BLM Research Proposal Format

A. COVER PAGE

US Department of Interior
Bureau of Land Management
Wild Horse and Burro Program

Proposal for Research Effort

(PRIVILEGED COMMUNICATION)

1a. Developing and testing aerial survey techniques for wild burros
TITLE OF PROPOSAL (90 Character Maximum)

1b. Schoenecker, Kate; Cain, James; Roemer, Gary; Delaney, David
INVESTIGATORS (Principal Investigator LAST NAME, FIRST NAME; Co-Investigators LAST NAME, FIRST NAME)

2a. Dr. Kate Schoenecker
NAME OF PRINCIPAL INVESTIGATOR (PI)

2b. (blank)

2c. Ecologist
POSITION TITLE

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2e. USGS; Ecosystem Dynamics Branch
INSTITUTION AND DEPARTMENT

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2h. ADDRESS: 2150 Centre Ave., Bldg C, Fort Collins, CO 80526, USA

3a. THIS PROPOSAL IS A: (Mark one only) _X_ NEW APPLICATION ___ CONTINUATION ___ UNPLANNED EXTENSION

3b. FOR COMPLETION, A FUNDING REQUEST IS:

INCLUDED and REQUIRED	INCLUDED but NOT REQUIRED	NOT INCLUDED
X		

3c. AMOUNT OF FUNDING REQUESTED:

FIRST PARTIAL YEAR	SECOND YEAR	THIRD/ FOURTH YEAR
$140,685	$155,799	$126,664/ $0

3d,e. DATES OF PROPOSED STUDY:

START	END	
April 2015	April 2018	Total: $423,128

AGREEMENT: It is understood and agreed by the undersigned if this proposal / application is approved, whether or not a grant is made, it will be according to the terms of the proposal and the stipulations set forth in the accompanying instructions. In addition, a written agreement appropriate for the nature of the proposed work (e.g., Memorandum of Understanding, Assistance Agreement, Task Order, letter of agreement) will be required to outline the obligations of the researchers and the BLM in the conduct of the study.

PRINCIPAL INVESTIGATOR ASSURANCE: I agree to accept responsibility for the conduct, completion and reporting of the study proposed here and to provide the agreed upon progress and final reports.

4a. SIGNATURE OF PRINCIPAL INVESTIGATOR: K Schoenecker DATE: 5/31/2015

CERTIFICATION AND ACCEPTANCE: I certify that the statements made in this application are true and complete to the best of our knowledge, and I accept the obligation to comply with the above agreement. I understand that the Principal Investigator and his/her department will be responsible for any expenses incurred by this project which exceed the approved funding amount.

4b. OFFICIAL SIGNING FOR ORGANIZATION: [signature] DATE: 6/9/15

Dave Hamilton, Center Director, USGS Fort Collins Science Center

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B. RESEARCH OBJECTIVES

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Name and Address of Applicant or Applicant Organization:
Dr. Kate Schoenecker, USGS Fort Collins Science Center,
2150 Centre Ave., Building C, Fort Collins, CO 80526

TITLE

Developing and testing aerial survey techniques for wild burros

ABSTRACT

Wild burros are notoriously difficult to count accurately. Their pelage blends in with surrounding vegetation, they stand still when overflown, and often occur alone or in small groups that are difficult to detect. As a result, existing survey methods and analyses may not provide accurate and precise population size estimates. In particular, the simultaneous double-observer technique used to estimate population size of free-roaming wild horses is expected to produce population estimates for burros that are lower than true burro population sizes because there can be an unknown, but possibly substantial, fraction of the population that is never 'available' to be seen by any of the observers because they are hidden under vegetation. We propose to quantify those otherwise-invisible burros using two methods. First, we propose to develop a hybrid double-observer sightability (hybrid DOS) analysis method that incorporates the simultaneous double-observer technique, sighting covariates, and observations from radio-marked burros. We aim to develop the hybrid DOS model across a range of burro habitat types and observers, to develop a broadly applicable model that can be applied at other Herd Management Areas (HMAs). Second, in trials in the same burro populations where we develop the hybrid model, we propose to test high-resolution infrared (IR) camera technology for aerial burro surveys. IR technology is becoming more common in ungulate aerial surveys, and the quality of infrared cameras has improved to the point that ungulate species can usually be differentiated if photos are zoomed. IR data can be combined with distance sampling statistical analyses to account for imperfect detection probability, given model assumptions are met. The two methods proposed here are designed to statistically quantify, and compensate for, the problem of imperfect detection that is inherent in burro aerial surveys.

Name, official title, department, project responsibilities and time commitment:

Kate A. Schoenecker, Ecologist, USGS: project oversight, study design, data collection, analysis, publication (25%)
James Cain, USGS New Mexico Coop Unit: data collection, analysis, publication (10%)
Gary Roemer, New Mexico State University: data collection, analysis, publication (10%)
David Delaney, U.S. Army Construction Engineering Research Laboratory: data collection, analysis, publication (10%)
Roger Oyler, BLM Arizona WH&B State Lead: capture and survey oversight (5%)
Gus Warr, BLM Utah WH&B State Lead: capture and survey oversight (5%)
Steve Bird, BLM Wild horse and burro Specialist: capture, surveys, publication (15%)
Mike Twedell, BLM Wild horse and burro Specialist: capture, surveys, publication (15%)

C. RESEARCH PROPOSAL

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

1. Goals / Objectives / Hypotheses

Goal

To test existing population estimation techniques for burros, and identify and develop new population estimation techniques for burros that can be applied widely across their range.

Objectives

1. Develop and test the accuracy and precision of three techniques for wild burro aerial surveys, replicated in 3 HMAs.
    A) Simultaneous double-observer method (double-observer)
    B) Hybrid double-observer sightability model (hybrid DOS)
    C) Next generation thermal infrared imaging (IR) with distance sampling analyses.

2. Publish all results in peer reviewed literature.

Hypotheses

H_1: In most cases, the raw number of burros counted in visual aerial surveys is a large undercount of true population size.

H_2: Simultaneous double-observer analyses (double-observer) that account for individual group covariates are an improvement over raw numbers of burros counted, but still lead to burro population estimates that are lower than true population size.

H_3: Hybrid double-observer sightability (hybrid DOS) models can provide accurate burro population estimates using data from radio-collared animals to quantify the amount of 'heterogeneity bias' in standard simultaneous double-observer data. Heterogeneity bias occurs because unknown factors (bias) make some animal groups more likely to be seen by both observers, or missed by both observers.

H_4: Raw counts from surveys using high definition infrared (IR) imaging are still lower than true abundance, and vegetation cover or rugged topography in the surveyed landscape may further reduce accuracy.

H_5: In surveys that use high definition IR imaging, data about animal distance from the transect line can be analyzed in a distance sampling framework, leading to more accurate estimates of burro population size, if all assumptions for distance sampling analyses are met.

2. Specific Aims

Year	Month	Aims
2015	April to October	Identify HMAs that will be study sites for the research project. Screen potential radio frequencies for signal interference at study sites. Order radio collars from manufacturer. Contract for IR surveys from vendor. Design IR and hybrid DOS survey flight patterns in GIS.† Finalize compliance for capture and collaring; BLM takes lead on NEPA. Conduct one aerial survey per HMA, using standard simultaneous double count survey methods (without radio-telemetry).
2015-2016	November to April	Conduct first set of IR surveys, 1 per study area HMA.* Capture burros to deploy 25-30 radio collars on 20+ wild burro groups in each of the study area HMAs. Conduct burro gather and removal.
2016	February to May	Conduct second set of IR surveys directly after gather/removal, 1 per study area HMA.* Provide raw count and distribution data to BLM.
2016	March to June	Conduct first set of hybrid DOS surveys with telemetry, 1 per HMA.* Provide raw count and burro distribution data to BLM.
2016	August to October	Conduct second set of hybrid DOS surveys with telemetry, 1 per study area HMA. Provide raw count and distribution data to BLM. IR survey results are reported to USGS & BLM by the vendor. Initiate distance sampling analyses on IR data.
2016	November to February	Conduct third set of hybrid DOS surveys with telemetry in winter not summer, 1 per study area HMA. Provide raw count and distribution data to BLM.
2016	January to December	Monitor the movements and home ranges of GPS radio-collared burros in both HMAs.
2017	March to June	Conduct fourth set of hybrid DOS surveys with telemetry, 1 per study area HMA. Provide raw count and distribution data to BLM.
2017	March to September	Contract for a statistician to translate the double observer method analysis currently in excel to R script. Begin hybrid DOS model building; analyze hybrid DOS data, estimate population sizes for all hybrid DOS with telemetry surveys.
2017	October to December	Prepare publication or publications; submit to peer reviewed journal.
2018	January to April	Document the hybrid DOS statistical model for future application to burro surveys outside the initial study areas.

† The IR surveys will most likely be end-product agreements, in which case the vendor may design the exact flight patterns, but following USGS guidelines.

* The timing of surveys is somewhat flexible, but *cool temperatures are optimal for the IR surveys*. One set of IR surveys and simultaneous double-observer surveys should happen before the burro roundup (gather) and removal. The other IR survey should occur shortly after the gather, as should at least one of the hybrid DOS with telemetry surveys. Removals test the accuracy of aerial survey methods.

3. Background and Significance/Preliminary Studies: (Not to exceed 3 pages)

Wild burro management requires accurate estimates of the number of animals in each HMA (National Research Council 2013). The frequency of burro gathers and the numbers of animals removed are based on burro population estimates from surveys, projected population growth rates, and appropriate management levels (AMLs). BLM, USFS, and other federal and state managers and biologists share the need for aerial burro estimation techniques that are accurate, operationally feasible, affordable, and scientifically defensible.

Accurately estimating wild burro numbers in the rugged lands of Arizona, California, Nevada, Oregon, and Utah is a challenge. Some burro characteristics make them difficult to detect in aerial surveys: burros are relatively small; often cryptic-colored; can be hidden by trees and shrubs; often occur in small groups, and may stand still during surveys (BLM, 2000). Depending on environmental conditions, as many as 30%–70% of wild burros may be missed during a standard helicopter survey (Little and Grissom 1999; BLM, 2000).

The Arizona Burro Census Team reviewed eight potential burro population estimation techniques (Little and Grissom 1999). Little and Grissom (1999) recommended further research and testing on the use of the simultaneous double-observer technique (Caughley and Grice 1982, Graham and Bell 1989) and sightability modeling (Samuel et al. 1987, Unsworth et al. 1999), and remarked that surveys with thermal IR imaging were also promising. Based on studies with aerial surveys for other ungulates, those methods each have known advantages and limitations.

Simultaneous Double-observer Technique

The simultaneous double-observer method is essentially a form of mark-resight in which animals are detected independently by separate observers in the same aircraft. When one observer detects a group, that is analogous to "marking," and if a second observer also detects the group, it is comparable to the group having been "resighted." Recording data about which animals are detected or missed by each observer allows for the creation of equations that describe the overall probability of a group being seen by one or more observer. As applied in Arizona burro analyses in the past (BLM, 2000), the estimation process was based on simple equations with just a single correction factor applied to all observed groups, to make population estimates. A more thorough way to analyze double-observer data is to account for the effects of each group's 'sighting covariates.' These are attributes that could influence the ability of observers to detect groups, such as group size or vegetative cover (Ransom 2012). Correction factors are calculated for each group according to the inverse of their detection probability (Huggins 1989, 1991); groups that would be less likely to be detected get larger correction factors. Here, the group-specific correction factor is the number of groups, with the same covariates, represented by the observed group. The estimate of population size comes the number of animals that were counted plus the estimated number of animals that were missed by all observers.

There are advantages to the double-observer method: data from each survey are used to calibrate the equation related to detection probability, so there is no need to capture or mark animals; and disturbance to animals is minimal. The technique is relatively inexpensive and has been used with wild horses in Australia (Graham and Bell 1989, Walter and Hone 2003) and in the USA (Lubow and Ransom 2007). One major disadvantage that may be especially problematic for burro aerial surveys is that the technique can lead to underestimates of the true population size, particularly if there is a subset of the surveyed population that has a very low detection probability to all observers. In theoretical terms, this means that analysis of double-observer data is subject to a high, but unknown level of 'heterogeneity bias' (Griffin et al. 2013). This type of bias arises when the observers on a survey are not truly independent, because some unknown factor (bias) makes animal groups more likely to be seen by both observers, or missed by both observers. This limitation could be pronounced for burros, because the double-observer technique cannot account for animals that are never potentially available to be seen by either of the two observers, such as animals that are behind a topographic barrier or under such dense cover that they are completely hidden from view. Because burros are often hidden under thick vegetation, and in rugged topography, the effect of heterogeneity bias could be large.

Sightability Modeling Technique[1]

Sightability models predict the probability that observers detect animals, as a function of sighting covariates (Samuel et al. 1987). Sightability models have been created for ungulates in rugged topography (Udevitz et al. 2006, Rice et al. 2008). Sightability models are made by recording the detection or non-detection of known animal groups during surveys. Usually, those known groups are identified using radio-telemetry or ground crews. Shortly after passing them, aerial observers go back to locate known groups that were missed during the surveys, then record the sighting covariates for those missed groups. The resulting sightability model provides population estimates that account for animals that were not seen during surveys (Steinhorst and Samuel 1989). Sightability model estimates typically have wide confidence intervals because there is a limited number (i.e., ~100, Wong 1996) of observations used to develop the model. Also, because sightability models are typically developed at one place and time, the equation that describes the effect of sighting covariates can become outdated if conditions or observers change (Williams et al. 2002).

Developing a Hybrid Double-observer Sightability Model for Burros

Hybrid DOS models incorporate all observations from ongoing double-observer surveys, but also account for heterogeneity bias using observations from known animal groups marked with radio collars (Griffin et al. 2013). Heterogeneity bias is the unobserved portion of the population during a survey. For example, in surveys with no radio collars, animal detections are biased in favor of those individuals that are easiest to detect by observers. If radio collars are deployed in the population, and an aerial survey is flown in which all marked animals are located whether they were seen or not by helicopter observers, that sample is random (because some animals will be out in the open and detected, and others will be standing under tree canopy and undetected yet still found [and counted] due to radio collars). The survey using radio collars is a random sample, and the survey without radio collars is a biased sample. By comparing these two samples, we can quantify the proportion of the population that goes undetected. In this way, hybrid DOS models quantify the effect of sighting covariates, but also account for that fraction of the population that would not otherwise be included in double-observer population estimates. This leads to better accuracy than simultaneous double-observer models and better precision than sightability models (Griffin et al. 2013). The magnitude of the heterogeneity bias estimated in one set of surveys can be applied to other areas with comparable survey methods and habitat conditions. In collaboration with Dr. Bruce Lubow, we have developed hybrid DOS models for elk in Mount

[1] We are not proposing to develop a sightability model in this study. This explanation is for background.

Rainier National Park (Griffin et al. 2013) and Rocky Mountain National Park (Schoenecker et al., *in press*).

Thermal Infrared Imaging

Aerial surveys that use IR imaging are a promising method for accurately and reliably estimating burro population sizes. Thermal IR imaging can be used to detect a heat signature from animals that would otherwise be cryptic, so long as there is a large enough difference between the animal's body temperature and the background temperature, In 2005, USGS conducted initial tests of forward-looking infrared (FLIR) in horse aerial surveys, but the image resolution at that time was inadequate to reliably differentiate between ungulate species (USGS, unpublished data). The resolution on more recent systems has improved to the point that IR has been used to locate sage-grouse leks (Gillette et al. 2013), and IR is now being widely used in ungulate research and monitoring programs (Storm et al. 2011, Franke et al. 2012, Beaver et al. 2014). Like direct counts, the raw counts of animals detected by IR surveys are not a reliable estimate of population size, even in cases where IR surveys may detect a higher percentage of burros than do visual observers. It is possible, though, to account for imperfect detection probability in IR surveys (Kissel and Nimmo 2011) by analyzing the data in a distance sampling framework (Buckland et al. 2008) – this method converts the raw count from IR surveys to an actual estimate of population size, including confidence intervals. We are unsure at this time if IR detectability of animals is perfect on the centerline, which is an important assumption for distance sampling analysis.

Future Application of Preferred Methods

The main benefit of this research project will be in testing the applicability of two new methods that have potential to improve burro population estimation. It is conceivable, but unlikely, that the IR surveys may detect such a high proportion of the burro populations that uncorrected IR counts will be adequate for population management. More likely, IR survey counts will need to be corrected with a distance analysis to make accurate estimates of the surveyed burro population. Finally, the hybrid DOS modeling approach has the promise to quantify the potentially large fraction of burros that are not accounted for in standard double-observer method of aerial survey. If we demonstrate that the hybrid DOS model is widely applicable, then future burro surveys can use the standard double-observer methods for data recording, but when the analyst applies the hybrid DOS model to those data, the population estimates will account for the animals that would otherwise be left out of estimates, because of heterogeneity bias.

The testing phase of the project will take place after there have been four double-observer surveys with telemetry in each of the study areas. The end of this part of data collection will allow us to complete the hybrid DOS model. At that point, we will evaluate the accuracy of the different methods. We will present our evaluation of these methods in a peer-reviewed publication.

4. Experimental Approach: (Not to exceed 5 pages)

Study Sites and Equipment

To ensure that the results from this study are broadly applicable, we will coordinate with BLM to identify three or four HMAs in which to conduct the research. The ideal HMAs for this study would have high burro populations (~200 or more) where there is a need for a population count, in which burros can be readily captured 1-2 months before surveys, and where there will be a gather and removal operation during the time period of this study. The US Army has indicated interest in using the population of Department of Defense burros at Fort Irwin National Training Center as one of the study sites, so we will collaborate with researchers from the USGS-New Mexico Coop Unit, New Mexico State University, and the U.S. Army Construction Engineering Research Laboratory (U.S. Army CERL) to include this study area.

We intend to deploy radio-collars on 25-30 burros, ideally from at least 20 groups in each of the HMAs. They will be randomly selected during the gather or water trapping by placing radio collars on every 3rd or 4th or 5th jenny in the line-up until all collars are deployed assuming the individual is an adult in good health and body condition. If not, the next individual jenny will be selected. Radio collars have long signal transmission ranges and battery lives (2-4 years), and have been used on burros in the USA (Seegmiller and Ohmart 1981) and Western Australia (Woolnough et al. 2012, M. Elliott, Dept. of Agriculture and Food Western Australia, pers. comm.). Radio collars will remain on burros for up to 4 years, at which time they will be scheduled to fall off with a timed release mechanism. USGS is conducting a separate study to test radio collar safety on captive burros, starting in February 2015. Collars survive wear and tear longer on females (jennies) than on males (jacks) (Norment 2012). The effort and time required to capture and mark 25-30 burros, in 20 or more separate groups in each of the three study populations (75-90 collars in total) could be substantial. At the two study areas identified for funding by this proposal, we will rely on BLM staff for wild burro capture and handling operations (Army staff will be in charge of operations at Fort Irwin). USGS or other experienced personnel will be on hand to conduct radio collar fitting. Capture and handling operations costs at Fort Irwin, and the cost of the 30 radio collars there, are covered by a separate study that has already been funded by the Department of Defense. James Cain (USGS-New Mexico Cooperative Fish and Wildlife Research Unit), Gary Roemer (New Mexico State University), and David Delaney (U.S. Army CERL) are co-PIs on that study.

We will order radio collars to be made with frequencies with no interference at the study sites. We will request to use VHF and GPS wildlife radio frequencies that will not conflict with other agencies or tribes. Before ordering radio collars for each HMA, we will use ground-based and aerial telemetry to confirm that there is no signal interference on the frequencies for the area.

High quality thermal IR imaging devices require no ambient light to visualize objects in the field of view because the internal sensors detect heat emitted by the objects. Animals are clearest to detect when the background temperatures of rocks and vegetation are cold, such as in winter, before and shortly after sunrise. In trials in 2005, USGS used an uncooled, or ambient-temperature, IR device with a pixel resolution that was inadequate for distinguishing cows from horses. In contrast, contemporary internally-cooled IR cameras have far greater sensitivity and resolution. Mounted under an airplane, an internally-cooled IR camera can distinguish ungulate species in a ¼ mile wide swath from a safe cruising elevation of ~1000 m above ground level (~3300 feet). We propose to contract for aerial IR surveys because the required equipment is expensive to purchase and maintain, and because DOI personnel cannot fly on small aircraft before sunrise.

Survey Flight Design
USGS will work with the local WH&B specialist to identify the survey area in and around each HMA, and to plan pre-determined flight lines that will ensure complete and systematic coverage for IR surveys and for double-observer surveys. For IR surveys, the fixed wing flight patterns will be a regular grid that entirely covers the survey area. For double-observer survey flights with or without radio telemetry, the helicopter flight patterns will also achieve complete coverage; they will be generally grid-like, but may vary in width according to vegetative cover and topography, and may follow topographic curves or ridges. We will record the airplane's and helicopter's actual flight paths with GPS.

IR Surveys
Aerial surveys with a thermal IR camera will be conducted by a fixed-wing aircraft, piloted along pre-determined flight lines and altitudes, well above any topography. The entire flight path of the survey will be recorded via GPS at 1-second intervals. The internally cooled IR camera will be mounted to provide the greatest possible width of field, pointed downward and slightly forward. A technician in the cockpit will monitor and record video from the camera output with a laptop application. If a there is a 'hot spot' with an unidentified ungulate species, the technician will help the pilot to navigate back to that location to record a second view of the target. Importantly, the technician will zoom in on the 'hot spot' target to record a much more detailed view of the animals in question. The zoom feature will allow for positive species identification, and better counts of the number of animals in each detected group. Hot spots where burros are detected will be mapped as points in GIS, and the video frames where those burros were seen will be flagged.

The contractor will provide USGS with video footage of the IR surveys, the GPS track of the airplane's path, and the raw count of individual burros identified by the IR system, not including burros recorded in the same location, but on different passes of the flight path.

Double-observer Survey Flights and Radio Telemetry
To collect the data needed to develop a hybrid DOS model for burros, observers will conduct surveys using simultaneous double-observer methods, will record which of the observed groups included radio-marked burros, and will use telemetry to return and record covariates for 'missed' groups. The USGS aerial survey specialist and /or BLM research coordinator will train observers in simultaneous double-observer observation methods and data recording, and the use of radio telemetry, and will join BLM staff for the flights. As much as possible, we will seek to include BLM observers from many district offices where burros are found, so that the range of observers is representative of the variety of potential observers across the BLM WH&B program.

During the course of the many double-observer surveys, we will undoubtedly be recording a large number of burro groups with no radio collars, and these will be useful in parameterizing the effects of sighting covariates on detection rates. Whenever any burro group is detected, observers will use a GPS unit to mark a waypoint, will determine whether the group contains a radio-collared animal, and will record sighting covariates including: side of flightline, group size, amount of vegetative cover, and topographic characteristics in the vicinity of the group. To ensure that large groups' sizes are correctly recorded, we will photograph the group with an image-stabilized zoom lens.

To develop the hybrid DOS model, we need to record ~80-100 observations of groups with radio-marked burros (Wong 1996). Data from these known burro groups that were either detected or missed during a survey will allow us to quantify that part of the population that goes undetected due to heterogeneity bias. Helicopter observers will use a telemetry receiver to check whether each observed group contains any radio-collared burros. Then, at topographic break points during the flight, the crew will point the telemetry antenna back toward areas that have already been surveyed and will scan through the frequencies of radio collared burros that have not yet been found. If the survey crew has passed any radio-collared burro group without detecting it, then the crew will use telemetry to find the radio-collared burro, and will record the sighting covariates for that missed burro's group.

Upon landing from each survey, the observers will double-check that data sheets are complete, and download all photographs and GPS data. Observation data will be entered into a relational database created to hold horse and burro simultaneous double-observer data, and then proofed. Until the development of a longer-term BLM structure for file storage and sharing, USGS will store files from each survey.

Much of the data used to create the hybrid DOS model will be typical double-observer data from burro groups that have no radio collar. This type of data allows us to quantify the effect of sighting covariates like group size, distance, and animal motion. In that category of data, we will be able to include double-observer burro data that was already recorded in 2014.[2] The additional observations from groups that *do* include a radio collar are the essential piece that will allows us to quantify heterogeneity bias – that extra fraction of burros that wouldn't otherwise be estimated by double-observer methods alone.

Analysis of the hybrid DOS model will allow us to assess whether a single function for the heterogeneity bias parameter fits across the range of HMAs where the model was developed. If so, then after the model is developed, observers in surveys at other HMAs and into the future can simply conduct the survey using the standard simultaneous double-observer methods in the air, without the need for radio collars. Estimates of population size from those future surveys, though, will have the accuracy that comes from the hybrid DOS model. Assuming that the HMAs used for model development are representative of the entire range, and that the range of observer acuities is representative of observers used in future surveys, there will be no need for radio collars in future surveys.

A separate benefit of having radio collars on burros in the study population is that we will be able to share information about the burros' seasonal movements with the BLM. Depending on the model of radio collar that we use (which is dependent on the outcome of the radio collar study), we would expect to receive one or more locations per day per radio collared burro, transmitted via satellite link. This will allow us to monitor the seasonal movements of individuals or burro groups with at least one radio collared animal. This type of almost-daily

[2] This includes surveys at Sinbad HMA, Lake Pleasant HMA, Black Mountain HMA, Cibola-Trigo HMA, McGee Mountain HMA, Warm Spring Canyon HMA, and Marietta Wild Burro Range HMA.

information on movements and home ranges could be useful to local wild horse and burro specialists throughout the year in assessments of seasonal patterns of habitat and water usage.

Testing the Accuracy of Each Method

Ultimately, the accuracy of any population estimation method should be tested with respect to a population of known size (Lubow and Ransom 2009) or with pre-gather and post-gather surveys in populations from which known numbers of animals have been removed (BLM 2000). There are currently no wild burro populations of known size. Instead, we will use pre-gather and post-gather surveys to test the accuracy of the aerial survey methods, where approximately half of the population (minimum of 60 burros), are removed from each population. We will compare population estimates before- and after-removal to the known number of burros removed; this would constitute one 'trial.'

In each trial we will calculate population size estimates and confidence intervals using the two raw counts (the visual search direct count, and the IR survey raw count) and three analysis methods (IR surveys with distance sampling, double-observer, and hybrid DOS) from pre-gather and post-gather surveys. We will quantify accuracy as a percentage based on the differences between pre-gather and post-gather population estimate, compared to the true number of burros removed from the population. We would note which method led to the best accuracy. The BLM may consider any of the methods acceptably accurate if the differences between pre-gather and post-gather population estimate are within ±20% of the true numbers of burros removed, because that would suggest that estimates from single surveys are accurate to within ~ ±10%. This approach to testing the efficacy of the methods reflects an assumption that the only source of population change between the two surveys is the removal of burros. For this reason, it would be best if the pre-gather and post-gather survey flights were as close as possible in time to the gather.

Future Tests of the Hybrid DOS Model at Other HMAs

In addition to the trials noted above, the accuracy of the hybrid DOS model can also be tested at any HMA in the future where some substantial, known number of burros will be gathered and removed from the population. All that would be required would be one aerial survey of that HMA shortly before the gather and removal operation, and another aerial survey shortly after. The data should be recorded using the standard double-observer method. It would not be necessary to have radio-collared burros in the population. Analysis of the double-observer data will use the hybrid DOS model; this means that the effect of heterogeneity bias will be accounted for. The difference between the pre-gather population estimate and the post-gather population estimate should be within ~20% of the true numbers of burros removed, as noted above. We encourage BLM to consider such trials in the future as opportunities arise.

We will keep track of survey costs including amount of area flown and aerial survey costs so we can calculate a cost per thousand acres. We will provide information on the cost of our methodology to managers.

5. Statistical Methods: (Not to exceed 1 page)

The entire set of double-observer survey data will be used to parameterize standard double-observer models (Huggins 1989, 1991). The hybrid DOS model will also use those data, along with data from burro groups that were missed by observers but found via telemetry (Griffin et al. 2013). Both categories of burro groups are used to parameterize the effects of sighting covariates on detection probability, but only the radio-marked burro groups can be used to estimate the heterogeneity bias parameter. The hybrid DOS model entails fitting a suite of competing model structures to data from three types of independent observers: front seat human observers, back seat human observers, and a telemetry receiver. Each model structure is a set of Huggins (1989, 1991) logistic regressions fit to the data with program MARK (White and Anderson 2003).

Each model structure represents a competing hypothesis about the effects of different sighting covariates, individual observers, the position of the animal group relative to the helicopter, and the heterogeneity bias parameter. Various model structures will also represent two opposing hypotheses related to the heterogeneity bias parameter: that this parameter is predictable across the range as a function of habitat parameters such as vegetative cover and topography (steep canyons versus flats), or that heterogeneity bias is idiosyncratic to a particular sets of observers, in which case it might not be applicable to future surveys with different observers. We will evaluate the relative support for different model structures with reference to each model structure's Akaike Information Criterion score (AIC; Burnham and Anderson 2002).

The double-observer data collection methods used in the helicopter aerial surveys are identical to methods used in other double-observer surveys, except with some additional survey time required to find radio collared burros that were not seen during the survey. As a result, we would be able to make preliminary analyses of population size for each survey, using standard simultaneous double-observer analysis methods (*e.g.*, Griffin, in press). Those preliminary results could be useful to HMA managers as they make management decisions.

For the hybrid DOS models, we will analyze all data sets after all the surveys with radio telemetry are complete. We will report point estimates of population size after model-averaging (Burnham and Anderson 2002) predictions from each model structure about each observed burro group's detection probability and associated correction factor. We will estimate confidence intervals for population size based on bootstrapped simulations of the data (Wong 1996). If possible (financially), we will structure all hybrid DOS analyses using the R statistical software language (R Core Team, 2013). Writing scripts in this language has the advantage that future analyses will be somewhat automated. For future surveys, it will be only necessary to add a table of new double-observer data to the existing data set used to originally create the hybrid DOS model.

We will use distance analysis (Buckland et al 2008) to convert the raw counts of burros seen on IR surveys to estimates of burro population size. We will use the recorded images of burros from the IR flight to analyze each observed burro's distance from the flight line, based on the airplane's UTM coordinates at the time of the video frame, the horizontal and vertical angle to the burro compared to the center of the flight line, and the airplane's elevation above ground level. The distribution of distances from the centerline will be used to parameterize a distance detection function (Kissel and Nimmo 2011) that can be used to calculate correction factors and total burro abundance, and associated confidence intervals. An important assumption in distance analysis is that 100% of animals on the transect line directly below the aircraft are detected. We will test for a decreasing frequency of detections according to distance, but we will not be able to test that assumption directly. Rather, the gauge of the validity of the IR method will be the test of IR survey accuracy, with respect to the number of animals removed.

6. Pitfalls and Limitations: (Not to exceed 1 page)

Developing a hybrid DOS statistical model depends on having an adequate sample size of observations from radio-collared burros. The precision of the heterogeneity bias parameter will depend on the number of observations from radio-marked burros. As a result, the hybrid DOS portion of this project will depend on the availability of a radio collar design that is safe and effective for use on burros. In a study that began in February 2015 in Pauls Valley, Oklahoma, USGS is assessing four models of radio collar for their safety on burros. We fully expect that one or more of these models will work; there is already a collar design that does not injure wild horse mares, and has a reliable drop-off mechanism (Collins et al. 2014).

The infrared camera that we will use in aerial IR surveys represents a totally independent aerial survey method that can be used even if no burros are radio-collared. Specialists and state leads have expressed interest in testing this method on burros. The newest generation of internally-cooled IR cameras, sensitive enough to identify sage grouse leks (Gillette et al. 2013), should be adequate for burro identification. The IR surveys in this study will test the ability of new IR cameras to distinguish among multiple species of large ungulates in the study areas.

The biggest factor that may limit our ability to test the accuracy of the three methods identified in the Goals / Objectives / Hypotheses section of this proposal is the uncertain timing and location of burro gathers and removals. The optimal way to test the accuracy of each of the two direct counts and three analysis methods is to conduct trials, where there are pre-gather and post-gather surveys in HMAs with a gather and removal scheduled. We have budgeted for the two trials to take place in the study locations where radio collaring, IR surveys, and frequent aerial surveys will take place, following the protocols in this proposal.

We recognize that the timing and location of burro gathers might not fit into the optimal schedule for a research project like the one proposed here. However, we strongly urge that there be pre-gather and post-gather IR surveys and pre-gather and post-gather double-observer surveys to further test the accuracy of the IR survey methods, standard double-observer analysis methods (Griffin 2015), and the hybrid DOS model for burros proposed here.

7. Anticipated effects

During our study, burros will be captured either by a helicopter gather or by water trapping. In addition, individual burro jennies will be radio collared, and aerial surveys will be conducted over the population(s) to count individuals for development of the population estimation model for burros.

Gathers

Gathers or water trapping will be conducted by the BLM following their established guidelines and policy (BLM IM 2013-059). We anticipate that gathers or water trapping will be carried out calmly and at as slow a speed as possible in order to minimize stress and injury, however it is possible that small injuries (at the level of abrasions) may occur. Due to the removal of animals in the gather or water trapping and because animals may have to travel back to their ranges after the gather, individual burros may not return to the same group or area in which they were found before the gather, although the frequency of this is not known.

Collars and tags

Based on numerous other studies that have used GPS or VHF radio collars to study the ecology of wild ungulates we expect these devices to have minimal effects on the animals wearing them. However the following effects are possible:

1. Collar going over the ear: In other equids this has only been observed in males (G. Collins, USFWS and P. Kaczensky Vetmeduni Vienna, personal communication). We will only radio collar jennies, so we do not anticipate radio collars going over the ears. In addition, all jennies wearing collars will be observed at least once a month throughout the year. Should the collar go over the ear of jennies the remote-release (also known as the drop-off mechanism) will be deployed manually (by locating the individual and walking to within 200m of it, and using the UHF manual release unit). If this fails the collar will be removed after capturing the animal with bait or water traps or darting, depending on what options are best in the specific situation and HMA.
2. Neck abrasion/sores: Rubbing and sores have not been reported in other studies where equids have been collared (e.g., Collins et al. 2014), and were not seen in burros during the first 5 months of our collar test at Pauls Valley adoption facility, Oklahoma. We therefore do not anticipate that they will be a problem. All burros will be visually checked at least monthly, and this check will include for clear and open sores. Burros in the wild are susceptible to wounds, most of which heal within a month. If sores caused by a collar have not healed within 4 weeks of when it was first observed, that individual will have its collar remotely triggered to drop off, or will be captured with bait or water traps or darting, depending on what options are best in the specific situation and HMA.
3. Collar too tight: Every effort will be made to put collars on at the correct tightness, which in burros is similar to how we fit collars on elk (*Cervus elaphus*). It will fit somewhat comfortably snug when the head is raised, and slightly looser when the head is lowered. Should an individual jenny gain an unusually large amount of weight it is possible that the collar may become tight, although this is unlikely. However, in such a case the individual will be bait-trapped and the collar removed or replaced.
4. Death or injury: in almost all studies in which ungulates are radio collared by helicopter netgunning, there is some incidental mortality or injury from handling or stress, typically ranging from 1% to 3%. There is nothing reported in the literature on the incidental accidents, injury, or capture-related mortality for burros that are fitted with radio collars. The method of capture we will use (gather or water trapping) is far less stressful than being netgunned from a helicopter. We anticipate being able to quantify this rate, if mortalities or injuries occur. However, BLM has gathered burros for decades and methods for the gather are well established.

Aerial Surveys

Aerial surveys are part of the normal management for burros. They are typically counted from a helicopter every 3-4 years. Burros respond by either moving away, running, or more typically standing still, or hiding under tree cover.

Other

We anticipate some mortality or injuries to individuals due to the rigors of life in the wild, and specifically expect mortality of juveniles in early spring. These are natural processes.

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Samuel, M. D., E. O. Garton, M. W. Schlegel, and R. G. Carson. 1987. Visibility bias during aerial surveys of elk in Northcentral Idaho. Journal of Wildlife Management 51:622–630.
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Seegmiller, R. F., and R. D. Ohmart. 1981. Ecological relationships of feral burros and desert bighorn sheep. Wildlife Monographs 78:1-58.
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D. BIOGRAPHICAL SKETCH

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

Name: Kathryn A. Schoenecker ("Kate") **Title:** Ecologist

Education:

Institution and Location	Degree	Year	Scientific Field
Colorado State University, Ft.Collins	Ph.D	2012	Ecology
University of Arizona, Tucson	M.S.	1997	Wildlife Biology
University of Wisconsin, Madison	B.A	1987	Internatn'l Relations

(Includes 1 year at Friedrich Wilhelm Universität, Bonn, West Germany)

Honors/Awards: National Park Service Regional Director's Award for Excellence in Natural Resources Research, 2006; IUCN Bison Specialist Working Group, 2006-present; BLM Science Appreciation Award, 2001; USGS Star Awards, USGS Performance Awards, and USGS Appreciation Award; 1999-2012; USGS Aviation Safety Award, 2013

Major Research Interest: Grazing ecology of large herbivores; Ungulate population dynamics and modeling; Ungulate population estimation techniques; Interspecific interactions of ungulates.

Role in Proposed Project (be specific):
Principal Investigator

- Project oversight
- Model design
- Data collection
- Publication

Previous and Current Research Support Relating to the Current Proposal:

- Developing an elk and bison carrying capacity model for Great Sand Dunes National Park, Baca National Wildlife Refuge, and the Nature Conservancy's Medano Ranch in the San Luis Valley of Colorado, 2010; $80K NRPP
- Habitat interactions of wild horses and bighorn sheep in the Pryor Mountain Wild Horse Range and Bighorn Canyon National Recreation Area, 2001-2003 (NRPP; $70K/yr)
- Habitat conditions of the Sheldon-Hart NWR complex and impacts of wild horses 2012-2013; SSP; $25K/yr
- Wild horse demography in the Pryor Mountain WH Range, 1997-2004 ($185K/yr).
- Re-vegetation of the common corrals (shared by cattle, wild horses and bighorn sheep) in Bighorn Canyon National Recreation Area, 2006 (Rapid Response; $40K)
- Grazing ecology of elk and bison in the Great Sand Dunes National Park—Baca National Wildlife Refuge complex of lands, 2005-2009 (NPS NRPP; $150K/yr)

Research and/or Professional Experience

1997–2004 Co-PI on USGS research investigating wild horse behavior and ecology (population estimation, and intraspecific interactions) in the Pryor Mountain Wild Horse Range. Assisted at BLM wild horse round-up with Gus Warr, Utah, 2001.

2001-2003 Principal Investigator on research investigating habitat interactions of wild horses and bighorn sheep on the Pryor Mountain Wild Horse Range and Bighorn Canyon National Recreation Area.

1997-2015 18 years of experience as an ungulate ecologist for the U.S. Geological Survey, Fort Collins Science Center, Fort Collins, Colorado.

Recent Relevant Publications:

Schoenecker, K.A., and B.C. Lubow. 2015. Use of a hybrid model and simple techniques to reduce bias in population estimates for elk (*Cervus elaphus*) inhabiting a cold desert ecosystem. Journal of King Saud University Science, Invited paper for Special Issue on Arid Ecosystems: *in press*.

Schoenecker, K.A., S.R.B. King, M. Nordquist, N. Deitich, Q. Kao. Chapter 4: Habitat selection and diet of equids, *In* Ransom, J.I. and P. Kaczensky, Eds., Wild Equids - Ecology, Management, and Conservation. *In press for spring 2016 release*. Johns Hopkins University Press, Baltimore, USA.

Mask, T.A., K.A. Schoenecker, A.J. Kane, J.I. Ransom, and J.E. Bruemmer. 2015. Serumantibody immunoreactivity to equine zona protein after SpayVac vaccination. Theriogenology 84(2):261 – 267.

Wockner, G., Boone, R., Schoenecker, K.A., and Zeigenfuss, L.C., 2014, Modeling elk and bison carrying capacity for Great Sand Dunes National Park, Baca National Wildlife Refuge, and The Nature Conservancy's Medano Ranch, Colorado: U.S. Geological Survey Open-File Report 2014–1200, 23 p.

Zeigenfuss, L.C., K.A. Schoenecker, J.I. Ransom, D.I. Ignizio, and T. Mask. 2014. Grazer biomass and seasonal precipitation influence vegetation production in a Great Basin Ecosystem. Western North American Naturalist 74(3): 286–298.

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Roelle, J.E., Singer, F.J., Zeigenfuss, L.C, Ransom, J.I., Coates-Markle, L., Schoenecker, K.A. 2010. Demography of the Pryor Mountain Wild Horses 1993–2007. USGS Scientific Investigations Report 2010–5125.

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D. BIOGRAPHICAL SKETCH

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Name: James W. Cain III **Title:** Research Wildlife Biologist

Education:

Institution and Location	**Degree**	**Year Conferred**	**Scientific Field**
University of Arizona, Tucson	Ph.D.	2006	Wildlife Ecology
California State University, Sacramento	M.S.	2001	Biological Conservation
Colorado State University, Ft. Collins	B.S.	1997	Biology

Major Research Interest: large herbivore ecology, forging ecology, wildlife-habitat relationships, population ecology

Role in Proposed Project (be specific):

Co-Investigator:

- Project oversight
- Study design
- Publication

Research and/or Professional Experience:

Assistant Unit Leader-Wildlife (2010 – present) – U.S. Geological Survey, New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, New Mexico.

Adjunct Associate Professor (2010 – present). – Departments of Fish, Wildlife and Conservation Ecology, and Biology, New Mexico State University, Las Cruces, New Mexico.

Honorary Research Fellow (2008 – present) – Center for African Ecology, School of Animal, Plant, & Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa.

Assistant Professor (2008 – 2010) – Wildlife and Conservation Science, Department of Biological and Environmental Sciences, Texas A&M University-Commerce, Commerce, Texas

Recent Research Projects and Grants:

2014-2016 U.S. Department of Defense, Fort Irwin. The ecological web contributing to a sarcoptes mange epizootic in coyotes of the Mojave Desert, Fort Irwin, California. $114,426 (Co-PI)

2014-2016 U.S. Department of Defense, Fort Irwin. An estimate of abundance and an assessment of the efficacy of sterilization techniques for the control of wild burro populations. ***$131,524 (Co-PI)***

2013-2017 Pueblo of Jemez. Resource selection and movements of mule deer and elk on the Jemez Pueblo. $161,053 (PI)

2013-2015 U.S. Fish and Wildlife Service. Population trends and predicted trajectories of American Pronghorn (*Antilocapra americana*) in the American Southwest $39,291 (PI)

2013-2016 U.S. Geological Survey, National Climate Change & Wildlife Science Center. Assessment of drought impacts on selected fish and wildlife species in the southwestern U.S. $200,000 (Co-PI)

2011-2019 USDA Forest Service/Valles Caldera National Trust. Research Cooperative Agreement. Large mammal monitoring for the southwest Jemez Mountains collaborative forest landscape restoration project. $458,074 (PI)

2012-2014 New Mexico Department of Game and Fish. Research Cooperative Agreement. Influence of livestock grazing on activity budgets, foraging efficiency, and forage resources of desert bighorn sheep. $94,028 (PI)

2011-2014 New Mexico Department of Game and Fish. Research Cooperative Agreement. Survival and cause-specific mortality of neonatal desert bighorn sheep in New Mexico. $109,866 (PI)

2011-2016 New Mexico Department of Game and Fish. Research Cooperative Agreement. Estimation of black bear abundance and densities in New Mexico using non-invasive genetic analysis. $423,672 (Co-PI)

Recent Relevant Publications:

Pitman, J.W., **J.W. Cain III**, S.G. Liley, W.R. Gould, N.T. Quintana, and W. B. Ballard. 2014. Post-parturition habitat selection by elk calves and adult female elk in New Mexico. Journal of Wildlife Management 78:1216-1227.

O'Shaughnessy, R., **J.W. Cain III**, N. Owen-Smith. 2014. Comparative diet and habitat selection of puku and lechwe in northern Botswana. Journal of Mammalogy 95:933-942.

Pepper, M.B., L.D. Howery, P.R. Krausman, G.B. Ruyle, **J.W. Cain III**, and D.W. Schafer. 2013. Adaptive grazing management for cattle and elk forage use in central Arizona. Southwestern Naturalist 58:20-27.

Macandza, V.A., N. Owen-Smith, and **J.W. Cain III**. 2012. Habitat and resource partitioning between abundant and relatively rare grazing ungulates. Journal of Zoology 287:175-185.

Macandza, V.A., N. Owen-Smith, and **J.W. Cain III**. 2012. Dynamic spatial partitioning and coexistence among tall grass grazers in an African savanna. Oikos 121:891-898.

Cain, J.W., III, N. Owen-Smith, and V.A. Macandza. 2012. The costs of drinking: comparative water dependency of sable antelope and zebra. Journal of Zoology 286:58-67.

Marshal, J.P., **J.W. Cain III**, V.C. Bleich, and S.S. Rosenstock. 2009. Intrinsic and extrinsic sources of variation in the dynamics of large herbivore populations. Canadian Journal of Zoology 87:103-111.

Cain, J.W., III, P.R. Krausman, J.R. Morgart, B.D. Jansen, and M.B. Pepper. 2008. Responses of desert bighorn sheep to the removal of water sources. Wildlife Monographs 171.

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Cain, J.W., III, P.R. Krausman, S.S. Rosenstock, and J.C. Turner. 2006. Thermoregulation and water balance in desert ungulates. Wildlife Society Bulletin 34:570-581.

Cain, J.W., III, P.R. Krausman, B.D. Jansen, and J.R. Morgart. 2005. Influence of topography and GPS fix interval on GPS collar performance. Wildlife Society Bulletin 33:926-934.

Cain, J.W., III, J.V. Gedir, P.R. Krausman, J.P. Marshal, J.D. Allen, G.C. Duff, B.D. Jansen and J.R. Morgart. In prep. Extreme precipitation variability, forage quality and large herbivore diet selection in arid environments. . To be submitted to Ecology.

D. BIOGRAPHICAL SKETCH

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

Name: Gary W. Roemer **Title:** Professor of Wildlife Ecology

Education:

Institution and Location	Degree	Year Conferred	Scientific Field
UCLA	Ph.D.	1999	Biology
Humboldt State University, Arcata	M.S.	1989	Wildlife
University of Wisconsin, Parkside	B.S.	1982	Life Science

Honors/Awards: 2006, Southwestern Association of Naturalists – George Miksch Sutton Award in Conservation Research; 2004-2005, Distinguished Research Award, College of Agriculture & Home Economics, New Mexico State University; 1999, Robert C. Lasiewski Award for Outstanding Research Accomplishments in Organismic Biology, Department of Biology, UCLA.

Major Research Interest: population ecology, landscape genetics, carnivore ecology, raptor ecology, behavioral ecology

Role in Proposed Project (be specific):
Co-Investigator:

- Project oversight
- Study design
- Publication

Research and/or Professional Experience:

Professor (2014 to Present) – Dept. of Fish, Wildlife & Conservation Ecology, New Mexico State University

Research Associate (2011 – 2014) – National Museum of Natural History, Smithsonian Institution, Washington D.C.

Associate Professor (2007 – 2014) – Dept. of Fish, Wildlife & Conservation Ecology, New Mexico State University

Assistant Professor (2001 – 2007) – Dept. of Fishery & Wildlife Sciences, New Mexico State University

Post-doctoral researcher/Lecturer (1999 – 2000) – Dept. of Biology, UCLA

Research Biologist (1985 – 2000) – Institute for Wildlife Studies, Arcata, CA.

Recent Research Projects and Grants:

2014-2016 U.S. Department of Defense, Fort Irwin. The ecological web contributing to a sarcoptes mange epizootic in coyotes of the Mojave Desert, Fort Irwin, California. $114,426 (Co-PI)

2014-2016 U.S. Department of Defense, Fort Irwin. ***A***n estimate of abundance and an assessment of the efficacy of sterilization techniques for the control of wild burro populations. ***$131,524 (Co-PI)***

2014-2015 USFWS Division of Migratory Bird Management. Research Cooperative Agreement. An assessment of the landscape genetic structure of the western continental golden eagle population. $127,244 (Co-PI)

2011-2016 New Mexico Department of Game and Fish. Research Cooperative Agreement. Estimation of black bear abundance and densities in New Mexico using non-invasive genetic analysis. $423,672 (Co-PI)

2010-2013 U.S. National Park Service. DECSU Cooperative Agreement. The Ecology and Conservation of Mesocarnivores at White Sands National Monument. $100,166 (PI)

Recent Relevant Publications:

Robinson, Q. H., D. Bustos and **G. W. Roemer**. 2014. The application of occupancy modeling to evaluate intraguild predation in a model carnivore system. Ecology 95:3112-3123.

Dickson, B. G., **G. W. Roemer**, B. H. McRae and J. M. Rundall. 2013. Models of regional habitat quality and connectivity for pumas in the southwestern United States. PLoS One 8(12) e81898:1-11.

Moses, M.R., J.K. Frey and **G.W. Roemer**. 2012. Elevated surface temperature depresses survival of banner-tailed kangaroo rats: Will climate change cook a desert icon? Oecologia 168:257-268.

Facka, A. N., **G. W. Roemer**, V. Mathis, M. Kam, and E. Geffen. 2010. Drought leads to collapse of black-tailed prairie dog populations reintroduced to the Chihuahuan Desert. Journal of Wildlife Management 74:1752-1762.

Bakker, V.J., D. Doak, **G.W. Roemer**, D. Garcelon, T. Coonan, S. A. Morrison, C. Lynch, K. Ralls and R. Shaw. 2009. Incorporating ecological drivers and uncertainty into a demographic population viability analysis for the island fox. Ecological Monographs 79:77-108.

Roemer, G. W., M. E. Gompper and B. Van Valkenburgh. 2009. The ecological role of the mammalian mesocarnivore. BioScience 59:165-173.

Facka, A. N., P. L. Ford, and **G. W. Roemer**. 2008. A novel approach for assessing density and range-wide abundance of prairie dogs. Journal of Mammalogy 89:356-364.

Angulo, E., **G. W. Roemer,** L. Berec, J. Gascoigne and F. Courchamp. 2007. Double Allee effects and extinction in the island fox. Conservation Biology 21:1082-1091.

Coonan, T. J., C. A. Schwemm, **G. W. Roemer**, D. K. Garcelon and L. Munson. 2005. Decline of an island fox subspecies to near extinction. Southwestern Naturalist 50:32-41.

Andersen, M. C., B. Martin, and **G. W. Roemer**. 2004. Use of matrix population models to estimate the efficacy of euthanasia versus trap-neuter-return for management of free-roaming cats. Journal of the American Veterinary Medical Association 225:1871-1876.

D. BIOGRAPHICAL SKETCH

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

Name: David Delaney **Title:** Research Wildlife Biologist/Bioacoustician

Education:

Institution and Location	Degree	Year Conferred	Scientific Field
Northern Arizona University	M.S.	1997	Forestry
University of New Hampshire	B.S.	1990	Wildlife Management

Honors/Awards:

Department of the Army Superior Civilian Service Award, 2011

Department of the Army Commander's Award for Civilian Service, 2006.

Strategic Environmental Research and Development Program. 2001 Environmental Project of the Year. Effects of Military Training Operations on Red-cockaded Woodpeckers on Fort Stewart, GA.

Major Research Interest: threatened, endangered, and at-risk species ecology, anthropogenic disturbance effects on wildlife, wildlife activity and behavioral patterns.

Role in Proposed Project (be specific):
Co-Investigator:

- Data collection
- Analysis
- Publication

Research and/or Professional Experience:

Research Wildlife Biologist/Bioacoustican (1998 – present) – U.S. Army Construction Engineering Research Laboratory, Champaign, IL.

Adjunct Professor (2014 – present). – Departments of Fish, Wildlife and Conservation Ecology, and Biology, New Mexico State University, Las Cruces, New Mexico.

Recent Research Projects and Grants:

2014-2017 U.S. Department of Defense, Fort Irwin. Grant Officer Technical Representative/Researcher on coyote project. The ecological web contributing to a sarcoptes mange epizootic in coyotes of the Mojave Desert, Fort Irwin, California. $298,413.52 (Co-PI)

2014-2017	U.S. Department of Defense, Fort Irwin. Grant Officer Technical Representative/Researcher on feral burro project. An estimate of abundance and an assessment of the efficacy of sterilization techniques for the control of wild burro populations. $150,000.00 (Co-PI)
2014-2015	Department of Defense Legacy Program. Demonstrating on the use of acoustics to quantify and characterize military munitions entering sensitive wildlife areas downrange of active military ranges ($30,000.00)
2013	Bureau of Land Management. Assessment of the Potential Effects of Wind Turbines on Desert Tortoises ($30,000.00)
2012	Department of Defense Legacy Program. Mohave ground squirrel workshop ($65,000.00)
2011-2012	U.S. Department of Defense, Fort Irwin. Grant Officer Technical Representative/Researcher on Mohave ground squirrel project ($525,000.00)
2011-2012	Bureau of Land Management. Mohave ground squirrel survey ($100,000.00)
2010-2013	U.S. Department of Defense, Fort Benning. The potential effects of military training activity on Red-cockaded Woodpeckers ($750,000.00)
2009-2010	U.S. Department of Defense, U.S. Army Corps. Assessment of surveys techniques for Mohave ground squirrels in the western Mojave Desert ($250,000.00)

E. FACILITIES STATEMENT

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

USGS Fort Collins Science Center will provide office space, information technology resources, vehicles, field observation equipment, cameras, and administrative support.

F. DETAILED BUDGET FOR EACH 12 MONTH PERIOD

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

YEAR 1: DATES FOR THIS 12 MONTH PERIOD FROM April 30, 2015 TO Sept. 30, 2015

Salary & Wages (Describe % effort or hours for each person)

Description	Itemized Cost	In-Kind, USGS	In-Kind, BLM	Project Costs	In-Kind, Dept. of Defense
K. Schoenecker		8,000			
Steve Bird and Mike Twedell			3,000		
J. Cain		3,500			
D. Delaney					5,000
USGS data management staff		4,000			

Project Category Total: $0

Equipment & Supplies (Describe and give cost of each item over $100) – Itemize

Radio collar purchase for low fix rate collars (2x/day)	40 @ $800 each			32,000	
Radio collar purchase for high fix rate collars (8-12x/day)	10 @ $3,500 each	35,000			
Drop off mechanisms	40 @ $290 each			11,600	
2 Telemetry receivers with scanning capability	2 @ $750 each			1,500	
Helicopter bracket for telemetry antenna				750	
Standard double-observer survey without telemetry at study areas	2 HMAs @ $15,000/each			30,000	
Pre-gather IR surveys at 2 HMAs	2 @ $20,000 each	20,000		20,000	
Radio frequency screening	2 HMAs @ $1,500 each			3,000	

Project Category Total: $98,850

Miscellaneous Costs (assays, etc,) – Itemize

Travel: frequency screening	2 HMAs @ $600 each			1,200	
Travel: Double-observer surveys	2 HMAs @ $1400 each			2,800	

Project Category Total: $4,000
Project Sub Total: $102,850
Indirect Costs: $37,834
PROJECT TOTAL: $140,685
AMOUNT REQUESTED OF BLM: $140,685

List other available support for this project (source and amount): 10 high fix rate radio collars will be purchased with funds for the radio collar project ($35,000).
List other requested support for this project (source and amount): The aerial surveys at Fort Irwin will be conducted and paid for with DoD funds, by collaborators from New Mexico State University.

F. DETAILED BUDGET FOR EACH 12 MONTH PERIOD

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

YEAR 2: DATES FOR THIS 12 MONTH PERIOD FROM Oct. 1, 2015 TO Sept. 30, 2016

Salary & Wages (Describe % effort or hours for each person)

Description	Itemized Cost	In-Kind, USGS	In-Kind, BLM	Project Costs	In-Kind, Dept. of Defense
K. Schoenecker		8,000			
Steve Bird and Mike Twedell			3,000		
J. Cain		3,500			
D. Delaney					5,000
USGS data management staff		3,000			

Project Category Total: $0

Equipment & Supplies (Describe and give cost of each item over $100) – Itemize

Radio collar data fees for 12 mos.	$20/month*40*12mos ($9,600); $50/month *10*12 mos.($6K)			15,600	
Double-observer survey with telemetry at study areas	4 @ $18,000 each (2 surveys at 2 HMAs)			72,000	
Post gather Infrared surveys at study areas	2 @ $20,000 (1 each at 2 HMAs)	20,000		20,000	

Project Category Total: $107,600

Animal Costs (Including board and maintenance) – Itemize

Burro gathers at 2 HMAs			TBD		

Project Category Total: $0

Miscellaneous Costs (assays, etc,) – Itemize

Travel: Radio collaring at burro gather/removal.	2 @ $1,250 each			2,500	
Travel: Double-observer surveys with telemetry	4 @ $950 each			3,800	

Project Category Total: $6,300
Project Sub Total: $113,900
Indirect Costs: $41,898
PROJECT TOTAL: $155,799
AMOUNT REQUESTED OF BLM: $155,799

List other available support for this project (source and amount): Data collection (monitoring) for 10 high intensity radio collars will come from the Sentinel Demography project budget ($6K)
List other requested support for this project (source and amount): None

F. DETAILED BUDGET FOR EACH 12 MONTH PERIOD

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

YEAR 3: DATES FOR THIS 12 MONTH PERIOD FROM Oct.1, 2016 TO Sept. 30, 2017

Salary & Wages (Describe % effort or hours for each person)

Description	Itemized Cost	In-Kind, USGS	In-Kind, BLM	Project Costs	In-Kind, Dept. of Defense
K. Schoenecker		8,000			
Steve Bird and Mike Twedell			3,000		
J. Cain		3,500			
BLM contract statistician [Lubow]			7,000		
D. Delaney					5,000
USGS data management staff		3,000			

Project Category Total: $0

Equipment & Supplies (Describe and give cost of each item over $100) – Itemize

Radio collar data fees for 12 mos.	$20/month*40*12mos ($9,600); $50/month *10*12 mos.($6K)			15,600	
Double-observer survey with telemetry at study areas	4 @ $18,000 (2 per 2 HMAs)			72,000	

Project Category Total: $87,600

Animal Costs (Including board and maintenance) – Itemize

Project Category Total:

Miscellaneous Costs (assays, etc,) – Itemize

Travel: Double-observer surveys with telemetry	4 surveys @ $1,250			5,000	

Project Category Total: $5,000
Project Sub Total: $92,600
Indirect Costs: $34,063
PROJECT TOTAL: $126,664.00
AMOUNT REQUESTED OF BLM: $126,664.00

List other available support for this project (source and amount): [1]Additional funds will be used from CMVRB (USGS funds) to contract for double observer R script (up to $10K)
List other requested support for this project (source and amount): None

F. DETAILED BUDGET FOR EACH 12 MONTH PERIOD

BLM Wild Horse and Burro Program
Proposal for Collaborative Research Effort

Privileged Communication

YEAR 4: DATES FOR THIS 12 MONTH PERIOD FROM Oct.1, 2017 TO April 30, 2018

Salary & Wages (Describe % effort or hours for each person)

Description	Itemized Cost	In-Kind, USGS	In-Kind, BLM	Project Costs	In-Kind, Dept. of Defense
K. Schoenecker		4,000			
S. Bird			1,000		
J. Cain		3,000			

Project Category Total: $0

Equipment & Supplies (Describe and give cost of each item over $100) – Itemize

Page charges for 2-3 publications		6,500			

Project Category Total: $0

Animal Costs (Including board and maintenance) – Itemize

None					

Project Category Total: $0

Miscellaneous Costs (assays, etc,) – Itemize

None					

Project Category Total: $0
Project Sub Total: $0
Indirect Costs: $0
PROJECT TOTAL: $0
AMOUNT REQUESTED OF BLM: $0

List other available support for this project (source and amount): USGS will cover costs for salaries and publications in the final year of the study
List other requested support for this project (source and amount): None

G. HUMANE CARE AND USE OF ANIMALS

BLM Wild Horse and Burro Program

This study will require restraining wild horses and burros within a squeeze panel for the fitting of collars. A veterinarian will be present and participate during radio collaring. We will not use chemical immobilization for radio collaring.
No other direct contact will be made with living animals. Collars will be designed to drop off at the end of the study period. All procedures will follow protocols approved by USGS Animal Care and Use Committee.

Protocol number: ***FORT IACUC 2015-10***

Title of proposal: Field use and testing of radio telemetry collars and radio tags on free-roaming wild horses and burros in the Western United States.

Investigators: Drs. K.A. Schoenecker, and S.R.B. King

Pursuant to procedures established by the Bureau of Land Management, Wild Horse and Burro Research Program, I certify that the above described protocol follows guidelines set forth in the National Institutes of Health "Guide for the Care and Use of Laboratory Animals" (#85-23) and the "Animal Welfare Act of 1966" (PL 89-544) as amended.

Signature: ___*(Please see attached signature page)*_ Date __7-13-2015___

Name: ______Bill Iko__________________________
Chair, Institutional Animal Care and Use Committee

Name of Institution: ___U.S. Geological Survey, Fort Collins Science Center__

NOTE: This completed form must be in receipt of the BLM WH&B Research Coordinator before the initiation of funding or collaborative work can commence. Private individuals must seek local/regional institutional approval.

G. HUMANE CARE AND USE OF ANIMALS

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Fort Collins Science Center
2150 Centre Avenue, Bldg C
Fort Collins, CO 80526-8118

July 13, 2015

To: Kate Schoenecker, Sarah King, Fort Collins Science Center and Colorado State University

From: Bill Iko, FORT IACUC Chair

Re: FORT IACUC Approval of Study Plan entitled "Field use and testing of radio telemetry collars and radio tags on free-roaming wild horses and burros in the Western United States."(FORT IACUC Approval 2015-10).

After completion of preliminary review of your submission (6/17/15), PI review and resubmission (7/7/15), your FORT IACUC document has been approved (FORT IACUC Approval 2015-10). This approval is good for 3 years, at which time the PI will need to request an extension and report on the current progress of this project.

Just a reminder that the FORT IACUC has a minimum of 10 working days to complete their preliminary review. With committee review, PI review, and resubmission of amended document, this review process can take up to 20 working days (1 month), so please plan accordingly. PIs cannot start their field or laboratory research with animals until the FORT IACUC approval has been given.

Sincerely,

William M. Iko
FORT IACUC Chair