Wild Horse and Burro Research and Related Projects

Research Entity; Project Name	Dates; Budget	Description and Status
BLM-funded, ongoing WHB research and related projects		
1. Colorado State University; Re-immunization of Free-Ranging Horses with GonaCon Vaccine	2015–2020; $287,884	Goal: Determine the optimum booster schedule; duration of effectiveness; and safety and physiological side-effects (if any) following booster vaccination with GonaCon. Status: A single GonaCon booster dose, when delivered at an appropriate time, seems to consistently cause 3 or more years of infertility. Field crews observed foaling rates in 2016-2017, and will continue in 2018-2020. Control mares foaled at high rates of 75-100% over several years. The foaling rate for mares re-treated with GonaCon 4 years after initial dose were 0% in 2015, 16% in 2016, 16% in 2017, and 8% in 2018. Among mares that were boostered 2 years, 1 year, or 6 months after their primer dose, the respective 2018 foaling rates were 7%, 0%, and 14%. The researchers summarized early behavioral and efficacy results in a 2018 scientific paper (Baker et al. 2018. PLoS One).
2. Colorado State University; Effect of Immunization against Oocyte Specific Growth Factors in Mares	2015–2019; $1,110,065	Goal: Test vaccines against two ovary-specific proteins (BLM-15 and GDF-9) in domestic mares. They may result in permanent sterility through premature oocyte depletion. Long-term goal is to develop a vaccine that can cause permanent sterility after a single dose. Status: Results in 2017 suggested that vaccination against each protein individually led to irregular follicle development, and that vaccination against one led to reduced ovulations, In 2018, ten mares were vaccinated against a combined vaccine with both proteins. Behavioral and ultrasound observations in 2018 indicated that: none of the mares ovulated, and many follicles developed but only to a very early and small stage. Thus, this new vaccine shows some promise as a new method for fertility control. The researchers published one article based on the single-protein vaccines, and presented at a meeting in 2017 (Davis et al. 2018. Animal Reproduction Science).
3. Ohio State University; Electrospun delivery to enhance the effectiveness of immunocontraception strategies in equids	2016–2020; $799,565	Goal: Develop and test polymer capsules that would be a new delivery vehicle for porcine zona pellucida (PZP) vaccine, to increase the duration of vaccine effectiveness. Status: The researchers tested the burst-mechanical strength of trial capsules made from various surgical grade polymers, to determine optimal thickness of implantable capsules. One-month hydrophilic silicone oil + PZP emulsion, and 3-month, 12-month and 12+ month capsules were implanted in domestic mares in summer 2017. Ongoing antibody titer monitoring suggests that the 1-month emulsion and 3-month capsule seem to have delivered the PZP, approximately on schedule. As of 1 year post-implantation, no significant titer peak that would be associated with the 12-month or 12+ month capsules has yet been seen. The researchers are currently preparing scientific papers which address how well capsules of various compositions degrade and release liquid contents in vitro; 2 papers will be submitted this fall. Future papers will discuss titer results from trials in horses.

Research Entity; Project Name	Dates; Budget	Description and Status
BLM-funded, ongoing WHB research and related projects (continued)	
4. Purdue University; Development of next-generation anti-fertility vaccines for horses	2016-2019; $78,375 BLM (*$375K matching from HSUS*)	Goal: Develop and test new PZP-type vaccines for use in mares, making use of a water-soluble adjuvant, and recombinant ZP proteins. Status: One experiment identified promising new adjuvants for vaccine, based on in vitro testing to determine optimal formulation of a new adjuvant. The new vaccine, with recombinant ZP (rZP) proteins and a water-soluble adjuvant, caused a strong immune response in mice. Another experiment tested the antibody response of mares injected with rZP and the new adjuvant, starting in late spring 2017; those antibody titer response levels were not as high as predicted, though it is not always clear how titer levels relate to fertility response. In a third experiment, two doses of the new, water soluble 'combination adjuvant' itself, comprised of two immune-stimulating molecules and of nanoparticles that adsorbed a model antigen (ovalbumin), led to a strong immune response. The system for rZP3 protein expression is working well; researchers are refining production of rZP2 and rZP4. In the next 6-8 months, they intend to test a new vaccine with the 'combination adjuvant' and the recombinant ZP proteins. Future work will include developing a time-release booster dose.
5. Humane Society of the United States; Applicability and efficacy of ZonaStat-H on wild burros in northwestern Arizona	2015–2019; $64,975 (*HSUS matched $350K*)	Goal: BLM-HSUS collaborative to test whether ZonaStat-H (a PZP vaccine) can be effectively darted to wild burros in the vicinity of Oatman, Arizona. Status: 108 jennies were enrolled in the pilot project as either treatment or control animals. This includes all of the available burro jennies in the town of Oatman. Trapping, marking, and initial treatments are completed. HSUS continues to deliver booster doses via dart to those jennies that only received a primer dose (with good success to date), and to monitor foaling rates and any apparent injection site responses. Some burros had abscesses at injection sites and transient lameness, which has resolved.
6. University of Wyoming; Adobe Town HMA Wild Horse GPS Collar Study	2016-2021; $40,000 (*$120K matching from WY Dept. of Ag.*)	Goal: Assess habitat use, and movement in / out of checkerboard lands, and potentially across state lines, in Adobe Town HMA. Status: 14 mares were fitted with radio collars after bait trapping in early 2017, but 9 of those were removed in 2017 due to collar failure (4) or improper fit (5). 23 radio collars were placed on mares in October 2017 in conjunction with a helicopter-gather in the HMA. Fit since then has been good, but some collars have had GPS failure in the last year. 20 collars are currently operational. Researchers continue to monitor collared horse welfare once per month, and measured vegetation in summer 2017 and 2018. This study will contrast horse habitat use with habitat use by pronghorn antelope and Greater sage-grouse in the same region, based on GPS collars and tags on those other species.

Research Entity; Project Name	Dates; Budget	Description and Status
BLM-funded, ongoing WHB research and related projects (continued)	
7. Texas A&M University; BLM Wild Horse and Burro genetic testing	2015–2020; $98,000	<u>Goal:</u> Analyze genetic diversity for wild horse and burro populations, based on hair samples taken during capture operations. <u>Status:</u> This study provides monitoring information to BLM that is useful for management. BLM sends hair samples to the researcher. The researcher then provides genetic monitoring reports to BLM. The researcher is analyzing metapopulation structure (genetic connections between sampled herds), and preparing a scientific manuscript on the topic.
8. Arizona Game and Fish Department; Evaluation of burro movements and collisions along roads near Lake Pleasant HMA	2016-2021; **$0**, but BLM funds captures (*~$200K AZ Dept. of Trans. funding*)	<u>Goal:</u> Use GPS collars on wild burro females (jennies), to determine movement patterns near roads; to identify key crossing points; and to make inferences about what types of highway fencing could help to prevent burro-vehicle collisions. <u>Status:</u> Trapping began near the Lake Pleasant HMA in February 2017, and concluded in July 2018. 26 burros were collared. Two have died in vehicle collisions. Burro GPS data has already helped Arizona dept. of Transportation identify areas to improve barriers and reduce burro crossings.
9. USGS; Monitoring responses of wild horse behavior and demography to BLM management treatment *(spaying mares)*	2018–2022; $898,645[1]	<u>Goal:</u> This project would determine the behavioral and demographic effects of having a portion of spayed (ovariectomized) mares in a wild horse population. BLM plans to conduct the spay treatments with a veterinary contractor. USGS involvement would be limited to studies of on-range outcomes, after spaying. <u>Status:</u> The project has not yet started. An earlier proposal included Colorado State University, but that university chose to remove itself from the research. The revised USGS research proposal has been approved by BLM. The Decision Record was signed on September 12, 2018.
10. USGS; Evaluating behavior and ecology of geldings among a breeding population *(with Colorado State University cooperation)*	2015–2020; $826,099[1]	<u>Goal:</u> Determine the behavioral and demographic effects of having a portion of a herd be gelded male (neutered) wild horses. <u>Status:</u> Helicopter and bait/water trapping was completed at Conger HMA in 2016. 30 mares were fitted with radio collars. 29 studs were fitted with radio tags, but 13 of 14 GPS tail tags had firmware issues and were re-deployed in spring 2017. Behavior data collection started in March 2017. Aerial surveys were conducted in spring 2017 and 2018. After a gather in which family groups were captured, held, and released together, 27 studs were gelded in December 2017. Bachelor groups and social groups with geldings and untreated control stallions were returned to the HMA shortly after that. In 2018, horses including gelded stallions and untreated control stallions were observed for the first year of three post-treatment years. One mare's collar was removed via remote drop-off due to improper fit, and one mare that temporarily had improper collar fit is being closely monitored.

Research Entity; Project Name	Dates; Budget	Description and Status
BLM-funded, ongoing WHB research and related projects (continued)		
11. USGS; Evaluating the efficacy and safety of Silicone intrauterine devices as a horse contraceptive *(with Oklahoma State University cooperation)*	2016–2020; $750,826	Goal: Determine the efficacy and effects on mare health resulting from the long-term presence of a silicone IUD, based on results from a captive breeding trial. Status: In 2016, O-ring shaped IUD models fell out at rates that were not acceptable. Mares that received an injection of progesterone at the time of IUD insertion had better retention rates in the weeks immediately afterwards. From 2017 to 2018, a 'Y' shaped model stayed in mares at acceptable rates (greater than 75% for a 1-year period, out of n=20 mares). Pending funding availability, the project is scheduled to end in 2019; this will include an evaluation of return to fertility and effects on uterine health after IUD removal.
12. USGS; Population demography and ecology of wild horses in two sentinel herds in the western United States *(with Colorado State University cooperation)*	2015–2022; $1,287,654[1]	Goal: Study survival, fertility, fecundity, and recruitment rates; movement patterns; range use; habitat selection; and social behavior of wild horses. Status: About 95 horses were captured at Frisco HMA via a helicopter gather in summer 2016, with more captured in January 2017. Horses were fitted with radio collars, or radio tags, and released. Demographic observations began after radio marking, and are ongoing through 2018. Aerial surveys took place in spring 2017 and 2018. The unspayed portion of the Warm Springs HMA would comprise the second sentinel demography herd site.
13. USGS; Developing a suitable radio collar or radio tag for feral horses and burros *(with Colorado State University cooperation)*	2014–2016; $139,248	Goal: Develop and test four radio collar designs and two designs for mane and tail radio tags. Assess behavior and monitor for any injuries caused. Status: Fieldwork in captivity was completed March 2016. No substantial injuries were observed in mares, stallions, or jennies. The collars went over the ear of several stallions, so USGS recommends relying on radio tags braided into the tail for stallions. Further field testing is ongoing as a part of other USGS studies. A manuscript based the captive animals is in preparation, and analyses of field testing applications will start in fall 2018.
14. USGS; Developing and testing aerial survey techniques for wild burros	2015–2018; $185,139[1]	Goal: Test two new population survey methods for wild burros: use of infrared cameras; and using information from radio collared burros in double-observer surveys. Status: In the Sinbad HMA, USGS and BLM completed 3 infrared surveys and has conducted 4 double observer surveys, 3 using the radio collared animals. A fall 2017 survey at the Lake Pleasant HMA collected data using radio collared animals. In 2016 and 2017 USGS and BLM helped with burro aerial surveys at Fort Irwin NTC (Dept. of Defense), which will contribute data to the double-observer sightability modeling. Two more surveys (at Sinbad and at Lake Pleasant) are planned for October 2018, with data analysis using the full data set to follow.

Research Entity; Project Name	Dates; Budget	Description and Status
BLM-funded, ongoing WHB research and related projects (continued)		
15. USGS; Demography of two wild burro populations in the western USA *(with Colorado State University cooperation)*	2015–2020; $717,081[1]	<u>Goal:</u> Study survival, fertility, fecundity, and recruitment rates; movement patterns; range use; habitat selection; and social behavior of wild burros. <u>Status:</u> At Sinbad HMA, 30 burro jennies were returned to the range with GPS radio collars in 2016. Field work to monitor their welfare, movements, behavior, survival, and foaling took place May-September in 2016 and March-September 2017 and 2018, with monthly welfare checks in winter. The most recent aerial survey at Sinbad HMA took place in October 2017 with the next scheduled in October 2018. At Lake Pleasant HMA, trapping and collaring began in December 2016 and was completed in July 2018. 30 jennies were collared. Observations are ongoing, as at Sinbad. An aerial survey took place at Lake Pleasant HMA in June 2017.
16. USGS; Non-invasive (fecal) genetic sampling of free-roaming horses to estimate population size, genetic diversity, and consumption of invasive species *(with Colorado State University cooperation)*	2014–2015; $178,538	<u>Goal:</u> Collect and analyze fecal DNA as a noninvasive method to determine genetic diversity and estimate population size. Also, test for presence of invasive species, and seed germination. <u>Status:</u> Feces collection and analysis concluded in 2015. This seems to be a suitable method for population estimation in small areas, though the costs are very high. USGS has five manuscripts: one published on environmental degradation of horse fecal DNA (King et al. 2018. Ecology and Evolution); one in review on diet analysis; one in review on the potential spread of cheatgrass by horses one in preparation on using mark-recapture techniques to estimate population size; and one in preparation about genetic parameters and spatial distribution.
17. USGS; Development of a population model and cost analysis for managing wild horses (also known as "WinEquus II")	2016–2021; $459,859	<u>Goal:</u> Update the existing model used by managers for wild horse population projections. The update will compare population outcomes and economic costs resulting from PZP, removals, spaying, gelding and other population growth suppression tools. <u>Status:</u> Development began in spring 2017, and is ongoing. Beta testing with BLM staff will begin during winter 2018-2019.
18. Ipsos Public Affairs; Assessing knowledge, attitudes, preferences, and non-market values regarding WH&B populations and management	2014–2018; $236,943	<u>Goal:</u> Improve understanding of public perceptions, values, and preferences regarding the management of wild horses and burros on public rangelands. BLM is not aware of any polling data that measures public opinion about WHB issues, based on a statistically sound sampling design. <u>Status Update:</u> BLM is continues to work with the Department of the Interior on finalizing package to seek approval from OMB to conduct focus groups. Pending OMB approval, the next step of the project will be to convene the focus groups. Information from those focus groups will then inform a set of candidate questions for the national survey of the general populace; those questions will also need OMB approval.

Research Entity; Project Name	Dates; Budget	Description and Status
<td colspan="3" align="center">**BLM-funded, ongoing WHB research and related projects (continued)**</td>
19. BLM; Census of wild horse populations via remote sensing analysis	2018-2019; $0 (*staff time supported by BLM Wyoming*)	Goal: Pilot project that will attempt to use image classification technology to determine whether or not an algorithm can developed to accurately identify horses from available satellite or other aerial imagery. A BLM Wyoming employee is conducting the project as part of her masters degree program in GIS, through Kent State University. Status: Preliminary work has identified which satellite imagery that will be used for the analysis. Files are being screened by a person, to identify confirmed images of wild horses.
<td colspan="3" align="center">**BLM-funded WHB projects that never started or were cancelled**</td>
20. USGS; Testing efficacy of contraceptives for female burros (not approved)	Not approved; $0	Goal: Test the efficacy of the PZP vaccine and GonaCon-Equine vaccine in burros. Status: This project never started. It was not approved, due to lack of funding availability.
21. Oregon State University; Functional assessment of ovariectomy (spaying) via colpotomy in wild mares (cancelled)	2015–2016; $8,834 spent pre-closeout. *Original budget $42,063*	Goal: Researchers would have determined whether ovariectomy via colpotomy can be safely and effectively performed on pregnant and non-pregnant wild horse mares. Status: Although the project was approved and some spending occurred, this project never started; it was cancelled. BLM withdrew its decision to support this research project on September 9, 2016.
22. Oregon State University; Evaluation of minimally invasive methods of contraception in WH&B mares (cancelled)	2015–2016; $498 spent pre-closeout. *Original budget $315,189*	Goal: The project would have evaluated two procedures, tubal ligation and hysteroscopically-guided laser ablation of the oviduct papilla in standing sedated mares. Status: Although the project was approved and some spending occurred, this project never started; it was cancelled. BLM withdrew its decision to support this research project on September 9, 2016.
<td colspan="3" align="center">**BLM-funded WHB projects that have concluded**</td>
23. Louisiana State University; The use of membrane disrupting peptide / peptoid LHRH conjugates to control WH&B populations	2016–2018; $295,992 spent pre-closeout. *Original budget $850,002*	Goal: Develop and test an injectable protein agent that would decrease female and male gonad viability. The drug would destroy the cells that control spermatogenesis in the male and follicle growth, oocyte development, ovulation and cyclicity in the female. Status: Due to negative results, this project was closed out, and the remaining funds ($554,009) will be deobligated in early FY2019. The research group identified peptide conjugates that were most effective at targeting LHRH receptor cells *in vitro*, while at the same time not destroying blood cells. In late spring 2017, the group began *in vivo* trials of the D-and L-peptide conjugates in 6 ponies, to determine necessary doses to suppress estrus activity. Even at very high daily doses, the ponies did not cease to ovulate. Higher doses would not have been practical to deliver to wild horses.

Research Entity; Project Name	Dates; Budget	Description and Status
24. University of Kentucky; Tubo-ovarian ligation via colpotomy as a method for sterilization in mares	2015–2017; $120,228 spent pre-closeout. *Original budget $391,369*	Goal: This project ended early. The project aimed to help determine the effectiveness of placing a polyamide (nylon) cable tie around the ovarian pedicle and oviduct of mares via colpotomy for tubo-ovarian ligation. Status: Initial trials showed that the new instrument was effective for ligature placement. Several mares in the study, however, developed adhesions near the ovaries that caused concern. The project ended 1/31/2017. Researchers intend to publish negative results.
25. University of Toledo; Development of a 3-4 year controlled release PZP contraceptive vaccine for wild horses	2010-2017; $2,165,000	Goal: Produce PZP-22 pellets for use by BLM. Develop and test a 3-year or 4-year PZP pellet vaccine. Status: PZP-22 did not provide the second year of contraception that was expected. PZP-22 vaccine pellets seem to provide only 1 year of reliable contraception, but are convenient for providing the PZP booster dose without needing to re-capture or dart a horse. In the final year of the project, the researchers studied the PZP-release profile of a new design of 12-month pellets, in vitro; those pellets degraded by month 10, over the course of 3-4 weeks. The grant agreement ended March 31, 2017. BLM now procures PZP-22 vaccine pellets through a contract with University of Toledo.
26. USGS; Second pen trials of the SpayVac PZP vaccine	2014–2015; $127,379	Goal: Repeat an earlier trial of SpayVac, to test for long-lasting effects. SpayVac is a PZP-based immunocontraceptive with liposome technology. Status: This "SpayVac II" pen trial was discontinued in spring 2015, after initial results indicated that the SpayVac vaccine did not lead to the expected long-lasting contraception in mares.
27. Great Lakes Marketing Research; Analysis and evaluation of demand for off-range wild horses and burros	2015–2016; $109,300	Goal: Assess future demand for wild horses and burros through adoption and sales and to develop strategies for placing more animals into private care. Status: The contractor prepared analyses, presented final reports to the BLM, and led webinars on the implications.
28. University of Idaho; Focus on Impact of Wild Horses on Riparian Areas	2014–2015; $19,999	Goal: Use wildlife cameras to record use of riparian areas by wild horses, livestock, and wildlife, and vegetation measures in those areas. Status: Results suggested that wild horse presence influenced riparian streambank conditions and herbaceous stubble height to a greater degree than livestock presence, which also had an effect. The study found no statistical relationship between wild horse presence and wildlife presence. Results showed that per-animal impacts of horses on riparian disturbance, vegetation height, and biomass. A paper was published in Rangelands in 2018.

Research Entity; Project Name	Dates; Budget	Description and Status
WHB-related projects funded entirely by BLM partners or other sources	
29. US Navy; Testing the accuracy of horse and burro surveys, using a drone-mounted infrared camera	2016; **$0** (*funded by Department of Defense*)	Goal: Test the use of infrared and visual spectrum cameras mounted on a military Tiger Shark Unmanned Aerial Vehicle (UAV), to survey horses and burros at Centennial HMA (China Lake Naval Weapons Station). Status: Over several days of flights in December 2016, the sensor package on the drone did not perform well when panned out at a wide angle. This was not suitable for surveying large areas. Future flights could be improved by a sensor system with a more sensitive infrared camera.
29. USGS; Testing the Accuracy of High-definition Infrared Imaging for Wild Horse Aerial Surveys	2015–2016; **$0** (*funded by Wyoming Dept. of Agriculture*)	Goal: Test the use of distance-based analysis along with infrared aerial surveys, in an area with known horse population size. Status: Two infrared aerial surveys were conducted at the McCullough Peaks HMA: one in fall 2015 in the daytime and the other in summer 2016, at night. Estimated population sizes from that survey compared favorably to known population sizes. Costs are higher than typical surveys, and the method may not be suitable in areas with more tree cover. A manuscript is in press at the journal Wildlife Society Bulletin.
30. USGS; Modeling Carrying capacity of free-roaming horses (with Colorado State University cooperation)	2014–2017; **$0** (*funded by USGS*)	Goal: Develop a coarse model to evaluate changes in animal carrying capacity in response to changes in vegetation production. Status: USGS received data from various sources including BLM and remote sensing. The carrying capacity model was developed at Colorado State University. After final input using range health data to ground truth the statistical model, CSU is revising its analysis in light of feedback from BLM received February 2017. A final report is in preparation.
31. WEST, Inc.; Testing double-observer plus distance methods for aerial surveys	2016; **$0** (*funded by Wyoming Dept. of Agriculture*)	Goal: Tested a distance-based aerial survey method that is similar to those now used by BLM ("double-observer" method), but is based on an incomplete sample of the surveyed areas. Status: The contractor completed aerial surveys over areas including the North Lander complex and Red Desert complex in 2016. In a report sent December 2016, the contractor's method estimated lower horse abundance for the North Lander complex than was counted visually by BLM staff on a 2016 helicopter survey in the same area. The researchers used the same method to estimate feral horse abundance on Navajo Nation lands in 2017.
32. University of California Agricultural Extension	Ongoing (*funded by USFS*)	Goal: Use camera-traps to document interactions between wildlife, livestock, and wild horses, on the Modoc plateau. Status: Photo analysis is ongoing; no publications yet. This study is documenting use and habitat quality at water sources.

Research Entity; Project Name	Dates; Budget	Description and Status
WHB-related projects funded entirely by BLM partners or other sources (continued)	
33. Brigham Young University / US Army Dugway Proving Grounds	Multi-year *(funded by DoD)*	<u>Goal:</u> Use camera-traps to monitoring springs on the Dugway proving grounds, southeast of Salt Lake City, to assess WH – wildlife interactions. <u>Status:</u> This research group has published two papers demonstrating that native wildlife are negatively affected by the presence of wild horses near water sources (Hall et al. 2016. Journal of Arid Environments; Hall et al. 2018. Ecosphere)
34. Arizona State University	2014-2016; *(not BLM-funded)*	<u>Goal:</u> Use camera traps to monitor burro behaviors near water sources. <u>Status:</u> The study documented burros digging out water sources in sandy washes, creating 'wells' of water that are then available for other wildlife species. The student completed a masters thesis on the topic.
35. University of Nevada, Reno	Ongoing *(not BLM-funded)*	<u>Goal:</u> Use vegetation monitoring and camera traps to document riparian habitat use by livestock, wildlife, and wild horses. Status unknown. (S. Swanson, PI)
36. University of Nevada, Reno	Ongoing *(not BLM-funded)*	<u>Goal:</u> Use vegetation sampling, Greater sage-grouse locations, and horse, wildlife and livestock fecal transects to characterize ungulate versus sage-grouse habitat use in and near the Sheldon National Wildlife Refuge. Dissertation is in preparation. (J. Sedinger, PI)
37. Wildlife Protection Management, Inc.	Ongoing *(not BLM-funded)*	<u>Goal:</u> To develop a bait station that can remotely deliver contraceptive vaccine via darts. <u>Status:</u> This company is in the process of developing and testing a system for remotely triggered darting. A video feed shows when a horse is in position for dart delivery to the pectoral muscles, and the operator can then trigger the dart to be fired.

[1] Costs of aerial surveys are not included in the USGS project budgets. Those aerial surveys will be led by BLM.