerial survey.

Table 8: Three Fingers HMA and Jackies Butte HMA Noxious Weeds

Three Fingers HMA		
Weed Species		**Location**
Rush skeletonweed		Steamboat Ridge; suspected in Shadscale and other areas in HMA
Scotch thistle		Wildhorse Basin; Three Fingers Gulch; roadsides
Diffuse knapweed		Occasional along Fisherman’s road
Russian knapweed		Shadscale Flat; Wildhorse Basin; Three Fingers Gulch area
Whitetop		Along road systems
Halogeton		Along Fisherman’s road south of Three Fingers creek crossing.
Yellow starthistle		Not known inside the HMA, but very near the boundary in Sage Creek Basin
Saltcedar		Shadscale Flat; Three Fingers drainage; high watere line of Owyhee Reservoir and likely in any drainage/spring/seep in the HMA
Perennial pepperweed; Canada thistle; bull thistle		Most drainages near Owyhee Reservoir as well as riparian, springs and seeps.

Jackies Butte HMA		
Weed Species		**Location**
Scotch thistle		Caviatta Ridge; Blue Gate road; Dry Holes
Rush skeletonweed		Caviatta Ridge and N to Jackies Butte
Whitetop		Blue Gate road

Three Fingers HMA: numerous fires have burned portions of the HMA to the point that nearly all of it has burned once or multiple times. Already existing annual invasive species' populations increase following each fire. Areas that were moderately invaded by cheatgrass, became more heavily impacted and now have begun to convert to medusahead with some areas near total conversion. Lower elevation areas near the Owyhee reservoir in Wildhorse Basin and in Shadscale Flat are examples of these conversions, as is Steamboat Ridge. These areas are heavily utilized by horses. As horse numbers increase, intense grazing removes desirable vegetation and increases rate of spread and dominance in areas already nearing monocultures of invasive annual grasses (IAGs). Annual species provide little to no competition against invasion by noxious species, especially rush skeletonweed, Scotch thistle, diffuse knapweed, and yellow starthistle. The seeds of each of these species have a pappus which allows for wind transport into the vulnerable areas.

Jackies Butte HMA: Known sites for rush skeletonweed, whitetop, and Scotch thistle are subject to on-going treatments. Medusahead is moving south from Jackies Butte area and increasing from incidental, scattered sites near Caviatta to larger populations, especially in areas heavily utilized by horses and previously populated with an abundance of cheatgrass. Jackies Butte has burned numerous times. Scars from the wildfires are scattered across the HMA. The burned areas are dominated by IAGs, predominantly medusahead around Jackies Butte. Negative impacts from increasing numbers of horses in Jackies Butte HMA are the same as within Three Fingers HMA. As the vegetation community converts to IAGs, it becomes more easily invaded by Scotch thistle and rush skeletonweed seed sources as well as more susceptible to fires.

Environmental Consequences – Noxious Weeds

Affects Common to All Alternatives

Areas of high horse concentration are subject to heavy grazing. This disturbance opens up more niches for noxious weed and invasive annual grass (IAG) establishment and spread. By maintaining horse numbers at or below AML, the opportunities for noxious weed and IAG spread would be reduced. Limiting vehicle travel to existing roadways and timing gather events to avoid times of high spread potential (seed shatter, muddy conditions, etc.), as much as possible, combined with aggressive weed treatment during the year pre-gather and avoiding noxious weed and IAG infested areas when selecting trap sites, would limit the potential of noxious weed spread during gathering operations. Gather sites would be noted, monitored by the range staff, and should weeds become evident, those details would be reported to district weed personnel for treatment and monitoring. Gather related monitoring and treatment of noxious weeds are described in the Project Design Features section 2.1.1.

Impacts Common to Action Alternatives (1, 2, and 4)

By reducing horse populations and managing within AML, vegetation in areas of horse usage within the HMAs would be less heavily grazed, allowing the desirable vegetation to be more vigorous and competitive and provide less opportunity for new weed infestations. The fertility treatment may lengthen the time before horse numbers return to high AML which would allow the vegetation a longer time period in which to recover.

Maintaining populations within AML would be especially beneficial in the limited riparian areas, springs and seeps in either HMA. In Three Fingers HMA perennial pepperweed and Canada and bull thistles are common to the moist areas. Less horse usage in these areas would cause less degradation and decrease danger of dominance by these species.

If the gather activities follow the listed Standard Operating Procedures (SOPs) and Project Design Elements, including thoughtful selection of timing of gathers which minimize likelihood of weed spread, then the gather activities themselves would not increase the opportunities for increased noxious weed introduction and spread. Trap sites would be disturbed and would need to be monitored at least 2 years post-gather. Any weeds found need to be treated in a timely manner using the most appropriate methods.

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)
The continuing increase in horse numbers above the AML would lead to areas of higher horse concentrations causing more impacts to the vegetation due to overgrazing. This opens up more niches for noxious weeds to establish and spread. Areas of horse concentration and consequent heavy use typically are highest near riparian areas, springs and reservoirs. This would exacerbate the recovery of the riparian areas and lead to increases in Canada thistle and other riparian weeds such as perennial pepperweed and whitetop. Heavier use around already disturbed areas such as water holes and congregation areas would lead to increased disturbance and, consequently, increases in noxious weed establishment. Given medusahead's recent spread to new sites and alarming expansion of existing sites, it and other IAGs are a special concern in these over-used areas.

3.2.8 Hydrology and Riparian-Wetland Areas

Affected Environment – Hydrology and Riparian-Wetland Areas

<u>Three Fingers HMA</u>

There are only a few perennial water sources in the HMA including the Owyhee Reservoir which has terrain limited access. Wildhorse Basin Pasture has perennial water in Rookie Creek, Cherry Creek, and a handful of springs associated with both drainages. Riverside Pasture has perennial water along portions of Three Fingers Gulch and at various springs concentrated on the south end of the pasture.

The horses that typically used these riparian areas are currently displaced and putting pressure on other water sources due to the invasion of cheatgrass and medusahead into the burned areas. Some of the horses have moved into the Roger Spring area near the upper end of Three Fingers Gulch, but there is very little nutritional feed in this area. Many of the horses have relocated to the very southern end of the Riverside Pasture where there are several small perennial seeps along a ridgeline. These horses have been grazing outside of the HMA in the Leslie Gulch Area of Environmental Concern. The unauthorized entry and concentration of use has caused the denuding of riparian vegetation and loss of soil leading to the degradation of water quality and water holding capacity at spring sources in the ACEC. Areas of extreme wild horse grazing have seen encroachment of upland vegetation into the riparian area and due to yearlong use by wild horses, prevented any regrowth of riparian vegetation.

Most of the perennial springs in the HMA have been developed. The herbaceous and woody riparian vegetation in all of the riparian areas is typically heavily utilized. There is very little recruitment or regeneration of the herbaceous or woody vegetation. There are also many areas that are trampled and pawed by the horses looking for water. Trails into the perennial sources are heavily utilized and are causing stream bank instability. Season-long horse grazing in these areas becomes a resource concern as horse numbers increase.

There are also many seasonal or intermittent seeps, springs, and creeks that the horses impact. Many of these cool season water sources are severely impacted by hoof traffic and pawing. Horses tend to paw in these areas as the water dries up during the hot season. This type of hoof action negatively impacts the water sources as much of the capability of the area for soil-water storage is decreased with soil loss.

Jackies Butte HMA
Riparian vegetation is extremely limited in scope throughout the area, existing primarily at Hardin Springs, Dry Creek, and a few reservoirs. Riparian environments are even more limited in areas where gathers are likely to occur. While not extensive, riparian zones are an important resource for wildlife, wild horses, and livestock. Because of the demands on riparian areas, management considerations have focused on protecting these areas. Maintaining AML of wild horse herds is important to keeping utilization at acceptable levels and preserving riparian habitat.

Environmental Consequences – Hydrology and Riparian-Wetland Areas

Impacts Common to Action Alternatives (1, 2, and 4)
Under Alternatives 1, 2, and 4, trap sites would not be located adjacent to any surface water sources or riparian areas; therefore, there would be no direct impacts due to the gather.

The action alternatives would limit the intensity of use at water sources and surrounding uplands. Regulating the number of wild horses in the HMAs would decrease frequency, duration and intensity of use, reducing degradation to water sources and riparian areas in the HMAs

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)
Under Alternatives 3 and 5 the number of wild horses in the HMAs would increase and result in greater use and degradation of riparian areas. The disturbance and loss of riparian habitat would result in impacts to water quality through increased sedimentation and water temperatures. Riparian area vegetation would continue to be heavily utilized as additional horse use would decrease vegetation recruitment, reproductive ability, and vigor. In addition, riparian vegetation community types and distribution would be changed, root density lessened, and canopy cover reduced. This would lead to reduced riparian function and spring/seep dynamics and further deterioration of these systems.

3.2.9 Upland Soils and Biological Crusts

***Affected Environment* – Upland Soils and Biological Crusts**

<u>Three Fingers HMA</u>

The soils found in the Three Fingers HMA were surveyed and described in Oregon's Long Range Requirements for Water 1969, Appendix I-11, Owyhee Drainage Basin. Unit 60, Unit 98 and portions of Unit 76 occur on 20 to 60 percent slopes, while remaining portions of Unit 76 occur on 3 to 12 percent slopes. Microbiotic crusts have not been inventoried, but are known to exist throughout the HMA.

The area has Unit 60 soils that are moderately fine textured, well drained soils underlain by old lacustrine sediments. They occur on gently sloping to hilly uplands. This makes up approximately 60% of the HMA.

Unit 76 soils are shallow, clayey, very stony, well drained soils over basalt, rhyolite, or welded tuff. These soils occur on gently undulating to rolling lava plateaus and some very steep faulted and dissected terrain. This soil occurs mixed with Unit 77 soils in the northern end of the HMA on 3 to 12 percent slopes. It also occurs mixed with Unit 60 soils on steeper slopes. This soil makes up approximately 20% of the HMA.

Unit 98 is a miscellaneous land unit that makes up approximately 10% of the HMA. It consists of highly eroded and dissected raw old lacustrine sediments occurring as "badlands". Vegetative cover is very sparse in this soil.

<u>Jackies Butte HMA</u>

The soils found in the Jackies Butte Herd Management Area were surveyed and described in Oregon's Long Range Requirements for Water 1969, Appendix I-11, Owyhee Drainage Basin. They are mainly a combination of Unit 75 and S75 soils on slopes varying from three to twelve percent. The area also contains smaller amount of Units 76, S76 and 99.

Unit 75 soils are loamy, shallow, very stony, well drained soils over basalt, rhyolite, or welded tuff. Unit 75 soils occur on gently undulating to rolling lava plateaus with some very steep faulted and dissected terrain. The soil profile consists of very stony silt loam, stony loam, and stony silt loam over bedrock at 15+ inches.

Unit S75 soils are shallow, loamy, well drained, extremely stony on gently undulating to rolling plateaus of basalt, rhyolite, or welded tuff. The soil profile by depth consist of brownish gray gravelly loam, to light brown gravelly clay loam, to brown gravelly heavy clay loam, to silica cemented gravelly pan 6 to 20 inches thick over stratified loamy sand and gravel.

Unit 76 is described above.

Unit S76 soils are shallow, extremely stony, well drained soils over basalt, rhyolite, or welded tuff. They occuron gently undulating to steep plateaus. The soil profile by depth consist of stony loam, extremely stony clay loam, extremely stony clay over fractured bedrock at 11+ inches.

Unit 99 is a miscellaneous land unit consisting of recent lava flows. These flows are generally on low slopes, but do have extremely irregular, rough surfaces. There do tend to be small pockets of soil development on which there is some vegetation.

Biological Soil Crusts (BSCs) have not been inventoried, but are known to exist in the HMAs. BSCs contribute important functions in an ecosystem included but not limited to increasing the residence time of moisture and reducing erosional processes. Factors influencing distribution of BSCs include, but are not limited to: elevation, soils and topography, percent rock cover, timing of precipitation, and disturbance.

Possible disturbances that have occurred within the HMAs include, but are not limited to: effects from livestock grazing, vehicles, wild horses and recreation.

Environmental Consequences – Upland Soils and Biological Crusts

Impacts Common to Action Alternatives (1, 2, and 4)

Wild horses, much like livestock, tend to congregate around areas where resources are plentiful, such as water sources. When horse numbers increase, the impacts to soils and biological soil crusts (e.g. soil compaction) increase. Soil loss and compaction would be expected to decrease in those areas near water sources where horses are forced to concentrate. Lower populations of horses would result in less hoof traffic, thereby decreasing negative impacts to soil and BSCs.

Soil would be displaced and/or disturbed on two acres at each site in the construction of the trap, use of the access routes, and in the round-up and loading of the wild horses. The area of severe surface disturbance is normally less than 2,000 square feet. Minimal surface wind and water erosion is expected on these areas during the vegetative rehabilitation period (approximately 1 to 3 years).

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)

Under the Alternative 3 and the No Action Alternative, wild horse numbers would increase at a rate of approximately 11% and 20%, respectively, per year with no gathering to the lowest AML. Increases in horse numbers would lead to excessive overgrazing which would expose soils to wind and water erosion and remove biological soil crusts from the HMA. Larger areas around water resources would become compacted as animal numbers increase. Increased loss of biological soil crusts across the HMA would occur as wild horses utilize more of the area looking for resources as they become scarce.

3.2.10 Social and Economic Values

***Affected Environment* – Social and Economic Values**

As stated in an Office of Inspector General report (2010), fiercely competing interests and highly charged differences of opinion currently exist between BLM and private individuals and organizations concerning the need for wild horse gathers, the methods used to gather, and whether horses are treated humanely by BLM and its contractors during and after the gathers. Scoping comments received on previous NEPA documents proposing wild horse population management activities have included a wide range of both support and opposition to various methods of population management.

Many of these commenters derive benefit from the presence of these wild horse herds by actively participating in recreation to view the horses. Some individuals believe that any type of gathering and holding of wild horses is inhumane, or not in keeping with the intentions of the WFRHBA. Others value the existence of wild horses without actually encountering them. This value represents a non-use or passive value commonly referred to as existence value. Existence values reflect the willingness to pay to simply know these resources exist.

Conversely, a separate group of individuals may or may not support the existence of wild horses on public land yet express concern about wild horse numbers and the adverse impacts on other resources. These “other resources” include but are not limited to the economic impacts that could result from reduced livestock grazing opportunities, the impacts to wildlife and biodiversity resources and rangeland ecosystem functions, and the resultant decline in hunting opportunities.

For the purposes of the Social and Economic Values portion of this analysis; it is important to recognize the number of horses the BLM manages across the United States in order to fully understand the effects analysis area of social and economic costs of the decisions to be made for the Three Fingers HMA and Jackies Butte HMA. Table 9 displays the numbers of horses estimated on the range and in off-range corrals and off-range pasture holding facilities. The national total of high AML across all HMAs is 26,770 horses and burros.

Table 9: Number of horses and burros BLM manages nationally, on and off the range.

These numbers led the Office of Inspector General of the U.S. Department of the Interior (2016) to state that, “*BLM does not have a strategic plan in place to manage the wild horse and burro populations. The consistent on-range population growth drives the constant need for additional off-range holding and increased spending. If no plan is in place to control the on-range population source, the off-range holding and financial need will continue in this unsustainable pattern.”* In fiscal year (FY) 2019, $57.648 million (67% of the WHB Program budget) was allocated to off-range holding costs (USDI BLM, 2021b). Since that time, the BLM has provided reports to Congress indicating strategies to bring national populations down to AML, and to maintain them at that level.

Some of the costs associated with certain activities included in the range of alternatives is listed below. Not all activities are included in the list as it is extremely difficult to put a numerical value on such things as vegetative resource damage or decreased recreational opportunities, yet there is certainly a social and economic value associated with their improvement, maintenance or loss. Quantifiable costs of such things as holding, gathering and fertility treatment include, but are not limited to:

- Holding horses at Oregon's Wild Horse Corral Facility costs approximately $5 per day per horse.
- Long-term holding costs average about $2.01 per day per horse. Unadopted animals receive an estimated 25 years of care which adds up to approximately $46,000 per horse for the remainder of their life.
- Helicopter drive gather operations are currently costing around $600 per horse gathered.
- Bait, water, and horseback drive trap gathers are currently averaging $1,100 per horse trapped in Oregon.
- Field darting applications cost approximately $1000 per mare treated.
- GonaCon fertility treatment costs approximately $50 per dose.
- Zonastat-H fertility treatment costs approximately $30 per dose.
- PZP-22 fertility treatment costs approximately $500 per dose. This includes the drug cost only, not the cost of capturing the mare to be treated.
- Gelding of stallions costs approximately $60 per horse. This includes the castration surgery only.
- Mare sterilization costs approximately $300-$1000 per horse depending on the sterilization method used (including surgical and nonsurgical methods).

Environmental Consequences – Social and Economic Values

Impacts Common to Action Alternatives (1, 2, and 4)
For the purposes of this analysis, the Cumulative Effects Analysis Area (CEAA) for social and economic values is the extent of Malheur County. Past actions such as wild horse gathers to maintain AML have influenced the existing environment within the CEAA. Present actions associated with the HMAs have the potential to improve rangeland health and increase forage production for wildlife, wild horses and livestock, thereby, maintaining or possibly increasing economic opportunities and fostering more desirable recreation opportunities (i.e., wild horse viewing/photography) with associated economic benefits to the local economy. The decision to manage rangeland resources properly should lead toward improvements in range condition and aid in the sustainability of ecosystem function and ranching operations, depending on the grazing permit. In addition to sustaining livestock operations, rangeland improvement could also bring about increased sustainability for wild horse management, further improving the local economy and supporting a well-established, local, rural-oriented social fabric. So long as horses are gathered and AML is maintained, it is expected that there would be no measureable negative affect to social and economic values in Malheur County.

Impacts of Alternative 1 (Removal and Intensive Fertility Control)
Comments received from the public for BLM gathers over the past few years have emphasized the desire that BLM increase the use of fertility control in order to reduce the number of wild

horses to be removed from the range or maintained in long-term holding facilities. Alternative 1 includes the use of available and available fertility control in those mares that would be released back into the HMA to help maintain the wild horses within AML with fewer necessary removals in the future.

Costs associated with the proposed gather and implementation of the fertility control would be incurred under the Proposed Action. There would also be costs associated with both off-range corrals and off-range pasture holding facilities incurred once the gather is completed, but the percentages that would be adopted or sent to long-term holding are unknown at this time. The magnitude of these costs is uncertain as is any long-term costs of maintaining wild horses either within AML on the range or in holding facilities. An approximate calculation of cost savings of implementing the intensive fertility control project ranges anywhere from an estimated $100,000 to $500,000/year, depending on many variables and complexities within the HMAs.

The proposed actions encompass a ten-year time frame that would include one to two additional gathers following the initial gather, as needed, which would bring horse numbers down to low AML. The possibility of one to two gathers is based upon the typical 20% per year herd growth rate observed across most HMAs, and projections of when populations would normally reach high AML. However, the cost and frequency of gathers could decrease if more effective fertility control treatments become available for use on BLM wild horses.

Under the Proposed Action, wild horses would be gathered to the low end of AML. Over time the vegetation and hydrologic resources in the area would be allowed to recover due to the reduced amounts of utilization and forage competition with livestock and wildlife. Tourists drawn to the area to observe wild horses would still have that opportunity. Livestock permittees would be able to continue grazing their cattle, at permitted levels, in these areas further securing the possibility of economic benefits (e.g. income) for those permittees. This would contribute to the local economies through taxes, the purchase of supplies and other contributions to the local communities.

Habitat quality for wildlife, livestock and wild horses would be maintained or improved with management of wild horse populations within AML. When horse numbers are kept within AML, BLM is able to manage for a natural ecological balance. This means horses would have enough forage to maintain a healthy body condition throughout the year. BLM's understanding is that wild horses and public rangelands in good health are what the public wants to see, no matter if they are opposed to or proponents of gathers.

Maintaining wild horse populations within AML and contributing to a thriving natural ecological balance for the 10-year period of this proposed action would allow the rangeland improvement goals associated with the SEORMP/ROD (2002) to be more readily achieved. Managing wild horse populations in the HMAs ensures security for a sustainable livestock grazing operation. A sustainable livestock operation includes economic success and the ability to continue to contribute to the economy of Malheur County.

Impacts of Alternative 2 (Removal and Non-reproducing Portion of Population)

Under this alternative, impacts would be very similar to the Proposed Action. The only difference would be a slightly lower reproduction rate due to a smaller breeding population. This alternative would ensure in the ten-year time frame of this analysis there would be fewer gathers required as compared to Alternative 1. Under this alternative the public perception of BLM's management of wild horses would be similar to Alternative 1. Effects to past, present and reasonably foreseeable actions would be the same under this alternative as those described in Alternative 1.

Impacts of Alternative 3 (Fertility Control Vaccines Only)
Under this alternative, impacts due to fertility control application would be very similar to the Proposed Action. The only difference would be a more gradual reduction in reproduction rates and population decreases. The ultimate level of herd growth would depend on the rates of mares treated, as a fraction of the total number of mares in the herd, and on natural attrition. In the ten-year time frame of this analysis, this alternative would most likely result in the wild horse populations within the HMAs not achieving the goal of AML. Under this alternative the public confidence in BLM's ability to manage wild horses at AML would likely decline. Effects to past, present and RFFAs would be the same under this alternative as those described in Alternative 1.

Impacts of Alternative 4 (Gather and Removal Only)
The BLM a number of non-governmental organizations, and sectors of the public support some sort of fertility treatment applied for the management of wild horse numbers within AML and possibly to decrease the frequency of wild horse gathers. Under this alternative with no application of fertility control, the status quo of approximately 20% annual herd growth would continue. In the ten-year time frame of this analysis, this alternative would likely lead to three more gathers required, as nothing beyond gathering wild horses would be done to slow the population growth. Under this alternative the public confidence in BLM's ability to manage wild horses at AML would likely decline if no efforts are made to solve the current issues with growing wild horse populations. Effects to past, present and RFFAs would be the same under this alternative as those described in Alternative 1.

Impacts of Alternative 5 (No Action)
Under the No Action Alternative there would be no initial monetary cost to the agency in terms of direct wild horse related actions, as no gather would be conducted and no fertility treatments would be applied to slow wild horse population growth.

If wild horse numbers are left unchecked, over the next 4 years, numbers would likely increase to about 600 adult horses in Three Fingers HMA and >400 adult horses in Jackies Butte HMA given a 20% annual increase; these values are about 500 - 800% of low AML. Competition for forage would have become evident between wild horses, livestock and possibly wildlife. It is anticipated that at this point range conditions would be deteriorating enough to create a situation where livestock active preference would be reduced accordingly to prevent further degradation to range conditions under authority of CFR 43 Ch. II, Subpart 4110.3 *Changes in grazing preference* (2006). Livestock permittees would likely have to find feed elsewhere, probably at the private land lease rate which is significantly higher than the BLM lease rate, or sell their cattle. BLM's rate per AUM in 2021 is $1.35 while the private land lease rate is considered to be roughly $25 per AUM in Malheur County. The SEORMP/ROD (2002) decisions for the livestock grazing permits would be ineffective toward the sustainability of the livestock operation if livestock are not turned out on the allotments because the AUMs available are being utilized by wild horses. A livestock operation in Malheur that is not sustainable economically would further burden the struggling economy of Malheur County.

At 3-4 times the high AML, it is assumed, the body condition score of the wild horses would decrease as forage competition increased and water availability decreased. If horse numbers become too high and drought conditions persist, emergency situations arise where BLM must take extreme measures to save wild horses. Generally, these extreme measures include hauling water, gathering in the heat of summer to prevent water starvation, and even euthanizing horses too weak to survive. Wild horse based tourism to the county may decline if the herds in the area acquire a reuptation for being of unhealthy body condition.

Should a gather take place in the future, there would be a higher cost to remove wild horses as there would need to be more horses removed from the HMAs and an expected higher number of wild horses sent to off-range pasture holding facilities.

4.0 CUMULATIVE EFFECTS

The NEPA regulations define cumulative impacts as impacts on the environment that result from the incremental impact of Alternative #1 when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions (40 CFR 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The cumulative impacts study area for the purposes of evaluating cumulative impacts adjacent to the HMAs.

According to the 1994 BLM *Guidelines for Assessing and Documenting Cumulative Impacts*, the cumulative analysis should be focused on those issues and resource values identified during scoping that are of major importance. Accordingly, the issues of major importance to be analyzed are maintaining rangeland health and proper management of wild horses.

4.1 Past Actions

In 1971 Congress passed the Wild Free-Roaming Horses and Burros Act which placed wild and free-roaming horses and burros, that were not claimed for individual ownership, under the protection of the Secretaries of Interior and Agriculture. In 1976 the Federal Land Policy and Management Act (FLPMA) gave the Secretary the authority to use motorized equipment in the capture of wild free-roaming horses as well as continued authority to inventory the public lands. In 1978, the Public Range Improvement Act (PRIA) was passed, which amended the WFRHBA to provide additional directives for BLM's management of wild free-roaming horses on public lands.

Past actions include establishment of wild horse HMAs and establishment of AML for wild horses, wild horse gathers, vegetation treatment, livestock grazing, wildfires, and recreational activities throughout the area. Some of these activities have increased infestations of invasive plants, noxious weeds, and pests and their associated treatments.

In August 2002 the SEORMP was signed. Currently, management of HMAs and wild horse population is guided by the 2002 SEORMP. The AML range for the Vale District is 714-1392 wild horses. The Land Use Plan analyzed impacts of management's direction for grazing and wild horses, as updated through Bureau policies, Rangeland Program direction, and Wild Horse Program direction. It also reaffirmed boundaries and AMLs for the Vale District's HMAs to ensure sufficient habitat for wild horses and achieve a thriving natural ecological balance and rangeland health.

Adjustments in livestock season of use, livestock numbers, and grazing systems were made through the allotment evaluation/multiple use decision process. In addition, temporary closures to livestock grazing in areas burned by wildfires, or due to extreme drought conditions, were implemented to improve range condition.

The Southeast Oregon Resource Advisory Council (SEORAC) developed standards and guidelines for rangeland health that have been the basis for assessing rangeland health in relation to management of wild horse and livestock grazing within the Vale District. Adjustments in numbers, season of use, grazing season, and allowable use have been based on the evaluation of progress made toward reaching the standards.

4.2 Present Actions

Program goals have expanded beyond establishing a "thriving natural ecological balance" by setting AML for individual herds to now include achieving and maintaining healthy and stable populations and controlling population growth rates.

Though authorized by the WFRHBA, current appropriations and policy prohibit the destruction of healthy animals that are removed or deemed to be excess. Only sick, lame, or dangerous animals can be euthanized, and destruction is no longer used as a population control method. A recent amendment to the WFRHBA allows the limited sale of excess wild horses that are over 10 years in age or have been offered unsuccessfully for adoption three times. BLM is adding additional off-range pastures in the Midwest and West to care for excess wild horses for which there is no adoption or sale demand. Most animals not immediately adopted or sold have been transported to long-term grassland pastures in the Midwest. Approximately 59,000 excess wild horses and burros are being maintained within BLM's off-range facilities (USDI-BLM-WHB Program 2021).

The actions which have influenced today's wild horse population are primarily wild horse gathers, which have resulted in the capture and removal of some 1689 wild horses in Three Fingers HMA (Table 2) and 1061 wild horses in Jackies Butte HMA (Table 3).

Within the proposed gather area cattle grazing occurs on a yearly basis. Wildlife use by large ungulates such as bighorn sheep, elk, deer, and antelope is also currently common in the project area.

The focus of wild horse management has also expanded to place more emphasis on achieving rangeland health as measured against the rangeland health standards. Adjustments to numbers, season of use, grazing season, and allowable use are based on evaluating achievement of or making progress toward achieving the standards.

The "Greater Sage-Grouse Conservation Assessment and Strategy for Oregon" (Hagen 2011), the Oregon Sage-Grouse Action Plan (Sage-Grouse Conservation Partnership, 2015) and the Oregon Greater Sage-Grouse ARMPA (2015a) contains guidelines and actions for wild horse management as it relates to maintaining or enhancing Greater Sage-Grouse habitat. The plans emphasize appropriate wild horse management throughout the Vale District.

4.3 Reasonably Foreseeable Future Actions

Future wild horse management in the Vale District could focus on an integrated ecosystem approach with the basic unit of analysis being the watershed. This process could identify actions associated with habitat improvement within the HMAs. The BLM would continue to conduct monitoring to assess progress toward meeting rangeland health standards. Wild horses would continue to be a component of the public lands, managed within its multiple use mission.
While there is no anticipation for amendments to WFRHBA, any amendments may change the management of wild horses on the public lands. However, it is not possible to foresee what such changes may entail, and the BLM will follow the will of the US Congress in this regard if such changes are enacted.
If the BLM and USFS can achieve AML on a national basis, the timing of gathers should become more predictable due to facility space. Improved population growth suppression (PGS) may also become more readily available as a management tool, with treatments that last for a longer duration; this would reduce the need to remove as many wild horses and possibly extending the time between gathers. The combination of these factors could result in an increase in stability of gather schedules and longer periods of time between gathers and help resolve issues leading to the over population of wild horses in the proposed gather area.

The proposed gather area contains a variety of resources and supports a variety of uses. Any alternative course of wild horse management has the opportunity to affect and be affected by other authorized activities ongoing in and adjacent to the area. Future activities which could be expected to contribute to the cumulative impacts of implementing the Proposed Action include: future wild horse gathers, continuing livestock grazing in the allotments within the area, mineral exploration, new or continuing infestations of invasive plants, noxious weeds, and pests and their associated treatments, and continued native wildlife populations and recreational activities historically associated with them. The significance of cumulative effects based on past, present, proposed, and reasonably foreseeable future actions are determined based on context and intensity.

The "Greater Sage-Grouse Conservation Assessment and Strategy for Oregon" (Hagen 2011), the Oregon Sage-Grouse Action Plan (Sage-Grouse Conservation Partnership, 2015), and the Oregon Greater Sage-Grouse ARMPA (2015a) will continue to guide wild horse management as it relates to maintaining or enhancing Greater Sage-Grouse habitat. The plans emphasize appropriate wild horse management throughout the Vale District in the future.

4.4 Summary of Past, Present, and Reasonably Foreseeable Future Actions

Impacts Common to Action Alternatives (1, 2, and 4)

The cumulative effects associated with the capture and removal of excess wild horses includes gather-related mortality of less than 1% of the captured animals, about 5% per year associated with transportation, off-range corrals, adoption or sale with limitations and about 8% per year associated with off-range pastures (Government Accountability Office, GAO-09-77, p. 49). This compares with natural mortality on the range ranging from about 5-8% per year for foals (animals under age 1), about 5% per year for horses ages 1-15, and 5-100% for animals age 16 and older. In situations where forage and/or water are limited, mortality rates increase, with the greatest impact to young foals, nursing mares and older horses.

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 for this purpose. A similar limitation was placed on the use of FY2021 appropriated funds.

The other cumulative effects which would be expected when incrementally adding either of the Action Alternatives to the CSA would include continued improvement of upland 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.

Impacts of Alternative 3 (Fertility Control Vaccines Only) and Alternative 5 (No Action)

Under Alternative 3 and the No Action Alternative, the wild horse populations could exceed the low end of AML by approximately fiftenn to twenty-one times in eleven years. Under both alternatives, wild horse movement outside the HMAs would be expected as greater numbers of horses search for food and water for survival, thus impacting larger areas of public lands. Heavy to severe utilization of the available forage would be expected and the water available for use could become increasingly limited. Eventually, ecological plant communities would be damaged to the extent that they are no longer sustainable and the wild horse population would be expected to crash, but not before causing extensive and long-lasting ecological damage (NAS 2013).

Emergency removals could be expected under these alternatives in order to prevent individual animals from suffering or death as a result of insufficient forage and water. During emergency conditions, competition for the available forage and water increases. This competition generally impacts the oldest and youngest horses as well as lactating mares first. These groups would experience substantial weight loss and diminished health, which could lead to their prolonged suffering and eventual death. If emergency actions are not taken, the overall population could be affected by severely skewed sex ratios towards stallions as they are generally the strongest and healthiest portion of the population. An altered age structure would also be expected, with decreased numbers of very young animals.

Cumulative impacts would result in foregoing the opportunity to improve rangeland health and to properly manage wild horses in balance with the available forage and water and other multiple uses. Attainment of site-specific vegetation management objectives and Standards for Rangeland Health would not be achieved. AML would not be achieved and the opportunity to collect the scientific data necessary to re-evaluate AML levels, in relationship to rangeland health standards, would be foregone.

5.0 CONSULTATION AND COORDINATION

5.1 Agencies and Individuals Consulted

BLM Oregon/Washington Policy, (IM 2015-037 - ePlanning Phase 1 Implementation Minimum Standards for Oregon and Washington, USDI, 2015e) guides Vale District to use ePlanning to post NEPA documents, therefore, this EA and all related information are posted on the ePlanning site. A notice of availability of the EA and request for comment will be mailed to 76 interested individuals, groups, and agencies for a 30-day public comment period.

5.2 Interdisciplinary Team

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Marcella Tiffany, Range Management Specialist (Livestock Grazing Management, Vale District)
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Monica Ketchum, Wildlife Biologist (SSS-Animals, Migratory Birds, Wildlife, Vale District)
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Chelsie Dugan, Natural Resource Specialist (Riparian, Water Quality, Soils, BSCs, Vale District)
Brent Grasty, District Planning and Environmental Coordinator, Vale District
Dan Thomas, Outdoor Recreation Planner (Wilderness, WSR, WSAs, Recreation, Vale District)
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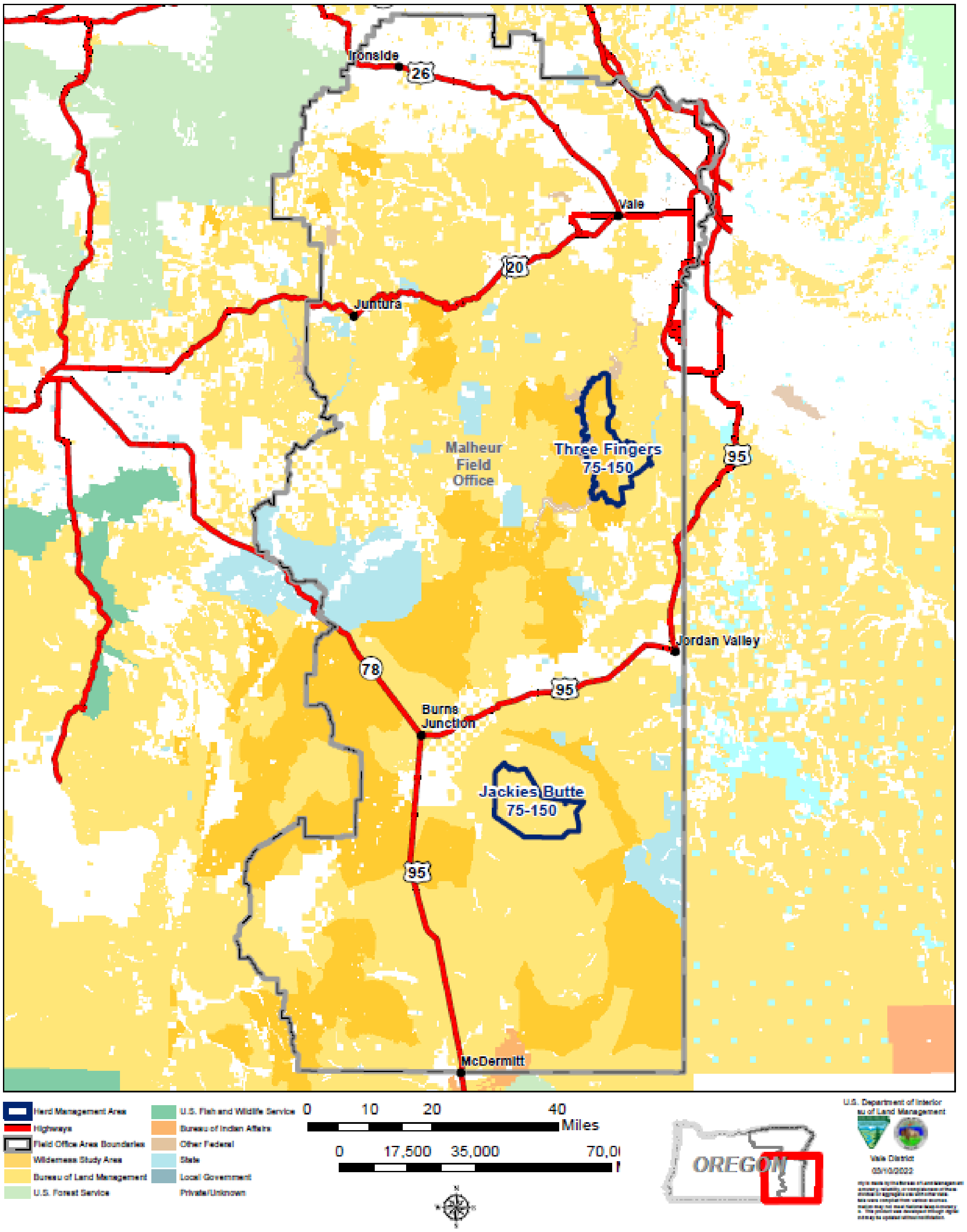
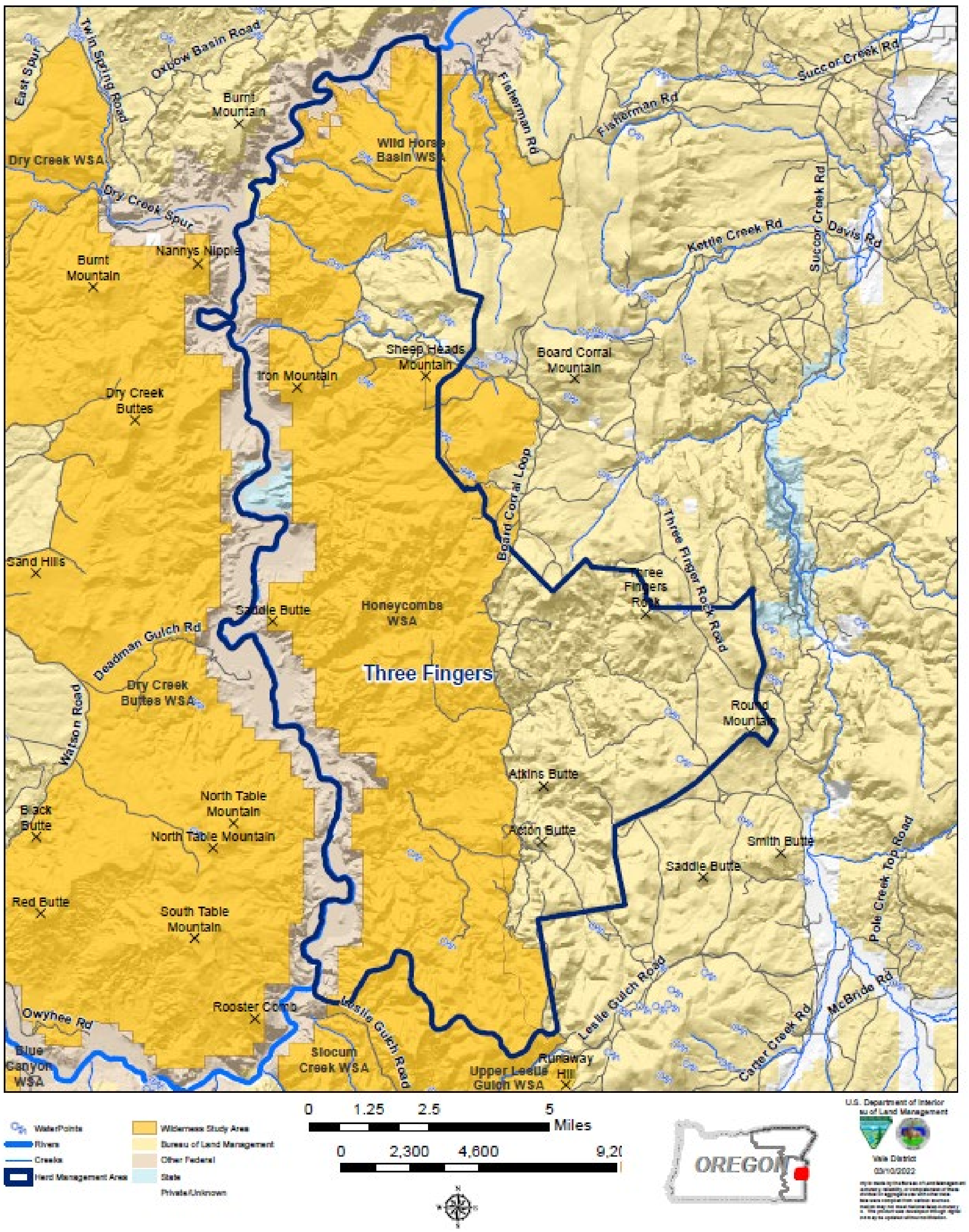
7.0 APPENDICES

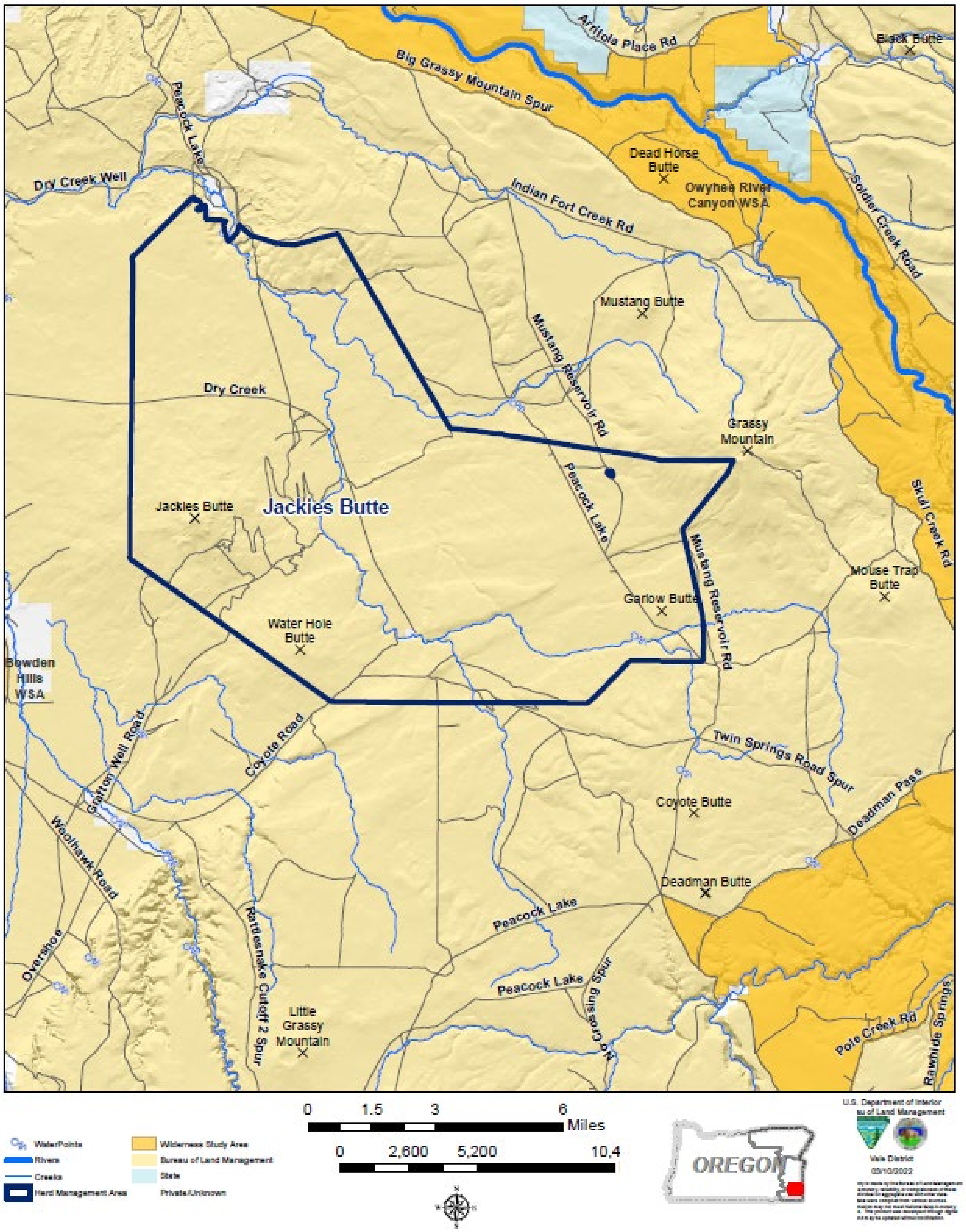
Appendix A – Three Fingers and Jackies Butte HMAs Vicinity Map



Appendix B – Three Fingers Herd Management Area Map



Appendix B – Jackies Butte Herd Management Area Map



Appendix C - Issues Considered But Not Analyzed in Detail

The following issues were raised by the public or Bureau of Land Management (BLM) during scoping and internal reviews for similar projects. These issues have been considered but eliminated from detailed analysis because they are outside the scope of this analysis or do not relate to how the proposed action or alternatives respond to the purpose and need:

- ***Can livestock AUMs be reduced to raise wild horse AUMs or enlarge HMAs?***
  Response: This is outside the scope of this document as Appropriate Management Level (AML) for wild horses, the HMA boundaries, and the livestock forage allocations are identified in the SEORMP ROD (2002, pp. 55-60).

- ***All information is requested on all of the horses previously captured in this HMA so the impacts of the roundup on horses can be adequately assessed.***
  Response: This information is summarized in Table 2 of the EA. Detailed information is available at the Vale District Office through the Freedom of Information Act (FOIA).

- ***Can BLM analyze and develop projects to prevent horses from leaving the HMA?***
  Response: This it outside the scope of this document as it does not fit the purpose and need.

- ***Can the EA disclose water usage of each oil and gas rig, wind turbine and geothermal plant; the number of acres designated for buildings/equipment associated with them; and their effects on sage-grouse, wildlife and wild horses?***
  Response: This issue is outside the scope of the analysis as there are no oil/gas rigs, wind turbines, or geothermal plants within the vicinity of the HMAs.

- ***Can BLM analyze and decrease the hunting of predators in the vicinity of Three Fingers HMA and Jackies Butte HMA, so they can be used as a natural method of population control?***
  Response: Predator control is outside the purview of the Vale District BLM. It is managed by Oregon Department of Fish and Wildlife, therefore, will not be analyzed in this document.

Appendix D – PIM 2021-002 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

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

Responsibilities Section	Responsibility
	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 E –Standard Operating Procedures for Population-level Fertility Control Treatments

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.

SOPs for Insertion of Y-shaped Silicone IUD for Feral Horses

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 (Fig. 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 (Fig. 1), and a plastic stopper attached to the other end (Fig. 2).

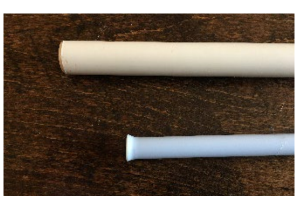


Figure 1. Interior and exterior pipes (unassembled), showing the ends that go into the mare

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 (Fig. 3).

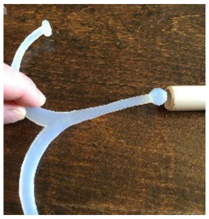


Figure 3. Insert the stem end of the IUD into the exterior pipe.

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

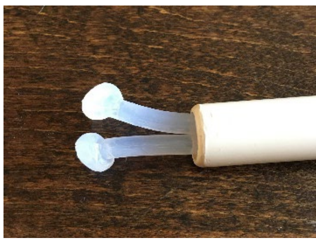


Figure 4. Insert the IUD until just the tips of the 'legs' are showing.

<u>Restraint and Medication</u>: 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.

Only a veterinarian shall oversee this procedure and insert IUDs. 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.

<u>Insertion Procedure</u>:

- 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.

Appendix F – Genetics Information

Genetic samples were taken for the purpose of monitoring genetic diversity during the 2011 gathers in both HMAs, and analysis was completed by E. Gus Cothran from Texas A&M University in 2012.

Genetics analysis in Three Fingers HMA was completed by using hair follicle samples collected from 50 horses (Cothran, 2012a). These samples indicated that observed genetic diversity within the Three Fingers HMA was high. Observed heterozygosity was 0.710 (Table A), which was very slightly lower than the recorded mean for wild horse herds. Because of the high allelic diversity measured at that time, many of the alleles present were found at low frequency, so that Cothran noted there was a high percentage of allelc diversity at risk. However, no unique or unusual alleles were noted, so it appears that the loss of alleles from this hered would not lead to loss of diversity at a larger scale of multiple wild horse herds. Cothran (2012a) stated that the ratio of observed heterozygosity to expected heterozygosity may have indicated population subdivision or inbreeding. However, in this case the difference was not great enough to suggest inbreeding at a rate that would cause concern. Highest mean genetic similarity of the Three Fingers HMA was with Light Racing and Riding breeds, followed closely by the North American Gaited breeds.

Three Fingers HMA baseline genetic diversity was previously sampled in 2002 (Cothran, 2003). The reports were based upon blood typing data but DNA data was collected and can be directly compared to the current data. Overall, genetic diversity levels in 2011 samples were similar to those from 10 years earlier. This herd appears to be similar to the feral horse mean in terms of genetic variation. Samples indicated that the herd was of mixed origins with no clear indication of primary breed type.

Genetics analysis in Jackies Butte HMA was completed by using hair follicle samples collected from 40 horses (Cothran, 2012b). These samples indicated that genetic diversity within the Jackies Butte HMA was well above the feral mean. Obseved heterozygosity was 0.750 (Table A). Highest mean genetic similarity of the Jackies Butte HMA was with Light Racing and Riding breeds and Old World Iberian breeds.

Jackies Butte HMA baseline genetic diversity was previously sampled in 2001 (Cothran, 2001), but it is unknown how many samples were taken as this number is not included in the report. The reports were based upon blood typing data but DNA data was collected and can be directly compared to the current data. In the samples that led to the 2001 report, genetic diversity of the Jackies Butte HMA was described as low and at a level that would indicate concern. The 2011 report shows that this diversity is well above the feral horse mean and, therefore, appeared to have improved over the decade. From 1988 to 1994, there were 17 wild horses from six other Oregon herds introduced into Jackies Butte to maintain genetic diversity. BLM has long understood the importance of keeping genetic diversity in these herds. The 2001 report indicated that, in comparison with other Oregon herds, the Jackies Butte herd shows closest resemblance to the Coyote Lake/Alvord-Tule Springs and Paisley herds

Because of history, context, and genetic relatedness, wild horses that live in the Three Fingers HMA and the Jackies Butte HMA should not be considered as a truly isolated populations (NAS 2013). Rather, managed herds of wild horses should be considered as components of interacting metapopulations, connected by interchange of individuals and genes over time, due to both natural and human-facilitated movements. These animals are part of part of a larger metapopulation (NAS 2013) that has demographic and genetic connections with other federally-managed herds in Oregon, and beyond. Wild horse herds in the larger metapopulation have a background of diverse domestic breed heritage, probably caused by natural and intentional movements of animals between herds. Under the action alternatives, hair samples would be collected during gathers to assess the genetic diversity of the herds at the time of the gather. Analysis would determine whether management is maintaining acceptable genetic diversity (and avoiding excessive risk of inbreeding depression). Under all action alternatives, fertile wild horse introductions could augment observed heterozygosity, which is a measure of genetic diversity. The result of introductions should be to reduce the risk of inbreeding-related health effects. Introducing a small number of fertile animals every generation (about every 8-10 years) is a standard wild horse management technique that can alleviate potential inbreeding concerns.

The 2013 National Academies of Sciences report included other evidence that shows that the herds in Three Fingers HMA and Jackies Butte HMA are not genetically unique or extremely 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 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 of 0.10 or lower indicate 'very little differentiation.' Only if values are above about 0.15 are any two sampled subpopulations considered to have evidence of 'elevated differentiation' (Frankham et al. 2010). Fst values for samples from the Three Fingers HMA samples (Cothran 2012a) had pairwise Fst values that were less than 0.05 with over 80 other sample sets. Fst values for samples from the Jackies Butte HMA samples (Cothran 2012a) had pairwise Fst values that were less than 0.05 with over 100 other sample sets. These results suggest that both herds have little genetic differentiation, compared to a very large number of other federally-managed herds in many western states. These results support the interpretation that the wild horses living in Three Fingers HMA and Jackies Butte HMA are components in a highly connected metapopulation that includes many wild horse herds.

Table A is a summary of the genetic report within both of the HMAs. The observed heterozygosity (Ho) is a measure of how much diversity is found, on average, within individual animals in a wild horse herd and is insensitive to sample size, although the larger the sample, the more robust the estimate. Ho values below the mean for feral populations are an indication that the wild horse herd may have diversity issues. Herds with Ho values that are one standard deviation below the mean are considered at critical risk. The Fis is the estimated inbreeding level (ratio of 1-Ho/He). Fis levels greater than 0.25 are considered the critical level and suggestive of an inbreeding problem. The key to remember is that BLM is not managing for genotype and that there are no rare genetic variants present. We are managing for horse characteristics (phenotype) and to maintain adequate variability.

Table A: Genetic Variability Measures Comparison.
Results of genetic monitoring from the most recently samples, from CLAT, SSHC, and Sand Springs HMAs, including observed heterozygosity (Ho), the effective number of alleles (Ae), and the estimated inbreeding level (Fis). For comparison, the mean and standard deviation (SD) values for feral horse herds are also shown. Numbers in parentheses () are from the blood typing DNA results, therefore, need to be compared to the respective SD.

	H_o	A_e	F_{is}
Three Fingers HMA 2011	0.710	2.93	0.058
Three Fingers HMA 2003	(0.412)	(2.320)	(0.006)
Jackies Butte HMA 2011	0.750	2.93	0.027
Jackies Butte HMA 2001	(0.297)	(2.343)	(0.036)
Feral Horse mean	0.716 SD=0.056 (0.360) (SD=0.051)	3.87 SD=0.66 (2.218) (SD=0.339)	-0.012 SD=0.071 (-0.035) (SD=0.118)

Cothran, E. Gus. 2001. *Genetic Analysis of the Paisley Desert, Alvord Tule Springs, Coyote Lake, Jackies Butte and Murderer's Creek HMAs from Oregon.* Department of Veterinary Science, Univeristy of Kentucky. Lexington, KY 40546-0076.

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Appendix G – 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).

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 that animals I 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 3 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).

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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. While wild horses and burros may have some beneficial ecological effects, such benefits are outweighed by ecological damage they cause when herds are at levels greater than supportable by allocated, available natural resources (i.e., when herds are greater than AML).

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).

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. For the majority of wild horse herds, there is little overall evidence that population growth is significantly affected by predation, although wild horse herd growth rates may be somewhat reduced by predation in some localized areas, particularly where individual cougars specialize on horse predation (Turner and Morrison 2001, Roelle et al. 2010). Andreasen et al. (2021) recently found that some mountain lions (*Puma concolor*) prey on young horses, particularly where horses are at very high densities and native ungulates are at very low densities. In that study, the greatest rate of predation on horses was in the Virginia Range, where the state of Nevada manages a herd of feral horses that is not federally protected. Where lion predation on horses was common, Andreasen et al. (2021) found that female lions preyed on horses year-round, but 13% or fewer of horses killed by lions were adults. BLM does not have the legal authority to regulate or manage mountain lion populations, and it is not clear whether there are any mountain lions in the three Fingers or Jackies Butte HMAs that specialize on horse predation. Andreasen et al. (2021) concluded that “At landscape scales, cougar predation is unlikely to limit the growth of feral horse populations.” Given the recent history of consistent annual herd growth rates in the Three Fingers and Jackies Butte HMAs, the inference that predation does not limit local wild horse herd growth rates there apparently applies.

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 et al. 2021). 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 nonnative 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).

Wild horses and burros may have ecologically beneficial effects, especially when herd sizes are low relative to available natural resources, but those ecological benefits do not typically outweigh damage caused when herd sizes are high, relative to available natural resources. Under some conditions, there may not be observable competition with other ungulate species for water (e.g., Meeker 1979), but recent studies that used remote cameras have found wild horses excluding native wildlife from water sources under conditions of relative water scarcity (Perry et al. 2015, Hall et al. 2016, Hall et al. 2018). Wild burros (and, less frequently, wild horses) have been observed digging 'wells;' such digging may improve habitat conditions for some vertebrate species and, in one site, may improve tree seedling survival (Lundgren et al. 2021). This behavior has been observed in intermittent stream beds where subsurface water is within 2 meters of the surface (Lundgren et al. 2021). The BLM is not aware of published studies that document wild horses or burros in the western United States causing similar or widespread habitat amelioration on drier upland habitats such as sagebrush, grasslands, or pinyon-juniper woodlands. Lundgren et al. (2021) suggested that, due to well-digging in ephemeral streambeds, wild burros (and horses) could be considered 'ecosystem engineers;' a term for species that modify resource availability for other species (Jones et al. 1994). Rubin et al. (2021) and Bleich et al. (2021) responded by pointing out that ecological benefits from wild horse and burro presence must be weighted against ecological damage they can cause, especially at high densities. In HMAs where wild horse and burro biomass is very large relative to the biomass of native ungulates (Boyce and McLoughlin 2021), they should probably also be considered 'dominant species' (Power and Mills 1995) whose ecological influences result from their prevalence on the landscape. Wild horse densities could be maintained at high levels in part because artificial selection for early or extended reproduction may mean that wild horse population dynamics are not constrained in the same way as large herbivores that were never domesticated (Boyce and McLoughlin 2021). Another potentially positive ecological effect of wild horses and burros is that they, like all large herbivores, redistribute organic matter and nutrients in dung piles (i.e., King and Gurnell 2007), which could disperse and improve germination of undigested seeds. This could be beneficial if the animals spread viable native plant seeds, but could have negative consequences if the animals spread viable seeds of invasive plants such as cheatgrass (i.e,, Loydi and Zalba 2009, King et al. 2019). Increased wild horse and burro density would be expected to increase the spatial extent and frequency of seed dispersal, whether the seeds distributed are desirable or undesirable. As is true of herbivory by any grazing animals, light grazing can increase rates of nutrient cycling (Manley et al. 1995) and foster compensatory growth in grazed plants which may stimulate root growth (Osterheld and McNaughton 1991, Schuman et al. 1999) and, potentially, an increase in carbon sequestration in the soil (i.e., Derner and Schuman 2007, He et al. 2011). However, when grazer density is high relative to available forage resources, overgrazing by any species can lead to long-term reductions in plant productivity, including decreased root biomass (Herbel 1982, Williams et al. 1968) and potential reduction of stored carbon in soil horizons. Recognizing the potential beneficial effects of low-density wild horse and burro herds, but also recognizing the totality of available published studies documented ecological effects of wild horse and burro herds, especially when above AML (as noted elsewhere), it is prudent to conclude that horse and burro herd sizes above AML may cause levels of disturbance that reduce landscapes' capacity for resilience in the face of further disturbance, such as is posed by extreme weather events and other consequences of climate change.

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).

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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 mare sterilization and gelding. 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 crossreact 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 (suggested by the "~"symbol) is measured as the relative decrease in foaling rate for treated mares, compared to control mares:

Year 1		
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			
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 7 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 about 50% (Baker et al. 2017), to 61% (Gray et al. 2010), to about 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 8 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 lead 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 sterilized 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).

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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 weather severity 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 surgically sterilized (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 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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Intrauterine Devices (IUDs)

IUDs are not considered to be a main method of any action alternative identified in this EA. The potential effects of IUDS are, however, included in this analysis for the purpose of comparison with immunocontraceptive vaccines, and in the event that a small number of mares from the Jackies Butte HMA or Three Fingers HMA may be treated with IUDs.

IUDs are considered a temporary fertility control method that does not generally cause future sterility (Daels and Hughes 1995). In any potential BLM application of IUDs as a part of fertility control in wild mares, it is expected that IUDs would only be inserted in non-pregnant (open) mares, and only by a veterinarian. Wild mares receiving IUDs would be checked for pregnancy prior to insertion of an IUD. 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 application used Y-shaped silicone IUDs (EPA 2020) 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. 2021). 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. 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. (2021) 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. Similarly, a flexible IUD with three components connected by magnetic force (the 'iUPOD') was retained over 90 days in mares living and breeding with a fertile stallion; after IUD removal, the majority of mares became pregnant in the following breeding season (Hoopes et al. 2021).

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, as they survive and regain fertility.

The exact mechanism by which IUDs prevent pregnancy is uncertain (Daels and Hughes 1995, Gradil et al. 2021, Hoopes et al. 2021). Turner et al (2015) suggested that the presence of an IUD in the uterus may, like a pregnancy, prevent the mare from coming back into estrus. However, some domestic mares did exhibit repeated estrus cycles during the time when they had IUDs (Killian et al. 2008, Gradil et al. 2019, Lyman et al. 2021, Hoopes et al. 2021). The main cause for an IUD to not be effective at contraception is its failure to stay in the uterus (Daels and Hughes 1995, NAS 2013). 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 by a veterinarian, in non-pregnant (open) mares. Wild mares receiving IUDs would be checked for pregnancy by a veterinarian 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. Only a veterinarian would apply IUDs in any BLM management action. 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 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, Lyman et al. 2021). 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. 2021). 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, Gradil et al. 2021, Hoopes 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), but more recent trials have shown that the magnetic IUD was retained even in the presence of breeding with a fertile stallion (Hoopes et al. 2021). 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). Because IUDs may prolong the time between estrus, but still allow for some degree of estrus behavior, it could be surmised that treated mares would continue to engage in behaviors consistent with estrus, though perhaps at somewhat reduced frequency. The demographic effects of temporary infertility due to IUDs use would also be comparable to those expected from PZP or GonaCon vaccination.

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Effects of Sterilzation

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 sterilizing mares and gelding stallions. Sterilizing a female horse (mare) or burro (jenny) can be accomplished by several methods, some of which are surgical and others of which are non-surgical. In this review, surgical mare sterilization generally refers to removal of the ovaries, but other surgical methods such as tubal ligation, or laser ablation of the uterotubal junctions that lead to sterility may also be considered forms of mare sterilization. Unlike in dog and cat spaying, surgical sterilization of a female horse or burro does not entail removal of the uterus. Here, 'gelding' is defined to be the sterilization of a male horse (stallion), 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. Gelding 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 (other than the sterility itself), 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.

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-sustaining 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 (e.g., NAS 2013, Appendix F), and BLM routinely moves animals from one to another to improve local herd traits and maintain adequate 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. Over 70,000 adult wild horses and nearly 15,000 adult wild burros roamed BLM lands as of March 1, 2021, 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 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), mare sterilization and gelding 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 sterilizing some mares or gelding some stallions 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 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.

Gelding Males

Castration (the surgical removal of the testicles, also called gelding or gelding) is a surgical procedure for 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 have 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 gelded 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 gelded 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 gelded males), the result will be that there will be a lower number of breeding females in the population. Including gelded 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). Initial results from the Conger herd, in which geldings were in a partially non-reproducing herd, indicate that geldings continued to behave, move and use habitat in a way that was not distinguishable from other horses (King et al., 2020). 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). However, BLM is not pursuing the chemical vasectomy method. The NAS panel noted that, even though chemical vasectomy had been used in dogs and cats up to that time, "There are no published reports on chemical vasectomy in horses..." and that, "Only surgical vasectomy has been studied in horses, so side effects of the chemical agent are unknown." The only known use of chemical vasectomy in horses was published by Scully et al. (2015); this was part of a study cited in the EA (Collins and Kasbohm 2016). They injected chlorhexidine into the stallions' epididymis. That is the same chemical agent as had been used to chemically vasectomize dogs. Scully et al. (2015) found that the chemical vasectomy method failed to prevent fertile sperm from being located in the vas deferens seminal fluid. Stallions treated with the chemical vasectomy method still had viable sperm and were still potentially as fertile as untreated 'control' stallions in that study. Thus, the method was not effective.

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 surgically sterilized mares 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). Unpublished USGS results from a study at Conger HMA indicate that a non-zero fraction of geldings that were returned to the range with their social band did continue with females, apparently excluding fertile stallions, for at least 2 years.

Despite these studies, gelded 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 gelded males in a herd need not necessarily be to reduce female fertility (although that may be one result). Rather, by including some gelded males in a herd that also has fertile mares and stallions, the gelded 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 gelded 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 gelded 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 Gelding

No animals which appear to be distressed, injured, or in poor health or condition would be selected for gelding. Stallions would not typically be gelded 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 gelding in the Antelope / Triple B gather EA, DOI-BLM-NV-E030-2017-010-EA).

Though gelding 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 but, as noted above, the study by Scully et al. (2015) indicated that the method was not effective in feral horses on the Sheldon NWR.

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 Gelding

Other than the short-term outcomes of surgery, gelding 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 or not a given gelded 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. Gelding 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 gelded 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 Gelding

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.

Gelding 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 about 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 castrating 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 have not yet been published. However, there is no statute or regulation that requires BLM to wait for the results of any study before it utilizes a particular population control method, and the notion cannot be squared with the WHA, which expressly authorizes sterilization and requires BLM to remove excess animals to achieve appropriate management levels "immediately" upon determining that an overpopulation exists and that action is necessary to remove excess animals.In the meantime, 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, though preliminary results from the Conger HMA suggest that the frequency of agonistic behaviors in recently-gelded males was not significantly different from that of fertile stallions (King et al. 2020). 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 castrated, 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. Unpublished USGS results from the Conger study herd indicate that geldings' movement patterns were not qualitatively different from those of fertile stallions, when controlling for social status as bachelor or harem 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

Herd-level birth rate is expected to decline in direct proportion to the fraction of sterilized mares in the herd because sterilized mares cannot become pregnant. Sterilizing 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: minimally invasive physical sterilization, pharmacological or immunocontraceptive sterilization, surgical sterilziation via colpotomy, and surgical sterilization via flank laparoscopy. Minimally invasive, physical forms of sterilization, such as trans-cervical methods that occlude the oviduct, are not labeled as spaying in this review, but may have similar physiological outcomes as surgical methods that leave the ovaries intact. Surgical removal of the ovaries (ovariectomy) would not be considered as a management action under Alternative 2. Only safe and humane methods of minimally-invasive physical sterilization, or pharmacological or immunocontraceptive sterilization would be considered for use in these HMAs. The surgical ovariectomy methods are only included in this analysis for the purposes of comparison, and because some anticipated results of sterilization would likely be common to multiple methods. Regardless of the method, the anticipated effects on the individual would be both physical and, potentially, behavioral. Physical effects of surgical methods would be due to post-treatment healing and the possibility for complications.

Minimally invasive, physical sterilization would include any physical form of sterilization that does not involve extensive incision, or removal of the ovaries. 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). Another form involves using a laser to cause scarring of less than about 1 cm^2 at the uterotubal junctions (Edwards 2021). Treated mares would need to be screened by a veterinarian (i.e., via transrectal ultrasonography) 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. However, additional NEPA analysis would be included before such a method is used in the areas considered here.

Ovariectomy via colpotomy is a surgical technique in which there is no external incision, reducing susceptibility to infection. That surgical method is not under consideration for use in these HMAs. Surgical sterilization in which a mare's ovaries are removed via colpotomy has been an established veterinary technique since 1903 (Loesch and Rodgerson 2003, NAS 2013). Such sterilization 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. 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.

Ovariectomy via 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. That surgical method is not under consideration for use in these HMAs. 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.

Effects of Mare Sterilization on Pregnancy and Foal

The minimally invasive sterilization techniques noted above require a trans-cervical technique, so those mares would have been screened for pregnancy ahead of time, and no pregnant mares would be treated with those minimally-invasive sterilization methods. If a mare treated with those methods were to become pregnant (i.e., because scarring of the oviduct or oviduct papilla did not permanently block eggs from reaching the uterus) then it is expected that pregnancies and foal development would proceed normally throughout the duration of the pregnacy, because the ovaries would still be functional.

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 an ovariectomy 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 Mare Sterilization

Minimally invasive sterilization methods are expected to have only minor and transient physical effects on treated mares, other than the blockage of the oviduct and prevention of pregnancy. In the case of the use of surgical grade cyanoacrylate use to cause oviduct occlusion, some scarring of the oviduct is the desired result, but that effect is localized and not anticipated to cause long-term discomfort. Similarly, laser ablation of the oviduct papilla is expected to cause scarring on a very small portion of uterine tissue (the papilla and a few square millimeters of tissue nearby), and to not cause long-term discomfort. The attending veterinarian would be responsible to provide appropriate analgesics for any animal treated, to alleviate short-term discomfort. Mortality due to either form of minimally-invasive sterilization method described here is not expected to take place.

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 8 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 mare ovariectomy surgeries on mares have low morbidity[3] 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

[3] Morbidity is defined as the frequency of the appearance of complications following a surgical procedure or other treatment. In contrast, mortality is defined as an outcome of death due to the procedure.

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 sterilizing wild horse mares that live with other fertile and infertile wild horses has not been well documented, but the literature review below provides evidence that 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 removal of the ovaries (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 ovariectomy usually greatly reduces female sexual behavior in companion animals (Hart and Eckstein 1997). In six ponies, mean monthly plasma luteinizing hormone[4] 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 different forms of sterilization on mares' social interactions and group membership can be inferred from available literature, even though wild horses have rarely been sterilized and released back into the wild, resulting in relatively few studies that have investigated their behavior in free-roaming populations. Wild horses and burros are instinctually herdbound and this behavior is expected to continue. Overall, the BLM anticipates that all mares treated with minimally-invasive sterilization methods would continue to exhibit estrus behavior which could foster band cohesion. Because these minimally-invasive sterilization methods do not remove the ovaries, the behavioral results could be similar to that observed for some mares treated with PZP, in that they could continue to cycle thougout the breeding season. The same may be true for some ovariectomized mares, which would be consistent with research that demonstrated continuing estrus behavior in ovariectomized mares, comparable to the effects seen in the anovulatory (non-breeding) season in intact mares (Asa et al. 1980). If freeranging 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

[4] Luteinizing hormone (LH) is a glycoprotein hormone produced in the pituitary gland. In females, a sharp rise of LH triggers ovulation and development of the corpus luteum. LH concentrations can be measured in blood plasma.

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. Insofar as minimally invasive mare sterilization techniques considered here would not remove the ovaries, it is likely that the the behavior of such treated mares may be comparable to the behavior of mares treated with PZP vaccine; that is, the continuation of estrus behavior at roughly 21 day cyclicity throughout the breeding season. As noted by the NAS (2013), the ideal fertility control method would not eliminate sexual behavior or change social structure substantially, and it appears that the various forms of mare sterilization noted here would most likely allow for the continuation of such behaviors.

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 yearround (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 sterilizing 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 sterilized 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.

Because mares treated with minimally-invasive sterilization methods may accrue greater fat reserves than pregnant and nursing foals, they may attain higher body condition scores and survive longer – as has been observed in mares treated with immunocontraceptive vaccines. In domestic animals, ovariectomy 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 sterilized mares. In horses, ovariectomy 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 (ovariohysterectomized) 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.

Ovariectomy 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 ovariectomy 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 sterilization 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 sterilized mares will change their spatial use patterns, but not having 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). Since treated females maintained group associations, this indicates that their movement patterns and distances may be unchanged.

Regardless of the method, sterilizing wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether sterilized mares would continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that sterilized 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 sterilized 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 sterilizing wild horses will cause them to lose their free-roaming nature.

A sterilized 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[5], 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).

Sterilization 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 Surgical Sterilization on Bone Histology

The BLM knows of no scientific, peer-reviewed literature that documents bone density loss in mares following ovariectomy. Nor would there be any such concern expected to result from any suterilization method that leaves the ovaries intact. 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

[5] "wild free-roaming horses and burros" means all unbranded and unclaimed horses and burros on public lands of the United States.

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 Mare Sterilization and Gelding

It is true that sterilized females and gelded 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.

Even in the action alternative that includes inclusion of some sterile animals in a partially non-reproducing herd, the HMAs under consideration in this EA would retain at least half of each herd as potentially breeding. 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, sterilizing some mares and / or gelding some stallions 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 fertile animals every generation (about every 10 years) is a standard management technique that can alleviate 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, and that is the case in both Three Fingers HMA and Jackies Butte HMA.

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, gelding 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.

Roelle and Oyler-McCance (2015) conclude that nothing in their results indicate wild horse managers should preclude the use of permanent contraceptive techniques, as long as results are monitored, and adjustments are made if necessary. They found little risk of local population decline or of genetic diversity loss due to mare sterilization unless starting population sizes and levels of genetic diversity were exceptionally small (Roelle and Oyler-McCance 2015). Vale BLM would be meeting WFRHBA, the WHB Handbook, and SEORMP and all other objectives by continuing to monitor the herd population and releasing horses to keep the numbers within AML.

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Appendix H - WinEquus Population Modeling

These population models were run based on the June 2019 simultaneous double count aerial surveys. The fertility control alternatives were adjusted for GonaCon to show success rates of 1 year = 90%, 2nd year = 85%, 3rd year = 80%, 4th year = 50% and 5th year =50%. The model does not provide a way to compute Alternative 2 so it is assumed with a smaller breeding population, the numbers would be similar or smaller than the Proposed Action.

THREE FINGERS HMA

Proposed Action – Alternative 1 (Gather and Fertility Control)

Average Growth Rate in 10 Years

Lowest Trial	4.7
10th Percentile	8.9
25th Percentile	10.5
Median Trial	**12.5**
75th Percentile	15.0
90th Percentile	16.8
Highest Trial	21.5

Population Sizes in 11 Years*

	Minimum	**Average**	**Maximum**
Lowest Trial	65	116	289
10th Percentile	75	127	296
25th Percentile	80	134	302
Median Trial	**85**	**146**	**315**
75th Percentile	90	160	334
90th Percentile	93	168	364
Highest Trial	98	190	442

* 0 to 20+ year-old horses

Totals in 11 Years*

	Gathered	**Removed**	**Treated**
Lowest Trial	369	158	25
10th Percentile	403	241	42
25th Percentile	424	257	52
Median Trial	**452**	**284**	**58**
75th Percentile	480	328	65
90th Percentile	509	358	70
Highest Trial	532	419	84

* 0 to 20+ year-old horses

Alternative 2 (Non-Reproducing Portion of Herd)

This was run with Removals Only and Removals/Fertility Control to cover a range of options with populations under this alternative.

Average Growth Rate in 10 Years (Removals Only and Removals+Fertility Control)

Lowest Trial	9.1	4.3

10th Percentile	12.0	9.3
25th Percentile	14.3	11.9
Median Trial	**16.3**	**15.9**
75th Percentile	18.7	18.3
90th Percentile	20.2	20.5
Highest Trial	22.4	23.4

Population Sizes in 11 Years*

	Minimum	Average	Maximum	Minimum	Average	Maximum
Lowest Trial	30	89	287	32	85	288
10th Percentile	37	95	296	39	95	294
25th Percentile	42	100	303	43	99	300
Median Trial	**45**	**104**	**312**	46	106	312
75th Percentile	47	109	328	52	115	328
90th Percentile	50	115	354	64	129	348
Highest Trial	54	128	402	79	141	425

Totals in 11 Years*

	Gathered	Removed	Gathered	Removed	Treated
Lowest Trial	256	233	305	167	6
10th Percentile	269	246	338	247	20
25th Percentile	278	253	348	256	26
Median Trial	**295**	**268**	375	274	32
75th Percentile	319	290	399	299	38
90th Percentile	344	316	429	327	43
Highest Trial	401	372	516	405	56

Alternative 3 (Fertility Control Only)

Average Growth Rate in 10 Years

Lowest Trial	11.6
10th Percentile	14.8
25th Percentile	15.9
Median Trial	**17.4**
75th Percentile	18.5
90th Percentile	19.8
Highest Trial	21.4

Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	275	550	1081
10th Percentile	295	647	1230
25th Percentile	300	734	1420
Median Trial	**311**	**805**	**1609**
75th Percentile	338	874	1792
90th Percentile	355	933	1919
Highest Trial	426	1036	2258

* 0 to 20+ year-old horses

Totals in 11 Years*

	Gathered	Removed	Treated
Lowest Trial	1605	0	673
10th Percentile	1813	0	772

25th Percentile	2044	0	859
Median Trial	**2280**	**0**	**963**
75th Percentile	2453	0	1029
90th Percentile	2628	0	1096
Highest Trial	2903	0	1275

* 0 to 20+ year-old horses

Alternative 4 (Gather Only)

Average Growth Rate in 10 Years

Lowest Trial	4.3
10th Percentile	14.0
25th Percentile	15.6
Median Trial	**17.5**
75th Percentile	19.5
90th Percentile	21.2
Highest Trial	25.1

Population Sizes in 11 Years*

	Minimum	**Average**	**Maximum**
Lowest Trial	54	101	288
10th Percentile	74	130	292
25th Percentile	79	134	299
Median Trial	**84**	**138**	**313**
75th Percentile	88	141	330
90th Percentile	91	143	356
Highest Trial	99	150	419

* 0 to 20+ year-old horses

Totals in 11 Years*

	Gathered	**Removed**
Lowest Trial	192	171
10th Percentile	275	252
25th Percentile	318	290
Median Trial	356	328
75th Percentile	372	344
90th Percentile	396	368
Highest Trial	460	424

* 0 to 20+ year-old horses

Alternative 5 (No Action)

Average Growth Rate in 10 Years

Lowest Trial	12.2
10th Percentile	14.3
25th Percentile	15.4
Median Trial	**17.1**
75th Percentile	18.3
90th Percentile	19.7
Highest Trial	22.9

Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	272	550	1058
10th Percentile	295	645	1178
25th Percentile	299	692	1339
Median Trial	310	767	1526
75th Percentile	330	834	1743
90th Percentile	352	910	1981
Highest Trial	427	1053	2393

* 0 to 20+ year-old horses

JACKIES BUTTE HMA

Proposed Action – Alternative 1 (Gather and Fertility Control)

Average Growth Rate in 10 Years

Lowest Trial	2.8
10th Percentile	6.6
25th Percentile	8.2
Median Trial	**9.9**
75th Percentile	11.9
90th Percentile	13.6
Highest Trial	16.3

Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	49	99	206
10th Percentile	72	118	210
25th Percentile	77	123	216
Median Trial	**82**	**129**	**223**
75th Percentile	87	135	232
90th Percentile	90	140	246
Highest Trial	95	155	276

* 0 to 20+ year-old horses

Totals in 11 Years*

	Gathered	Removed	Treated
Lowest Trial	280	91	45
10th Percentile	306	100	54
25th Percentile	324	109	60
Median Trial	**354**	**186**	**67**
75th Percentile	375	202	77
90th Percentile	392	218	87
Highest Trial	447	271	114

* 0 to 20+ year-old horses

Alternative 2 (Non-Reproducing Portion of Herd)

This was run with Removals Only and Removals/Fertility Control to cover a range of options with populations under this alternative.

Average Growth Rate in 10 Years (Removals Only and Removals+Fertility Control)

	Removals Only	Removals+Fertility Control
Lowest Trial	9.1	4.3
10th Percentile	12.0	9.3
25th Percentile	14.3	11.9
Median Trial	**16.3**	**15.9**
75th Percentile	18.7	18.3
90th Percentile	20.2	20.5
Highest Trial	22.4	23.4

Population Sizes in 11 Years*

	Minimum	Average	Maximum	Minimum	Average	Maximum
Lowest Trial	30	89	287	32	85	288
10th Percentile	37	95	296	39	95	294
25th Percentile	42	100	303	43	99	300
Median Trial	**45**	**104**	**312**	46	106	312
75th Percentile	47	109	328	52	115	328
90th Percentile	50	115	354	64	129	348
Highest Trial	54	128	402	79	141	425

Totals in 11 Years*

	Gathered	Removed	Gathered	Removed	Treated
Lowest Trial	142	131	225	111	18
10th Percentile	204	185	243	120	28
25th Percentile	212	195	266	126	33
Median Trial	**223**	**204**	290	166	39
75th Percentile	236	218	310	211	50
90th Percentile	258	236	338	234	58
Highest Trial	327	305	387	286	72

Alternative 3 (Fertility Control Only)

Average Growth Rate in 10 Years

Lowest Trial	12.5
10th Percentile	14.4
25th Percentile	15.8
Median Trial	**16.9**
75th Percentile	18.5
90th Percentile	19.4
Highest Trial	22.5

Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	141	310	625
10th Percentile	209	440	840
25th Percentile	212	475	957
Median Trial	**220**	**546**	**1130**
75th Percentile	230	612	1269
90th Percentile	250	650	1346
Highest Trial	279	770	1706

* 0 to 20+ year-old horses

Totals in 11 Years*

	Gathered	Removed	Treated
Lowest Trial	1190	0	486
10th Percentile	1330	0	548
25th Percentile	1405	0	598
Median Trial	**1570**	**0**	**660**
75th Percentile	1786	0	727
90th Percentile	1950	0	834
Highest Trial	2385	0	967

* 0 to 20+ year-old horses

Alternative 4 (Gather Only)

Average Growth Rate in 10 Years

Lowest Trial	10.0
10th Percentile	13.5
25th Percentile	14.9
Median Trial	**17.3**
75th Percentile	19.1
90th Percentile	20.3
Highest Trial	23.8

Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	47	111	206
10th Percentile	73	120	210
25th Percentile	78	124	214
Median Trial	**83**	**129**	**222**
75th Percentile	88	133	232
90th Percentile	91	136	256
Highest Trial	98	142	326

* 0 to 20+ year-old horses

Totals in 11 Years*

	Gathered	Removed
Lowest Trial	175	161
10th Percentile	194	174
25th Percentile	214	197
Median Trial	**276**	**258**
75th Percentile	302	282
90th Percentile	320	302
Highest Trial	348	320

* 0 to 20+ year-old horses

Alternative 5 (No Action)

Average Growth Rate in 10 Years

Lowest Trial	11.7
10th Percentile	13.2
25th Percentile	15.1
Median Trial	**16.8**

75th Percentile	18.4
90th Percentile	19.6
Highest Trial	21.3

Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	179	343	637
10th Percentile	208	422	784
25th Percentile	214	489	926
Median Trial	**222**	**547**	**1110**
75th Percentile	237	601	1222
90th Percentile	249	641	1368
Highest Trial	299	810	1731

* 0 to 20+ year-old horses