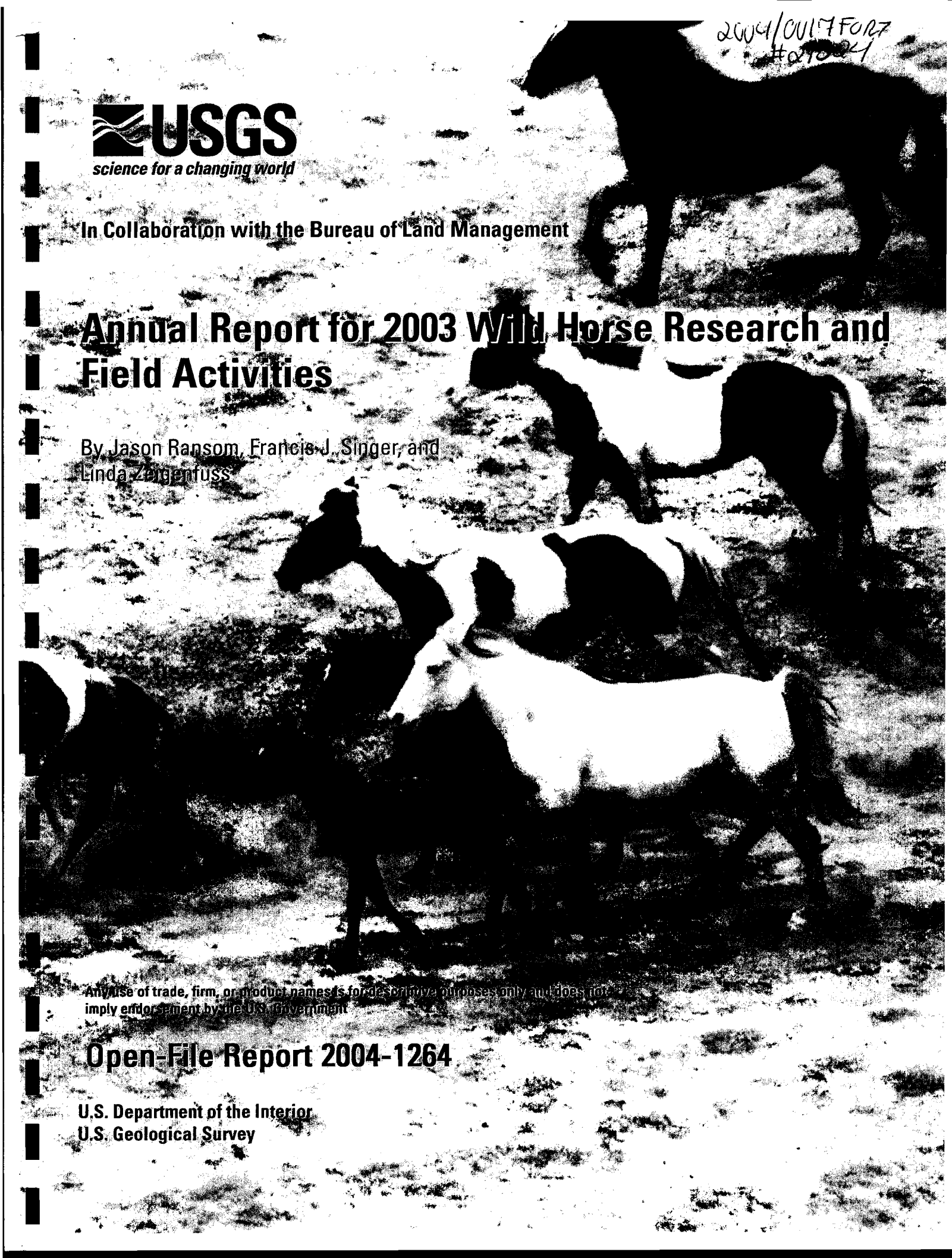

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Annual Report for 2003 Wild Horse Research and Field Activities

By Jason Ransom, Francis J. Singer, and Linda Zeigenfuss

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Annual Report for 2003 Wild Horse Research and Field Activities

By Jason Ransom, Francis J. Singer, and Linda Zeigenfuss, U.S. Geological Survey
In Collaboration with Linda Coates-Markle, Bureau of Land Management

Introduction

As stated in the Wild Horse Fertility Control Field Trial Plan, the Bureau of Land Management (BLM) has an immediate need for a safe, effective contraceptive agent to assist in the management of the large number of wild horses on western rangelands. The BLM and the U.S. Geological Survey-Biological Resources Discipline (USGS/BRD) are testing the immunocontraceptive agent *Porcine Zonae Pellucida* (PZP) in field trials with three free-roaming herds of western wild horses. Extensive research has already been conducted on the safety, efficacy, and duration of PZP applications in both domestic and feral horses on eastern barrier islands and in some select trials with wild horses in Nevada managed by the BLM. However, significant questions remain concerning the effects of PZP application at the population level in the wild, as well as effects at the individual level on behavior, social structure, and harem dynamics of free-ranging animals. These questions are best answered with field trials on wild horse herds under a tight research protocol. The ultimate goal is to provide the BLM with the protocols and information necessary to begin using fertility control to regulate population growth rates in wild horse herds on a broader scale. Fertility control is intended to assist the conventional capture, removal, and adoption process as a means of controlling excess numbers of wild horses and burros, and to greatly reduce the adoption costs and numbers of animals handled. Fertility control is not intended to totally replace the removal and adoption process.

The USGS/BRD began assisting the BLM with field trials of immunocontraceptive fertility control of wild horses in early 2001. The first PZP treatments were applied during gathers at the Pryor Mountain Wild Horse Range in September 2001, and the Little Book Cliffs Wild Horse Range, Colorado, in July 2002. At those gathers, 5 horses were treated in the Pryor Mountain WHR, and 23 were treated in the Little Book Cliffs WHR with PZP. These initial treatments were followed by booster injections in 2002. The second injection is required in order to raise, and maintain, the titer levels of mares high enough to be considered contracepted. By the end of 2002, 13 horses on the Pryor Mountain WHR had received both injections, as had 11 horses in the Little Book Cliffs WHR. In 2003, intensive research efforts were carried out by the USGS/BRD at three field locations; Pryor Mountain WHR, Little Book Cliffs WHR, and McCullough Peaks Wild Horse Management Area. The work at these sites during this calendar year included treatment of wild horse mares with PZP in the Pryor herd and Little Book Cliffs herd, development and implementation of behavioral research to investigate potential affects of PZP treatment, continued tracking of demography and foal production in all three herds, and early phases of investigating aerial population estimation survey techniques. Detailed descriptions of these research topics can be found in the Wild Horse and Burro Management Strategic Research Plan and the Wild Horse Fertility Control Field Trial Plan. Field work in 2003 was conducted by USGS/BRD and BLM staff with the assistance of many dedicated individuals. See *Acknowledgments* for more details.

This report is meant to highlight the activities of the 2003 field season, as well as to provide a general overview of the data collected. More in-depth data analysis will be conducted following the conclusion of each phase of the research project, and in many cases will not be possible until several seasons of data are collected.

Study Areas and Methods

Study Areas

The three study areas currently incorporated in the field trial research represent three different habitat/terrain and population types; mixed terrain/small population, open terrain/large population, and rugged terrain/small population. The Pryor Mountain WHR is located adjacent to Bighorn Canyon National Recreation Area near Lovell, Wyoming. It is 38,000 acres of mixed terrain that consists of desert, forested mountain slopes, and high alpine meadows. The herd totals roughly 160 wild horses, many of which congregate during the summer months in the alpine meadows. This congregation facilitates a high amount of social interaction and stallion competition, and is the focus of many of the behavioral observations conducted in this research project. Specific demographics on this herd, and all of the research herds, can be found in the Foal Production and Demographics section of this report.

The Little Book Cliffs WHR is located in western Colorado, about 8 miles northeast of Grand Junction. It is 36,113 acres of very rugged terrain (deep canyons and badland formations) that in areas is densely vegetated with piñon, oak, and sage. The herd of approximately 170 wild horses is scattered throughout the range. Some horses travel seasonally between the lower canyons and the higher elevations, but other horses are not migratory. The nature of the terrain and vegetation often makes it difficult to see the horses on this range. Like the McCullough Peaks, water can be scare and may be a source of propagating interactions between bands. The harems on this range do not routinely interact with other harems on a prolonged basis.

The McCullough Peaks WHMA is located 20 miles east of Cody, Wyoming. It is 110,000 acres of predominantly open sagebrush prairie, with some badlands along the western edge of the range. The herd of over 400 wild horses runs in large groups (several bands together) and the individual bands are approximately twice the size of those at the other two research sites. There is no single seasonal congregation area for horses on this range, and some areas are partitioned by fenced cattle allotments. Water can be very scarce and could be a large factor in determining horse movements, and thus, interactions between harems.

PZP Treatment Methods

After the initial PZP treatments were delivered by hand injection during the gathers of 2001 and 2002, all subsequent treatments have been delivered remotely. In 2003, we used scoped Pneu-dart 193 rifles and Dan-Inject CO2 blowguns, with 1 c.c. Pneu-dart darts (1 ½" needles). Primary treatments (primers) were composed of .5 cc PZP and .5 cc Freund's Complete Adjuvant (FCA), and all secondary injections (boosters) were composed of .5 cc PZP and .5 cc Freund's Incomplete Adjuvant (FIA). All injections were placed in the hind quarter, and delivered by trained USGS and BLM personnel. Treated mares were monitored for any potential swelling, stiffness, muscle tremors, nodules, granulomas, abscesses, and/or behavioral depression, which might develop subsequent to darting. We defined a 'nodule' as a lump that appeared less than 2 weeks after an injection. A lump that appeared or persisted longer than 2 weeks after an injection was defined as a persistent nodule. Physical evidence of a persistent nodule actually being a granuloma formation would require histopathological examination of the nodule. This has not been possible to date, but an examination will be made of any nodules should a treated animal die of natural causes.

Foal and Demographic Data Collection

The USGS/BRD has compiled annual demographic data for this research effort for the Little Book Cliffs WHR and Pryor Mountain WHR since 2001.[1] A comprehensive data collection effort was initiated in 2003 for McCullough Peaks WHMA. This demographic data consists of herd composition (sex and age), foal production, mortalities, harem sizes and compositions, and individual horse identification and documentation. Collecting this information in such challenging environments and situations has only been accomplished due to the dedication and extreme efforts of many volunteers, along with BLM and USGS employees. Horses were systematically photographed, identified, and entered into the Wild Horse Identification Management System (WHIMS) (developed by Ron Osborn, USGS). Each band was observed and documented as to composition, sex, and age class. Actual ages are known on most of the Pryor Mountain horses from previous BLM gathers, (for example, a specific horse might have been a yearling in 1991), detailed documentation of foal births (for the last 9 years), and partial documentation of births for 3 years prior to that (n = 12 years total). The actual ages of many Little Book Cliffs horses are also known from BLM data collected at the gathers. Foal production was noted from observed pregnancies and follow-up observations of new foals. Previous years' pregnancy data also exists from fecal steroid analysis in the Pryor Mountain WHR. Known mortalities reported are only the numbers of carcasses observed or reports that were confirmed. Records in the Pryors also provide data on horses that have been missing for >2 years; at which time they become reclassified as mortalities. The horses that are recorded as missing/unaccounted for are animals that have not been seen in the current year and may or may not be alive.

Behavioral Data Collection Methods

In order to investigate any potential social/behavioral impacts of PZP treatment, the USGS/BRD began an intensive behavioral study in 2003 (some previous behavior data collection occurred in 2001 and 2002, but under different protocols). In 2003, each study area was designated a minimum of 7 harems on which to conduct behavioral observations. Each study harem initially consisted of a stallion and at least one treated and one untreated mare. Due to mare interchange between some harems, a few of the focus harems were periodically without either a treated or an untreated mare. Whenever possible, observations were conducted in 3 subsequent sessions that fell within a set time period (0800–1200 hrs, 1201–1600 hrs, or 1601–2000 hrs). Each band was sampled over each time period at least one time each month (Table 1). An observation session consisted of recording the session information, spatial relationships at the start of the session, activity budget, 'all-occurrence' behaviors, and spatial relationships at the end of the session. All field observations recorded each horse by name and did not delineate its status as treated, untreated, or stallion. Later queries of the data cross-referenced all horse names and ID's with their appropriate treatment or control status and history. Horses were defined as 'treated' only after they had received their first booster. Horses that were not boostered in 2003 were considered to be 'post-treated' one year from their previous booster date in 2002.

The following information was recorded for each observation session; record number, band name, date, start and finish times, observer name, number of reproductive horses (stallion and all mares 1 yr and older), number of foals, number of other horses (colts and misc. studs), UTMs and elevation, temperature, precipitation, cloud cover, wind, and the body condition of each horse.

Spatial relationships were recorded as the distance observed (in horse-lengths) between each horse in the band. This was recorded at the beginning and end of each observation session. We performed a non-parametric one-way analysis of variance to test for differences in spatial relationships between stallions and treated mares vs. stallions and untreated mares in the Little Book Cliffs. We also tested for differences in distances between treated-

[1]Pre-treatment data, of various levels of completeness, is available for all 3 herd areas due to the efforts (with years of data collection) of a variety of volunteers, BLM personnel, and previous USGS studies, as follows: Pryor Mountain WHR, 1992-2003 (BLM Billings Field Office, Rev. Schwieger, BLM Volunteer, and USGS staff and volunteers), Little Book Cliffs WHR, 1983-2001 (M. Felix, volunteer), McCullough Peaks WHMA, 1999–2001 (Phyllis Preator and Ada Inbody, volunteers). The USGS will analyze the pre-treatment data in collaboration with these hard-working individuals later this year.

treated mares, treated-untreated mares, and untreated-untreated mares. Similar tests were also conducted to analyze differences in the amount of time spent in feeding activities in both the Little Book Cliffs and Pryor herds.

Activity budgets are based on a 20 minute point sampling of each reproductively active horse in the band. Every minute, a code was recorded as to the behavior exhibited by each horse. Behaviors were grouped into categories; feeding, locomotion, grooming, comfort, resting, standing attentive, excretion, interaction with humans, harem social, out of sight, herding, reproductive, aggression, and submission.

All-occurrences are behaviors that we designated as socially and/or reproductively important to know about every time they occurred. Some adjustments to all-occurrence codes were made mid-season, and we also began recording winner/loser for aggression encounters.

The definitions we used for the behavioral categories are as follows:

- *Feeding*: Any type of ingestion (or active seeking) of nutrients, including; grazing, drinking, coprophagy, soil ingestion, suckling, pawing at food source, and snow ingestion
- *Locomotion*: Any type of lateral movement that is taking the horse from one place to another and is not tied to a specific reproductive or playful act, including; walking, trotting, running, and swimming
- *Grooming*: Any type of self maintenance behavior in response to insects or hygiene, including; rolling, shaking, nibbling/biting self, licking self, rubbing, stomping off insects, and scratching
- *Comfort Behavior*: Any type of self-enjoyment behaviors including; sun-basking, shelter seeking, care-seeking, masturbation, sexual play, object play, locomotor play, play fighting, and misc. investigations (including agnostic olfactory investigation)
- *Resting*: Any type of resting behavior that shows lack of attention, including; standing, sleeping, lying down, yawning, and stretching
- *Standing Attentive*: Alert and attentive behavior, as distinct from standing at rest (does not include attention directed at humans)
- *Excretion*: Any type of defecation or urination
- *Harem Social*: This is the catch-all category for miscellaneous social interactions within the harem, including; mutual grooming, reproductive behaviors that are not proven as estrous or tending, and social olfactory investigations (i.e. routine sniffing of urine or stud pile)
- *Interaction With Humans*: Any interaction with humans that changes the natural behavior of the horse
- *Out of Sight*: Anytime the observer cannot see the horse during a sampling session (data is considered missing)

The following behavior definitions were used for 'All-Occurrences' as well as the Activity Budget. The specific behavioral groups recorded for 'All-Occurrences' are the options that follow each definition.

- *Herding*: Any type herd holding/gathering behaviors (snaking, driving)
- *Harem Tending*: Any attempt to recruit more horses into the harem, or to prevent another horse from taking members of the harem (recorded specifically as either defending or recruiting)
- *Reproductive*: Any individual reproductively important events that do not include aggressive or submissive participants in a fight or confrontation. This is broken down into the following categories; copulation successful, copulation unsuccessful, forced copulation, parturition, estrous, mare acceptance, mare rejection, stallion reproductive tending
- *Aggression*: Any type of aggressive or threatening behavior between individuals, including; threat, bump/push, chase, kick/stomp/bite, rear, strike, box
- *Submission*: Anytime an individual concedes in a confrontation with a dominant or more aggressive horse

Data was entered into an Access database on a form similar to the datasheet. Safeguards and validation rules were put in place to prevent inaccurate data from being entered (i.e., point counts could not add up to anything but 20, etc.). The data entered was checked twice for accuracy. A reference table was also created such that each horse was given a set of attributes (location, name, id number, age, sex, treatment status and dates, etc.). Variable attributes (such as band and body condition) were also incorporated, such that queries could be done independently or linked to look at specific attributes as related to seasonality, behavior, climate, etc.

Results to Date

PZP Treatments

A total of 48 mares were remotely darted with the PZP one-year agent in 2003. These treatments were delivered by both rifle and CO2 blowgun on each range, but the nature of the horses and habitat types mandated that most deliveries were by rifle in the Little Book Cliffs and by blowgun in the Pryors. There were a large number of dart failures this season. Of the 79 darts delivered; 11 came apart on impact, 5 did not discharge or only partially discharged, 2 needles broke, 2 cracked or split, and 3 hit bone. Fifty-six functioned correctly. All but 2 of the horses that were darted with failed darts subsequently received a successful dose of PZP during the 2003 season.

Little Book Cliffs WHR

Of the initial 23 horses treated in 2002, 11 were also boostered in 2002. We attempted to booster the remaining 12 mares, as well as prime several others, in the Little Book Cliffs during April 2003, with moderate success. Some horses were inaccessible and others could not be located, even with aerial searches for their location. Due to the seasonal movements of many of these animals, it was quickly determined that autumn would be a more feasible and efficient time to perform darting operations. Consequently, 25 treated horses were boostered in September/October 2003 in order to put them on an annual schedule for autumn booster treatments. This included 19 of the original horses plus another 6 that were both primed and boostered in 2003. Two horses were never boostered and were dropped from the experimental group. An additional 2 horses could not be found and still need their second booster. The Little Book Cliffs herd currently has 27 mares on PZP treatment. The heavily vegetated terrain and flighty nature of the horses makes this area challenging for remote darting, and the comfort zone of the horses is showing increase with each darting operation. In 2003, 88% of dart deliveries were by rifle and 12 % by blowgun. The distance for rifle delivery this season was 20–50 meters (mean 30 m). In 2002, it was 19–30 meters (mean 26 m). This also means that the personnel hours necessary to dart each horse is also increasing. In September 2003, over a three day period, with three darting teams, we successfully darted 12 horses. One team in Coal and Main Canyon darted an additional 4 horses in one day. The remaining horses, however, took several days/weeks each to successfully dart, and the flight distance of some mares fell into the 80 meter and greater range. The maximum range to safely deliver remote treatments by rifle is approximately 50 m.

Follow-up observations were very difficult in the Little Book Cliffs, but attempts were made to find and observe mares following darting operations; however, few horses could be found the same day as they were darted. Many observations occurred 3–4 weeks, or longer, after dart delivery. A total of 47 observations were made of 21 individual treated horses. No animals were observed exhibiting signs of behavioral depression, muscle tremors, or stiffness as a result of darting. One mare exhibited a 3 cm swelling on the same day it was darted, but subsequent observations showed no signs of trauma. Three mares exhibited signs of apparent abscesses and/or nodules. One mare exhibited a small nodule (Image 1) that was observed one month post-inoculation (booster with FIA). The next observation for this mare was five months post-inoculation, when we detected no remaining signs of the nodule. Another mare (Image 2) exhibited what appeared to be a small nodule 2 ½ months post-inoculation (booster with FIA). The next observation for this mare was 7 ½ months post-inoculation, when we detected no remaining signs of the nodule. The last mare (Images 3–5) to exhibit signs of dart trauma did so in response to two different dart deliveries. This mare was observed 1 month post-inoculation (booster with FIA) with a small abscess that was healing over. During the next observation, 3 months post-inoculation, it appeared as a small nodule. Another observation, 2 weeks later, could barely detect any sign of trauma. This mare was subsequently darted again in the fall, and when observed, 1 month after this inoculation (booster with FIA), we detected a small abscess. She has not been observed again.

Pryor Mountain WHR

Darting operations at the Pryor Mountain WHR took place in April and August–October 2003, with primary darting conducted by Zoo Montana and BLM staff. The majority of horses treated were easily found and approachable, thus darting operations were generally quick and efficient to perform (a few horses, of course, presented more of a challenge). The delivery distance was 10–25 meters (mean 14 m). There are no records to indicate delivery distance in 2002, but the close range of 2003 deliveries indicates little negative association made between the horses and the darters. This season, 65% of the deliveries in the Pryor Mountains were made using the CO2 blowgun, which is relatively silent. In conjunction with the common presence of humans during the summer months, and less dense vegetation, this may have contributed to the majority of treatments being delivered at such close range. There are currently 18 mares treated on this range, including 9 new mares added this year (3 mares were boostered in April, and all others were primed and/or boostered Aug–Oct). Two treated mares died in 2003 from natural physical traumas (one broken leg, one during parturition), and 1 mare is missing. Due to BLM management decisions, only 1 and 2 yr old mares have previously been treated on the Pryor Mountain WHR. Five older (14–17 yrs) mares were added in the fall of 2003. Five of the mares originally treated in 2002 were not boostered this fall, and will be allowed to return to fertility since they have reached 3 years of age.

Follow-up observations were much easier to conduct at the Pryor Mountain study site. All mares were observed at least once, with some being observed several times after each injection. A total of 61 observations were made of 19 individual horses, and most animals were observed within 24–48 hours after injection. No animals were observed exhibiting signs of behavioral depression or muscle tremors as a result of darting. Two mares showed temporary signs of stiffness, one of which was likely the product of a dart hitting bone. Both cases of stiffness quickly disappeared. Nine horses exhibited some temporary swelling at the injection site. Seven mares exhibited small nodules, 3 of which later developed into persistent nodules. In the nodule cases, two were from primary treatments using FCA, and one was from a booster using FIA. These cases were late in the season and there have been no subsequent observations of these mares to determine if any nodules have persisted. One of the nodules was accompanied by a small abscess with drainage. It had disappeared by the following observation two weeks later.

McCullough Peaks WHMA

The McCullough Peaks WHMA is scheduled to treat horses with the PZP time-release 22-month agent during the fall 2004 gather. This Herd Management Area is also a good candidate for testing any longer term agent.

Foal Production and Demographics

Little Book Cliffs WHR

Herd composition in 2003 consisted of 30 bands, each with a single dominant harem stallion. There were an additional 28 bachelors that did not run with a band, and 5 mares that ran alone or were often in transit. Fifty-nine mares comprised the breeding population and they contributed 39 foals (14 colts, 23 fillies, 2 unknown sex) in 2003. Total foal rate (calculated for all mares 2 yrs and older) was 66%, and surviving foal rate (alive as of Oct 31) was 63%. Two definite foal mortalities were recorded (1 colt, 1 filly). An additional 8 colts (yearlings and 2 yr olds) also ran with the bands. Ten horses were unaccounted for or missing. Two known adult mortalities were recorded (1 mare, 1 stud). The ratio of adult stallions to adult mares was 101:100. The total herd size is estimated at 169 horses (+/- 10) (Table 2).

Foal production for 2003 among the treated mares does not indicate any contraception effect since animals were entered into treatment only after potentially copulating in 2002. Of the 27 mares currently treated, 21 produced foals in 2003. The six that did not produce foals were two yearlings, one 21 yr old, and three 3–7 yr olds. Data from the 2004 season will be the first available opportunity to begin analyzing the efficacy of PZP treatments.

Body condition was recorded with each behavioral observation in the Little Book Cliffs, Pryor Mountain, and McCullough Peaks using a 0–5 body score system (Rudman and Keiper, 1991). Analysis will not be conducted until protocols can be developed to incorporate the many possible covariates involved, and to correct for repeated sampling on individual horses (a repeated measures analysis will be explored).

Pryor Mountain WHR

Herd composition in 2003 consisted of 32 bands, each with a single dominant harem stallion. There were an additional 33 bachelors that did not run with a band, 7 of which were gathered and removed. 16 colts (yearlings and 2 yr olds) also ran with the bands. 62 mares comprised the breeding population and contributed 30 foals (17 colts, 12 fillies, 1 unknown) in 2003. The total foal rate (calculated with all mares 2 yrs and older) was 48%, and the surviving foal rate (alive as of Oct 31) was 35%. Six horses were unaccounted for or missing. Five confirmed adult mortalities and 8 foal mortalities were recorded. In addition, 17 horses that were missing for 2 years were incorporated into the estimated total mortality. The ratio of adult stallions to adult mares was 104:100. The total herd size is estimated at 162 horses (+/- 6) (Table 2).

Foal production for 2003 among the treated mares does not indicate any contraception effect since animals were entered into treatment only after potentially mating in 2002. The treated mares that successfully produced foals in 2003 included five older animals that were entered into treatment in fall 2003. Data from the 2005 season will be the first available to begin analyzing the efficacy of PZP treatments on those animals. All other mares fell into the 1–3 yr age class and began treatment in 2002 and 2003. One of those mares did carry a foal, but died during parturition (in conjunction with other potential causes). The actual conception date and health of the prenatal foal is unknown.

McCullough Peaks WHMA

Herd composition in 2003 consisted of 35 bands, each with a dominant harem stallion. An additional 34 adult male horses ran in these bands. Some of these other adult males exhibited reproductive behaviors. There were 51 bachelors that did not run with a band. Eight adult male horses were transient between bands, as were 2 colts, 7 mares, 4 unknown horses, and 2 foals. 115 mares comprised the known breeding population and contributed 82 foals (31 colts, 16 fillies, 35 unknown) in 2003. Eleven of these foals were born in late August/September. One foal mortality was suspected. Total foal rate (calculated with all mares 2 yrs and older) was 70%. The surviving foal rate is 70% since no foal mortalities were confirmed. An additional 24 colts (yearlings and 2 yr olds) also ran with the bands, as did 44 horses of unknown sex (32 adults and 12 yearlings). Two horses were unaccounted for or missing. Three known adult mortalities were recorded. The ratio of known adult stallions to known adult mares was 108:100. The total herd size is estimated at 410 horses (+/- 2) (Table 2).

Behavioral Research

The behavior data collected in 2003 disclosed some demographic, social, climatic, and behavioral differences between the three populations, such that direct comparisons will not be made at this time. Factors such as competition, availability of resources, and population density, may have created differences in some values based on the specific population. It should also be noted that the McCullough Peaks WHMA is fragmented by seasonally intact fence lines and some horses may have access to resources that others do not. Analyses should be conducted at a later date to determine the role of several possible covariates that may have affected behavior.

Little Book Cliffs WHR

We found behavioral observations challenging to conduct in the Little Book Cliffs WHR. Thick vegetation, spooky horses, and rugged terrain made it difficult to conduct prolonged observations and/or to observe the finer details of behavior. Field staff performed 114 observations (approx. 3,420 minutes) from May 2 to September 9, 2003, with data collected on a total of 441 observation horses. Each unique horse was observed an average of 11.61

times. The observations resulted in the following sample sizes; 1,165 spatial relationships, 114 stallion activity budgets, 181 untreated mare activity budgets, and 140 treated mare activity budgets. Only 10 all-occurrence behaviors were seen initiated, and 9 all-occurrence behaviors received.

Spatial Relationships (Figure 1)

Stallions in the Little Book Cliffs WHR averaged a spatial relationship difference of roughly 1 horse-length (hl) closer to untreated mares than to treated mares. However, this difference was not statistically significant (p = 0.53, Mann-Whitney U test statistic = 40668). Treated mares maintained twice the average distance to other treated mares than untreated mares to other untreated mares ($p = 0.001$, $U = 8265$). Mares of either status maintained much closer distances to each other than to the stallion ($p < 0.001$, Kruskal-Wallis test statistic= 97.1).

Activity Budgets (Table 3)

Roughly 79% of time for all horses, regardless of status or age, was spent feeding and resting. Over 10% of the time the horses were unobservable. 5.5–7% of the time was spent in locomotion. Stallions spent over 4% of their time standing attentive, whereas mares of either status only spent 1.5–1.75% standing attentive. The remaining behaviors were each exhibited less than 1% of the time (grooming, comfort, excretion, interaction with humans, harem social, herding, reproduction, aggression, and submission). There were no significant differences between the activity budgets of treated vs. untreated mares. Untreated mares spent 6% less time feeding than treated mares (p = 0.09, $U = 14052$), but they also spent 5% more time resting. Collectively, both treated and untreated horses fed and rested roughly the same amount of time. There was a numerical difference noted between treated mares and untreated mares involved in harem social behaviors (primarily mutual grooming). No reproductive behaviors were observed among stallions, treated mares, or untreated mares.

All-Occurrences

Since so few all-occurrence behaviors were observed, no viable data exists. Horses most certainly exhibited reproductive behaviors, as well as aggression, but they went largely unobserved. This was primarily due to the thick vegetation and difficulty observing any group for an extended period of time. Many observation sessions were only conducted singularly, rather than in sets of 3 sequential sessions (as at the other 2 sites), which also limited the possibility of observing infrequent behaviors. More observations are necessary to determine the significance of all-occurrence behaviors.

Pryor Mountain WHR

The Pryor Mountain WHR provided an exceptional venue for behavioral observations in 2003. Field staff performed 501 observations (approx. 15,030 min) from January 14 to September 18, 2003, with data collected on a total of 2,105 observation horses. Each unique horse was observed an average of 37.59 times. The observations resulted in the following sample sizes; 7,461 spatial relationships, 495 stallion activity budgets, 1,019 untreated mare activity budgets, 568 treated mare activity budgets, and 1,040 all-occurrence behaviors.

Spatial Relationships (Figure 1)

Stallions appear to have held treated mares roughly 1 hl closer than they did untreated mares. Treated mares maintained a 2 hl closer distance to each other than untreated mares to other untreated mares. There is no 2003 data for untreated mares in the same age class as the treated in this population. Age is most likely an important covariate and this will be tested for later this winter. Analysis of pre-treatment data from 2001–2002 may also contribute to understanding the spatial relationships between treated and untreated mares.

Activity Budgets (Table 4)

Over 80% of time for all horses, regardless of status or age, was spent feeding and resting. Roughly 6% of their time was spent in locomotion, 1.5–2% grooming, .7–1.6% standing attentive, and 2% of the time they were unobservable. The remaining behaviors were each exhibited less than 1% of the time (comfort, excretion, interaction with humans, harem social, herding, reproduction, aggression, and submission). There were no significant differences between the overall activity budgets of treated vs. untreated mares. Untreated mares did spend 7% more time feeding than treated mares ($p = 0.001$, $U = 218276$), but they also spent 5% less time resting. Collectively, both treated and untreated horses fed roughly the same amount of time that they rested. Untreated mares exhibited some numerical differences in data representing reproductive, aggressive, and submissive behaviors in comparison to treated mares. Again, this may or may not be a product of age class. There was also a numerical difference noted between treated mares and untreated mares involved in harem social behaviors (primarily mutual grooming).

All Occurrences

All occurrence behavior records for this site were extensive due to the ease and proximity of observations. Herding was the most common behavior observed and was recorded 433 times (241 stallion to untreated mares, 168 stallion to treated mares, 17 stallion to foals/colts, 5 stallion to post-treated mares, 1 treated mare to treated mare, and 1 untreated mare to treated mare). While the number of times stallions herded untreated mares is numerically higher than the number of times stallions herded treated mares, the ratio is in fact comparable to the ratio of untreated vs. treated mares in each study band. It appears that stallions did not bias their herding in response to the status of the mare. Reproductive behaviors observed included; 4 successful copulations (2 stallion to treated mares, 1 stallion to post-treated mare, and 1 stallion to untreated mare), 33 cases of stallions reproductively tending mares (18 stallion to untreated mares, 14 stallion to treated mares, 1 stallion to post-treated mare). There was only 1 case recorded of a mare accepting the stallion tending, and none of rejection, though clearly acceptance/rejection occurred more than was recorded given the amount of tending and copulation recorded. 17 mares exhibited signs of estrous (11 untreated, 5 treated, and 1 post-treated). Stallions recruited mares 7 times (6 untreated, 1 treated), and defended mares 69 times. There were an additional 86 records of 'reproductive' behavior (prior to the refining of all-occurrence definitions) that were not specified (47 stallion to untreated mares, 37 stallion to treated mares, and 2 treated mares to stallions). The most common form of aggression was a threat, which was documented 262 times (90 stallion to stallion, and roughly 16–38 between each of the other status combinations). There were no numerical differences between the numbers of threats either initiated or received by treated vs. untreated animals. Higher levels of aggression observed included; 3 bumps (1 stallion to foal, 1 stallion to stallion, and 1 untreated mare to foal), 33 chases (19 stallion to stallion, and the rest evenly distributed among the status combinations), 62 kicks/bites (14 stallion to stallion, and the rest evenly distributed among the status combinations), 1 rear and 1 box (both stallion to stallion). 28 incidents of submission were recorded with untreated and treated mares submitting equally.

McCullough Peaks WHMA

Behavioral observations for pre-treatment data were conducted at McCullough Peaks WHMA in 2003. The extremely spooky nature of the horses made it difficult to observe the horses at close proximities, but when visibility, weather, and the horses allowed, observations were successful. Field staff performed 89 observations (approx. 2,670 min) from June 5 to October 15, 2003, with data collected on a total of 473 observation horses. Each unique horse was observed an average of 11.83 times. The observations resulted in the following sample sizes; 2,048 spatial relationships, 118 stallion activity budgets, and 355 untreated mare activity budgets. Observations of 95 all-occurrence behaviors were recorded. Some interesting attributes that were unique to this herd were; much larger band sizes (averaging twice the size of either of the other research herds) (Table 1) and some bands had multiple reproductively active males.

Spatial Relationships (Figure 1)

Spatial relationships were recorded between all reproductively active horses in each study band. The values are numerically similar to the distances observed at the Pryor MWHR. Since no treated mares exist at this site, there is no data to compare treatment. One interesting difference that was observed was that some bands had 2 or more

adult male horses that both participated in reproductive activities; thus, spatial arrangements sometimes had to incorporate relationships between a mare and two or more stallions.

Activity Budgets (Table 5)

Eighty-two to eighty-seven percent of time for all horses, regardless of status or age, was spent feeding and resting. Stallions spent over 6% of their time standing attentive, whereas mares only spent 2% standing attentive. Similarly, stallions interacted with humans 3 times more often than the mares did. All horses spent roughly 6.5% of their time in locomotion, 1% grooming, and 1% out of sight. The remaining behaviors were each exhibited less than 1% of the time (comfort, excretion, interaction with humans, harem social, herding, reproduction, aggression, and submission).

All Occurrences

All occurrence behavior records for this site serve only as pre-treatment data since there were no treated mares to compare behaviors with. Reproductive behaviors observed included; 4 successful copulations, 13 cases of stallions reproductively tending mares (with 3 cases of mares accepting and 1 of mare rejection), and 2 observations of mares in estrous. Stallions were observed herding mares 35 times. The most common form of aggression was a threat, which was documented 17 times (11 stallion to stallion, 2 mare to stallion, 1 mare to mare, and 3 stallion to mare). Higher levels of aggression observed included; 2 chases (1 stallion to stallion, and 1 stallion to mare), 9 kicks/bites (5 stallion to mare, 4 mare to stallion), 2 rearing (stallion to stallion), 2 striking (stallion to stallion), and 3 boxing (stallion to stallion). Two incidents of submission were recorded (1 mare to stallion, 1 stallion to stallion).

Aerial Population Estimation

In the fall of 2003, the USGS/BRD completed a work plan for researching aerial population estimation techniques for wild horses. This proposes 3 phases of research centering on large horse populations, small horse populations, and wild burros (tentatively). The work plan outlines the techniques under consideration as well as some proposed trials. An initial survey was conducted on the McCullough Peaks WHMA in October 2003, using the Lincoln-Peterson model with sighting covariates and dual observers. The survey was conducted using a Bell Jet Ranger 206 BIII at low altitude, with mark/recapture being conducted on visually unique horses using photography. The full report of this survey and the other planned trials is deferred until the remaining surveys are conducted during the winter of 2003–2004. It will be included in the next report.

Population-Based Field Trials with PZP

The BLM and USGS have entered into a series of experiments with the 22-month PZP time release agent. The purpose is to determine what effect on population growth rate the 22-month agent has when used within the normal 4-year gather cycle. Ron Hall, NPO-BLM, is spearheading the effort. USGS will assist with data analysis, as requested. Several herds are projected to be treated in late 2003 and in 2004.

Adjuvant Trials

BLM is investigating, in conjunction with the Science and Conservation Center (ZooMontana), the efficacy of Modified Freund's Adjuvant. The BLM is assisting with the study and with monitoring the mares.

Discussion and Recommendations

PZP Treatments

The primary concern with remote darting efforts in 2003 was the failure rate of darts. This has been addressed with Pneu-dart and Zoo Montana, and efforts are being made to determine the causes and solutions for this problem. Correspondence with other researchers using the same brand and volume darts has indicated that the problem is not unique to our darting operations. The next scheduled darting operations are not until fall of 2004, so we can afford to wait several months to see if Pneu-dart can solve the problem.

A second concern with the darting operations, primarily in the Little Book Cliffs WHR, is the climatic challenges of PZP storage in the field. Even in the fall, ambient temperatures rise well above 30 degrees Celsius, yet it is imperative to keep the PZP frozen until ready to use. Generally, it is kept in the propane powered camp freezer and then distributed into coolers with freezer-packs for each day's use. The main problems arise when a horse is located, it seems likely that it can be darted, but then attempts get drawn out over time. A dart is prepared and then the ensuing stalk/pursuit may continue for several hours in the hot sun. Many times, the attempt must begin again the following day. This presents questions as to the stability/viability of the drug in fluctuating conditions, and while the darter always attempts to keep the dart cold, it doesn't always happen. Due to the remote nature of the area, darters camp on the mountain for several days at a time and dry ice is not a realistic possibility for more than one day. This may be a significant variable in assessing the viability of remote delivery of immunocontraceptives in some management areas.

The third concern with remote darting is the increasing distance of comfort, and general spookiness of some of the Little Book Cliffs horses. This may be more typical behavior for most herds, unlike the somewhat habituated behavior of many of the Pryor horses. It may be prudent to drop some of the more elusive mares from treatment in order to keep remote darting financially efficient. While tracking one horse day after day for weeks may be an interesting challenge, it is not a cost-effective method for applying contraceptive treatments.

Field Trial Herds

Treatment animals in the Pryor Mountain WHR follow management guidelines that differ from the experimental design, thus the resulting experimental and control groups are not balanced. Treated animals are primarily 1 and 2 yr olds and all animals in that age class are treated. The Field Trial Plan states that treated and untreated mares should be in the same harem (page 11, paragraph 1). We have no simultaneously collected comparative data because all animals of a given age class are either treated or untreated. However, this does present considerable opportunity to document the return of mares to fertility from 2 years of PZP treatment. One solution to test for spatial and behavioral differences in this herd is to conduct a rigorous test for age as a covariate. Depending on the results, the treated mares could then be compared to untreated mares in the closest age class. The extensive pre-treatment data on foal dates, herd demography, mare interchanges, harem dynamics, age specific foaling rates, etc. will be more than adequate to test statistically for any treatment effects. Pre-treatment behavioral data in 2001 and 2002 may also be adequate for statistical comparison to post-treatment. This will be tested in the next few months.

A more intensive focus should be placed in the Little Book Cliffs WHR for 2004, including additional staff/paid volunteers to collect field data. This herd is currently our most valuable source of behavioral and foal production data, with experimental and control animals in every age class. It is, however, also the most difficult site to conduct the research. Ideally, behavioral data collection at this site in 2004 should triple the data collection in 2003. An effort should be made to enlarge the work force to accomplish this.

Proposed Work for 2004

In addition to the continuance of the work conducted in 2003, the USGS/BRD biologists (F Singer, L Zeigenfuss, J Ransom, and K Schoenecker), in collaboration with BLM specialists and the talented volunteers, will return to complete a more intense analysis of the pre-treatment data on all 3 herds. This effort was started in winter 2001–2002, but terminated due to health problems of the Project Leader. This information needs to be completely analyzed to compare to herd-level post-treatment effects, including data on: population dynamics and herd growth rates, foaling date patterns, harem dynamics, harem stallion dominance and spatial patterns, mare spatial dynamics by age group, and activity budgets by age group. Pre-treatment data on relations of genetics and heterozygosity must also be analyzed.

Additional 2003 Reports

Model Contraceptives and Economics

Two separate modeling reports are also available for 2003: An Economic Analysis of Alternative Fertility Control and Associated Management Techniques for Three BLM Wild Horse Herds (J Bartholow, USGS), and Initial Progress Report: Analysis of Options for Contraceptive Control of Wild Horse Populations (N Thompson Hobbs and J Bradford, Colorado State University).

GnRH Fertility Control

A final report on the use of two forms of GnRH as a potential fertility control is also available: Evaluation of Two Potential Contraceptive Agents in the Domestic Mare (P McCue, DVM, PhD, Colorado State University),

Tables, Images, and Figure

Table 1. Mean values for climatic and population conditions that existed during the behavioral observations for the 2003 field season. (McP = McCullough Peaks WHMA, LBC = Little Book Cliffs WHR, PRY= Pryor MWHR).

Number of Samples Recorded by Time Period

	0800–1200 hrs	1200–1600 hrs	1600–2000 hrs
McP	20	46	23
LBC	51	34	29
PRY	168	189	143

Temperature by Time Period

	0800–1200 hrs	1200–1600 hrs	1600–2000 hrs
McP	29	31	32
LBC	27	30	30
PRY	20	21	22

Climate (occurrence in % of observations)

	Cloud cover	Precipitation	Wind
McP	43%	3%	5–10 mph
LBC	34%	0%	<5 mph
PRY	69%	2%	<5 mph

Population

	Band Size	Population	Acreage
McP	9.51 horses	410	110,000
LBC	4.48 horses	170	36,113
PRY	4.55 horses	162	38,000

Table 2. Demographic composition of the study herds as calculated on Oct 31, 2003.

	Pryor MWHR	McCullough Peaks WHMA	Little Book Cliffs WHR
Adult Male	58	118	52
Adult Female	54	110	51
Adult Unknown	0	30	0
Foal Male	12	31	13
Foal Female	10	16	22
Foal Unknown	0	34	2
Yearling Male	8	30	7
Yearling Female	4	15	8
Yearling Unknown	0	12	0
2 yr Male	8	8	7
2 yr Female	8	5	7
2 yr Unknown	0	1	0
Missing	6	2	10
Adult Mortalities	5 (+17)	3	2
Foal Mortalities	8	1	2
Total Herd	162	410	169

Table 3. Little Book Cliffs WHR activity budgets, values shown as mean percentages of time spent exhibiting each behavior.

Status	Feeding	Locomotion	Grooming	Comfort	Resting	Standing Attentive	Excreting
Stallion	58.60	7.02	0.30	0.13	16.97	4.39	0.26
Untreated	61.23	6.99	0.30	0.17	19.14	1.49	0.17
Treated	67.39	5.50	0.43	0.07	13.82	1.75	0.07
Status	**Interaction w/ Humans**	**Harem Social**	**Out of Sight**	**Herding**	**Reproductive**	**Aggressive**	**Submissive**
Stallion	0.31	0.04	11.27	0.22	0	0.26	0.04
Untreated	0.28	0	10.25	0	0	0	0
Treated	0.21	0.04	10.68	0	0	0.04	0

Table 4. Pryor MWHR activity budgets, values shown as mean percentages of time spent exhibiting each behavior.

Status	Feeding	Locomotion	Grooming	Comfort	Resting	Standing Attentive	Excreting
Stallion	53.03	6.87	2.07	0.81	30.55	1.65	0.26
Untreated	62.61	6.10	1.42	0.19	26.19	0.71	0.24
Treated	56.46	6.44	1.77	0.40	30.85	1.29	0.25
Status	**Interaction w/ Humans**	**Harem Social**	**Out of Sight**	**Herding**	**Reproductive**	**Aggressive**	**Submissive**
Stallion	0.12	0.54	2.36	0.83	0.30	0.40	0.01
Untreated	0.09	0.33	2.09	0	0.01	0.06	0.02
Treated	0.25	0.56	1.71	0	0.04	0.036	0.01

Table 5. McCullough Peaks WHMA activity budgets, values shown as mean percentages of time spent exhibiting each behavior.

Status	Feeding	Locomotion	Grooming	Comfort	Resting	Standing Attentive	Excreting
Stallion	49.36	6.48	0.93	0.55	32.67	6.14	0.21
Untreated	49.58	6.72	1.24	0.14	38.18	2.08	0.13
Status	Interaction w/ Humans	Harem Social	Out of Sight	Herding	Reproductive	Aggressive	Submissive
Stallion	1.02	0.38	0.93	0.64	0.38	0.21	0
Untreated	0.30	0.28	1.10	0	0.06	0.07	0.03

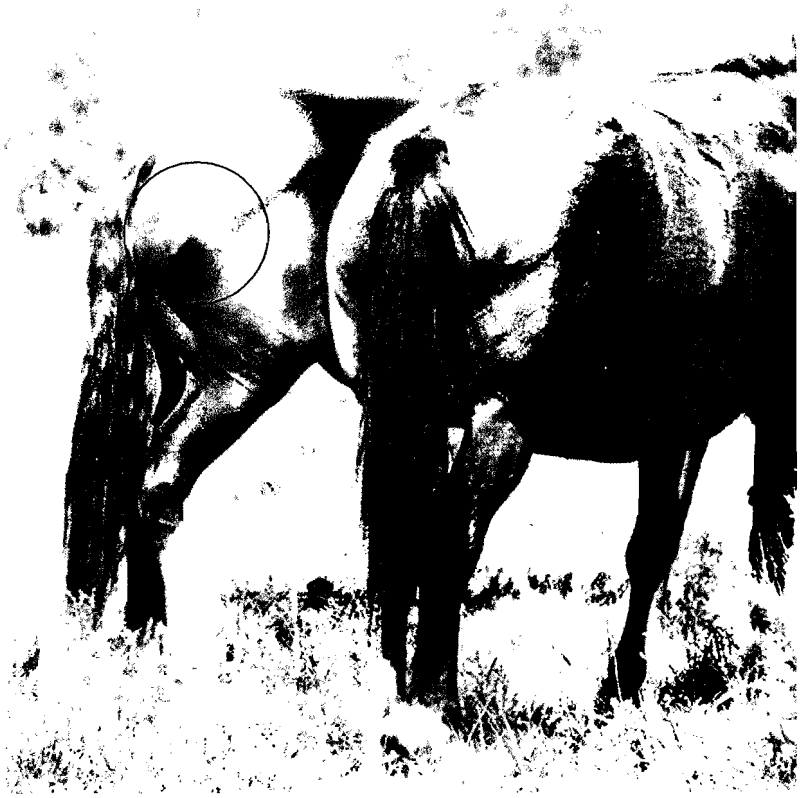

Image 1. Rojo, mare #7027, photographed 5/22/03, nodule from booster injection on 4/22/03.

Image 2. Sweetheart, mare #9305, photographed 4/16/03, nodule from booster injection on 1/28/03.

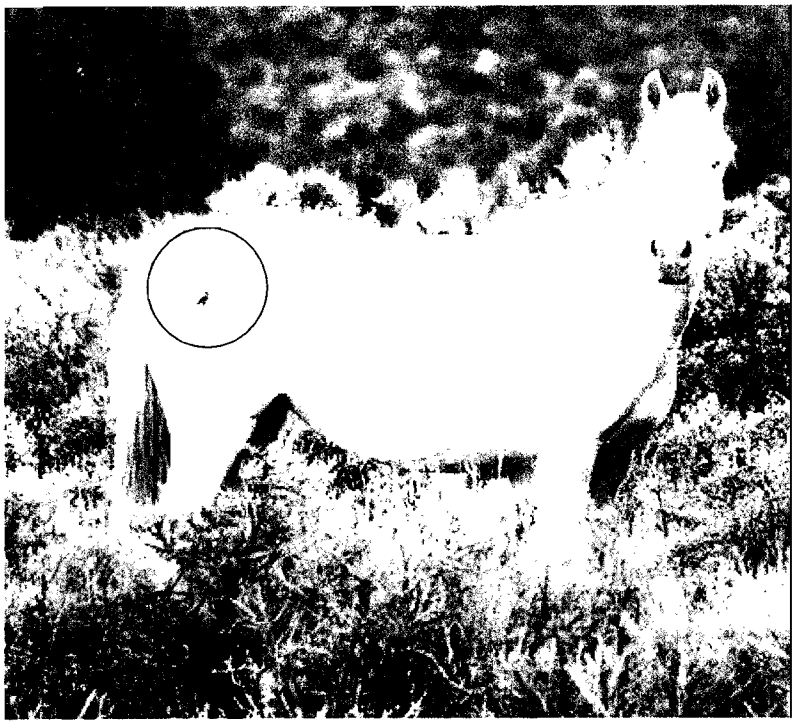

Image 3. Cloud, mare #9723, photographed 4/29/03, small abscess from booster injection on 3/21/03.

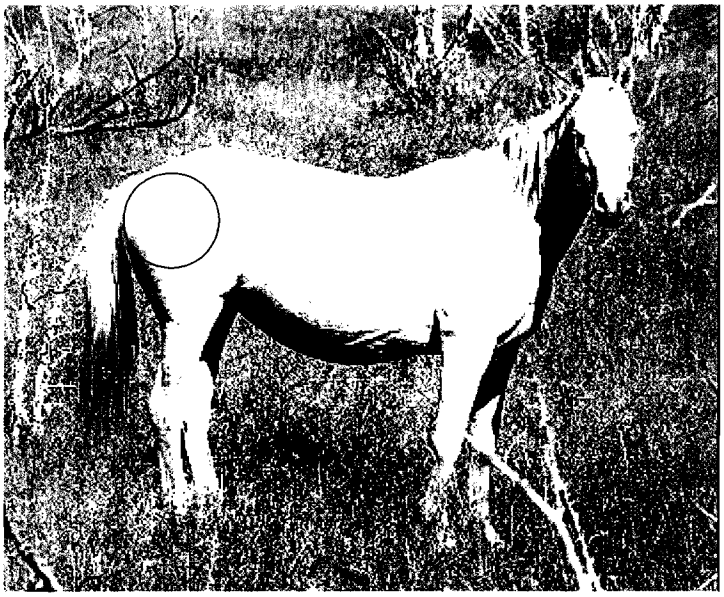

Image 4. Cloud, mare #9723, photographed 6/25/03, small nodule from booster injection on 3/21/03.

Image 5. Cloud, mare #9723, photographed 10/1/03, small abscess from booster injection on 9/5/03.

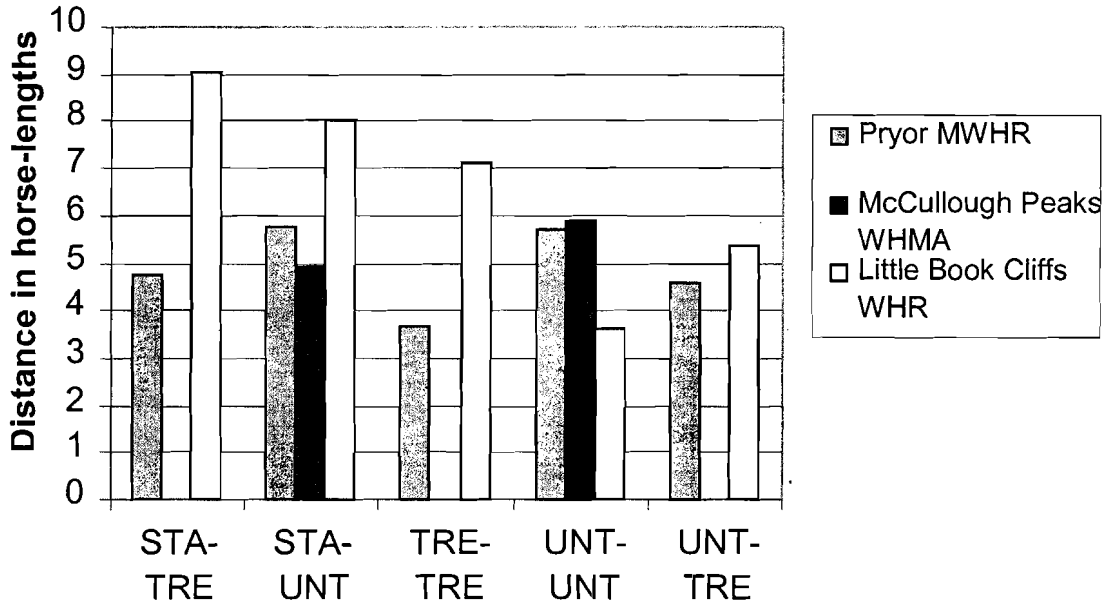

Figure 1. Spatial relationships (STA = Stallions, TRE = Treated mares, UNT = Untreated mares).

References

Rudman, R., and Keiper, R.R., 1991, The body condition of feral ponies on Assateague island: Equine Veterinary Journal, vol. 12, no. 6, p. 453–456.

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