REVIEW, SENSITIVE SPECIES WILDLIFE MONITORING PLAN, PINEDALE ANTICLINE

Submitted by the Sensitive Species Monitoring Plan Review Committee:

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Submitted: 02 April, 2010

Introduction

The Sensitive Species Monitoring Plan Review Committee (Committee) was given the task of conducting a peer review of wildlife monitoring efforts on the Pinedale Anticline Project Area (PAPA). The Committee understands the goal of the Wildlife Monitoring and Mitigation Plan and Associated Matrix (Appendix B of SEIS Record of Decision) to be to ". . . monitor wildlife populations while tracking their response to energy development." (Kauffman, M. J., Guidelines for third-party review of PAPA wildlife monitoring plans, 27 September 2009, p. 1). The specific questions addressed by the Committee were as follows:

Are the experimental designs and methods for monitoring described in the Monitoring Plans adequate to detect changes in the criteria identified by the Matrix within a reasonable timeframe?

If changes in an identified criteria (i.e., change in pronghorn survival) do occur in response to energy development on the PAPA, how likely are the monitoring methods described to detect this change and identify when stated thresholds have been met or surpassed? (Kauffman, M. J., Guidelines for third-party review of PAPA wildlife monitoring plans, 27 September 2009)

The Matrix criteria for sensitive species (pygmy rabbits and white-tailed prairie dogs) are substantially as follows:

Criteria	Method	Changes that will be monitored	Specific change requiring mitigation
Occurrence of species and change in numbers of each species	TRC data, existing and con-tinued	3-year change in presence/absence of species, and in numbers of individuals of each species, compared to reference areas	3 consecutive years of decline in presence or absence of a species, or an average of 15% decline in numbers of individuals each year over 3 years

(Pinedale Anticline Record of Decision, Appendix B, p. B-3)

The committee understands the matrix to call for monitoring of both presence-absence (distribution) and numbers of individuals (abundance). We further understand "3 consecutive

years of decline in presence or absence of a species . . .” to mean 3 consecutive years of reduction in presence of a species over replicated sampling sites, without respect to any specified effect size. In other words, the matrix does not identify any specified magnitude of change in presence-absence of either species. Also, the committee understands “. . . an average of 15% decline in numbers of individuals each year over 3 years” to mean any pattern of change in abundance that results in a net 38.6% reduction in abundance (15% compounded, or $1\text{-}0.85^3$) on replicated sampling sites over the 3-year period. Inasmuch as the proposed plan calls for monitoring of two attributes (presence-absence, abundance) for two species, we organize our review into four sections: presence-absence of pygmy rabbits, abundance of pygmy rabbits, presence-absence of white-tailed prairie dogs, and abundance of prairie dogs). In addition to answering the basic questions of sufficiency of approach, the Committee provides recommendations on how the approach can be made more efficient and statistically rigorous.

Presence-absence of Pygmy Rabbits

Are the experimental designs and methods for monitoring described in the Monitoring Plans adequate to detect changes in the criteria identified by the Matrix within a reasonable timeframe?

No. Portions of the monitoring plan are logical and well-founded on natural history of pygmy rabbits; however, the design of the protocol is not based on well-established sampling principles. Specifically, the monitoring plan does not permit an estimate of density of burrows or of abundance of pygmy rabbits. So, the criterion of a 15% decline in individuals over 3 years cannot be evaluated using the methods proposed. Also, no information presented in the protocol provides a basis for evaluating the likelihood that the protocol will be “. . . adequate to detect changes in the criteria identified by the Matrix within a reasonable timeframe.” Specifically, the protocol does not identify the sampling frame that is the basis for selecting sampling units for conducting field work. It does not identify any means for estimating a sampling variance associated with the point estimate generated from measuring a subset of the sampling frame. Using the current protocol, there is no way for the reader to understand how to compare reductions of presence in some areas with increases in presence in other areas within the development area. Only by presenting the methods to be used for calculating a variance associated with presence-absence is it possible to evaluate how presence-absence will be determined to have changed relative to reference areas or not, under some specified threshold Type I error probability. And only by providing the information above, along with sampling variances for pilot survey data, will it be possible to evaluate the sample sizes needed to determine whether presence-absence is changing over a 3-year interval.

The committee believes that it is desirable that the number of sampling units in the reference area be comparable to that in the developed area, approximating a balanced design. Further, the committee recommends that replicated reference sites be distributed around the perimeter of the developed area, not just to the west, as is proposed. This is desirable because of the possibility of small-scale perturbations, for example disease, that could affect abundance of pygmy rabbits over small geographic areas, with important consequences for the inferences drawn from differences between developed area plots and reference area plots.

Finally, the Committee notes that the ultimate goal of monitoring pygmy rabbits should be to place this monitoring activity into the context of occupancy modeling (MacKenzie et al. 2002, 2003, 2006) whereby detection rates can be estimated. This is the most powerful tool available for inferring changes in presence-absence, once a sound sampling design has been put into place.

If changes in an identified criteria (i.e., change in pronghorn survival) do occur in response to energy development on the PAPA, how likely are the monitoring methods described to detect this change and identify when stated thresholds have been met or surpassed?

This criterion is not possible to evaluate, without knowing the size of the effect (i.e. the percent change in presence or absence) that is to be detected, along with the sampling variances in the treatment and reference areas. No information on these attributes is provided in the protocol. Once pilot data on developed and reference sampling units are gathered, it will be possible to determine, using power analyses, the sample sizes needed to detect changes of interest.

Abundance of Pygmy Rabbits

Are the experimental designs and methods for monitoring described in the Monitoring Plans adequate to detect changes in the criteria identified by the Matrix within a reasonable timeframe?

No. The monitoring plan does not provide information about how abundance will be estimated, and therefore how a change in abundance such as that described in the matrix will be determined to have occurred. No protocol is proposed for estimating burrow density. If the monitoring plan assumes that burrow density is linearly correlated with abundance, and can thereby be used as an index of abundance, then such an assumption is not stated explicitly in the protocol. Such an assumption would be invalid in any case, according to the results of Price (2009), who showed that population density of pygmy rabbits was positively, but non-linearly related to density of active burrow systems across seven sites in Idaho. These results show the importance of understanding the relationship between population density and burrow density of rabbits across a range of population densities, accounting for temporal lags in burrow construction and maintenance, and calibrating the rabbit-burrow relationship for the PAPA. A statistically valid protocol for estimating abundance would need to describe the sampling frame, which could be the same frame used for estimating presence-absence. But, critically, the protocol would need to identify a means of estimating relative or absolute abundance in each of the sampling units selected for sampling. Currently, the only means that the committee knows for estimating absolute abundance would involve constructing encounter histories of individual animals. Estimating absolute abundance would be very costly, and better suited to the realm of research than to monitoring. By contrast, estimating relative abundance via an index, calibrated to the site, could be feasible and justifiable.

If changes in an identified criteria (i.e., change in pronghorn survival) do occur in response to energy development on the PAPA, how likely are the monitoring methods described to detect this change and identify when stated thresholds have been met or surpassed?

This is not possible to evaluate, without knowing how abundance will be estimated, along with the sampling variance in reference areas. No information on these attributes is provided in the protocol. It appears that the "identified criteria" for abundance (38.6% reduction over three years) is a much larger effect size than that for presence-absence, which is *any* net reduction in presence (reduction > 0 under some specified Type I error probability), for 3 consecutive years. Therefore, the change in abundance criterion appears much less likely to be met than the criterion for presence-absence. This inconsistency between the effect-size criteria for presence-absence vs. abundance raises questions about why both criteria, one invoking any detectable effect size and the other a 38.6% change, are in place. Because of this inconsistency, one criterion (presence-absence estimation) might call for mitigation whereas the other criterion (estimation of abundance) might not call for mitigation. Once pilot data on developed and reference sampling units are gathered, it will be possible to determine, using power analyses, the sample sizes needed to detect changes of interest.

Presence-absence of White-tailed Prairie Dogs

Are the experimental designs and methods for monitoring described in the Monitoring Plans adequate to detect changes in the criteria identified by the Matrix within a reasonable timeframe?

No. The protocol for white-tailed prairie dogs does not provide a basis for estimating changes in presence-absence. White-tailed prairie dogs are considerably easier to detect than are pygmy rabbits, particularly during spring and summer, and sampling methods are relatively well developed for this diurnal species (Andelt et al. 2009). However, the protocol does not identify the sampling frame that will be the basis for selecting sampling units for measurement. It does not identify any means for estimating a sampling variance associated with examining a subset of the sampling frame. The current protocol assumes that the locations of prairie dog colonies are known with certainty; however, Andelt et al. (2009) found that occupation rates for white-tailed prairie dogs in Colorado were not different between areas mapped by the Colorado Division of Wildlife as within and outside of colonies of the white-tailed prairie dog. Therefore, previous knowledge about the distribution of white-tailed prairie dogs should not be the basis of future monitoring efforts. Similar to what we found for pygmy rabbits, there is no way for the reader to understand how to statistically combine reductions in presence in some areas with increases in presence (e.g. new colonies) in other areas. The goal of this aspect of the monitoring plan should be to establish a statistically sound sampling design and place the results into a context of occupancy modeling, which is the method of choice for estimating changes in presence-absence across replicated sampling sites. Similar to what we found for pygmy rabbits, the Committee notes the need for a number of reference sampling units that is comparable to that for the developed area. Likewise, the committee recommends that reference areas be distributed around the perimeter of the developed area so that geographically isolated perturbations, for example disease, do not affect developed area – reference comparisons unduly.

If changes in an identified criteria (i.e., change in pronghorn survival) do occur in response to energy development on the PAPA, how likely are the monitoring methods described to detect this change and identify when stated thresholds have been met or surpassed?

This is not possible to evaluate, without knowing the effect size that is to be detected. The committee recommends that, once an occupancy model is constructed, power analyses be used to determine the sample sizes needed to detect changes of interest in presence-absence.

Abundance of White-tailed Prairie Dogs

Are the experimental designs and methods for monitoring described in the Monitoring Plans adequate to detect changes in the criteria identified by the Matrix within a reasonable timeframe?

No. The protocol does not describe how abundance of white-tailed prairie dogs will be estimated. Methods for estimating abundance of prairie dogs of various species have been described (Robinette et al. 1995, Magle et al. 2007), including indices of relative abundance and point estimates of absolute abundance with associated variances. The monitoring plan seems to assume that abundance can be estimated by mapping the perimeters of prairie dog colonies, but no evidence is presented to support this unstated assumption. Pauli and Buskirk (2006) have shown that massive die-offs (>90% of colony size) of black-tailed prairie dogs (*Cynomys ludovicianus*) result in survivors being scattered in a few areas within the former colony perimeter. It is not known how the proposed colony mapping protocol would represent such reductions in colony perimeter, or how such depictions would be related to abundance. The most logical basis for an estimate of abundance of white-tailed prairie dogs would be a two-stage sampling scheme in which the sampling frame was first stratified based on vegetation type, as described below (pygmy rabbit habitat vs. prairie dog habitat). Then, likely prairie dog habitat would be further stratified into low- and high-density prairie dog areas. These would receive differing sampling effort based on the magnitude (or variance) of prairie dog abundances across sampling units. Similar to what we found for pygmy rabbits, it is not clear that estimates of absolute abundance, based on constructing encounter histories of individual animals, is a realistic approach to monitoring changes in abundance of white-tailed prairie dogs. Such encounter histories are typically used in research contexts, but tend to be prohibitively expensive for monitoring applications.

If changes in an identified criteria (i.e., change in pronghorn survival) do occur in response to energy development on the PAPA, how likely are the monitoring methods described to detect this change and identify when stated thresholds have been met or surpassed?

This is not possible to evaluate. The committee recommends that, once a model for detecting changes in abundance is constructed, power analyses be used to determine the sample sizes needed to detect changes of interest in abundance.

Recommended Protocol for Monitoring Pygmy Rabbits

For monitoring pygmy rabbits, we suggest the following protocol:

a) Determine whether the area for development to which inferences are to be made is Core Area with Development Areas (CADA) or PAPA. Identify appropriate reference areas. We

suggest reference areas to the west (as already denoted), possibly to the south, and to the east of CADA or PAPA.

b) Overlay CADA or PAPA with a grid of rectilinear sampling units. A size of 400×400 m or 500×500 m seems appropriate. Number the grid cells and then randomly select the sample that will be monitored.

c) Decide whether the plots should be placed in a small number of strata (e.g. open and intermediate density sagebrush vs. dense sagebrush) that might help predict occupancy rates. Decide whether environmental covariates, such as temperature and Julian date, will be used to help predict detection probabilities.

d) Determine the change in occupancy that is to be detected, then use statistical power analyses to determine the appropriate number of plots to sample.

e) Because pygmy rabbits are obligate burrowers, identify burrows and fecal pellets to confirm presence. However, because fecal pellets of cottontails (*Sylvilagus* spp.) can overlap in size with those of pygmy rabbits, use DNA analyses to confirm species identity. To detect presence via burrows, the BLM pygmy rabbit survey protocol outlined in Appendix B of the Pygmy Rabbit RFQ can be followed. It should be noted, however, that this protocol will not allow the density of burrow systems to be determined. Observers should visit the plots at least 2 times to allow estimation of probability of detection.

f) Use Program MARK (White 2008, Andelt et al. 2009) to calculate detection rates, occupancy rates, and change in occupancy among years.

g) If estimates of absolute abundance for pygmy rabbits are desired, generate them via mark-resight or snow-track surveys, rather than by using burrows as a surrogate. Price (2009) evaluated an index of abundance based on active burrow systems in Idaho, but cautioned that use of such an index to estimate absolute abundance in other areas would require calibration to the new areas. Density of burrow systems can serve as a relative index of abundance within a plot over time, but will not allow estimates of absolute abundance without validation. Caution also should be used in comparing relative abundance based on burrow density across plots because of site differences that can influence patterns of burrow use.

h) For estimating absolute abundance within plots, a mark-resight protocol can be followed (see Price 2009). An alternative to mark-resight methods is to conduct surveys of previously mapped burrow systems on the day after new snowfall to determine whether the burrows are currently occupied (see Price 2009). This method requires that a census of burrow systems within the sample plot be conducted during the autumn. The surveys should be repeated to provide an estimate of variance associated with the abundance estimate.

Recommended Protocol for Monitoring White-tailed Prairie Dogs

For monitoring white-tailed prairie dogs, we suggest the following protocol:

a-d) Follow steps a-d as for pygmy rabbits, above.

e) Have 2 different technicians independently visit the 4 corners of each plot on different days, but within the same week. This will allow weather to serve as a covariate in the model, but ensure population closure); use 10× binoculars at each corner to count the number of prairie dogs observed. The repeated observations will establish detection rates and correct for false negatives (prairie dogs present, but undetected in one survey).

f) Use Program MARK (White 2008, Andelt et al. 2009) to calculate detection rates, occupancy rates, and change in occupancy among years.

g) For additional details on protocol for monitoring occupancy rates of white-tailed prairie dogs, see MacKenzie et al. (2002, 2003, 2006) and Andelt et al. (2009).

h) If estimates of absolute abundance are desired, then after conducting the visual observations ("a" through "f" above), use mark-recapture (for example, see Robinette et al. 1995) and program Mark (White 2008) or mark-resight and program NOREMARK (White 1996, Magle et al. 2007) to focus estimates of number of prairie dogs on plots where prairie dogs were observed during the above estimates of occupancy rates. However, some additional estimates of abundance also should be conducted on plots where prairie dogs were not observed. We recognize that estimating actual numbers of prairie dogs will be very time and labor intensive.

i) We recognize that estimating number of prairie dogs via mark-recapture or mark-resight will be much more defensible than using a surrogate, such as number of active burrows, for abundance of white-tailed prairie dogs. However, consider the approach of Biggins et al. (1993) for a surrogate for point estimates of absolute abundance of prairie dogs.

Stratification of Sampling

Importantly, all four of the permutations discussed above (two attributes, two species) could benefit from the use of sample stratification. Stratification is carried out on the basis of pilot data on the sampling frame, which allows the definition of strata such that, for the attribute being estimated, within-stratum variances are minimized and among-strata variances are maximized. Stratification is carried out for the purpose of minimizing sampling variance for a given sampling effort; effective stratification saves resources and increases precision of estimates. The question of stratifying sampling frames for pygmy rabbits and white-tailed prairie dogs first requires knowing whether the same sampling frame will be used for both species. Second, it requires knowing the number of and variances associated with sampling units in each stratum.

A plausible starting point for stratifying sampling for the two species recognizes that pygmy rabbits and white-tailed prairie dogs can be expected to have quite different habitat associations within the area of interest; pygmy rabbits can be expected to occupy areas with tall, old stands of big sagebrush (*Artemisia tridentata*) (Green and Flinders 1980, Larrucea and Brussard 2008), whereas white-tailed prairie dogs can be expected to occupy more open habitats (Seglund et al 2004). So, the initial stratification could attempt to identify likely pygmy rabbit and white-tailed

prairie dog habitat, using available habitat models. Monitoring for each species will then be focused in areas where they are most likely to occur. The committee notes, however, that some monitoring for each species should be conducted in areas where they do not currently occur, so that estimates can be generated for rates at which new areas are occupied. Then, further stratification could be done for each species for abundance monitoring, with the areas of greatest abundance likely to receive the most intensive monitoring. The committee notes that the two species have different seasons of highest detectability (winter for pygmy rabbits (Price 2009), spring and summer for white-tailed prairie dogs (Andelt et al. 2009)), so that field crews might be able to alternate between species monitoring activities seasonally.

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