



Proposal For Large Mammal Advisory Committee

Factors explaining the decline of black-tailed deer on public lands in northern California.

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Proposed Start and Completion Date:

July 2012-June 2014 (2-year contract extension of an ongoing project).

Executive Summary:

In 2009, the University of California at Davis (Heiko Wittmer) and the California Department of Fish & Game (David Casady) started a 3-year project aimed at understanding the factors affecting the decline of a hunted black-tailed deer population on public lands in the Mendocino National Forest. The project has been primarily funded by a contract administered by UC Davis in the amount of \$454,580 from the CDFG Deer Herd Management Plan Implementation Program as well as substantial in-kind support from CDFG. In-kind support likely exceeds the actual amount of the contract and includes (among other items) providing 2 trucks, gasoline, vehicle maintenance, snowmobiles, deer and mountain lions captures, as well as salary of CDFG employees. Additional direct funding of approximately \$93,000 has been provided by other organizations such as the California Deer Association. Project updates and summary reports have been submitted quarterly to CDFG. Here we request a 2-year project extension until June 2014 for the ongoing project to provide the funding required to a) collect additional data critical to previously proposed analyses and b) to conclusively attribute cause and effect for initial results.

Statement of Need:

Many deer populations in California have declined in abundance over the past decades. This decline has resulted in a substantial reduction in statewide opportunities for outdoor recreation (such as hunting) and consequently reduced revenues for local communities that depend on such activities. However, factors causing the observed declines remain poorly understood thus impacting our ability to implement effective management strategies. Our black-tailed deer study in the Mendocino National Forest provides a unique opportunity to understand causal relationships between deer population dynamics and environmental variables including habitat and predation. Such information is urgently required to allow better management of deer populations in California.

Introduction:

1) *Age-specific survival:* Since our study began in May 2009, we have captured and fitted a total of 81 fawns with VHF ear tag transmitters (2009 = 15, 2010 = 26, 2011 = 45 fawns). During the current project, we have also captured 41 females older than 1 year and fitted them with GPS collars. Data collected from marked deer have allowed us to begin estimating survival rates and determine causes of mortality. Survival estimates calculated using a staggered entry Kaplan-Meier method (Pollock et al. 1989) suggest that both fawn and adult female survival appears lower and more variable when compared to results from previous studies. For example, annual survival of fawns captured in 2009 was 0.15 (± 0.10) compared to 0.28 (± 0.09) for fawns captured in 2010. Preliminary survival estimates up to 3 months of age for fawns captured in 2011 suggest that annual estimates for the entire third year (i.e., 2011) may be closer to 0.40. A review of the literature, suggest that our observed fawn survival rates are at the lower range of fawn survival to 1 year of age reported for mule and black-tailed deer (average across

multiple studies = 0.38 ± 0.14 ; Forrester & Wittmer, unpublished report). Similarly to fawn survival, adult survival in our study appeared depressed in 2009 (0.53 ± 0.13) but was closer to results reported in the literature in 2010 (0.80 ± 0.09). Not only do our results show significant variation in age-specific survival among years, but any average survival rate based on our current samples will have large confidence intervals potentially precluding us from determining exact estimates of population growth and the vital rates influencing these estimates using matrix models (Caswell 2001). Given the large costs, both direct and indirect, already incurred discontinuing funding before such data are available appears financially unwise.

To address this issue, we propose to add 1 year to our study looking at rates and causes of mortality of fawns in the Mendocino National Forest. Funding for up to 50 new VHF ear tags has already been received from the California Deer Association (CDA). While additional data from a previous study are available (note that 23 additional adult deer had been captured and collared in the study area by David Casady between September 2004 and March 2007), we also propose to extend our study aimed at estimating rates and causes of adult mortality. This will require capturing and collaring approximately 20 additional deer older than 1 year of age in summer of 2012. Funding to refurbish 10 GPS collars has already been secured from the CDA.

2) *Fertility/fecundity estimates*: We have collected blood samples from a total of 64 adult females captured so far, allowing us to estimate pregnancy rates from progesterone levels detected in the samples. However, due to the lack of an ultrasound, we were unable to determine the number of foetuses per female. This shortcoming will potentially affect our ability to accurately determine the population dynamics and expected growth rates of deer in the Mendocino National Forest (Caswell 2001). While this proposal is not seeking any direct funds to address this issue, an extension will allow David Casady to acquire an ultrasound using CDFG funds and subsequently determine number of fawns in uteri per female during the proposed adult captures (see above).

3) *Population size & sex ratio*: Population size of deer in the Mendocino National Forest has been estimated in the past using helicopter surveys (CDFG, unpublished data). No new surveys have been conducted during the duration of the current research project although a survey has been scheduled for 2012 (David Casady, personal communication). However, interpretations of estimates of vital rates depend on an accurate estimate of population size and possibly population trend. In addition, a reliable estimate of the sex ratio of adults in the population is required to estimate trends. Non-invasive DNA methods increasingly provide opportunities to accurately estimate population size of ungulates in areas with low sightability (Poole et al. 2011).

In 2011, we have conducted a pilot study to determine the suitability of DNA methods based on pellet surveys to estimate population size using a modified protocol described in Brinkman et al. (2010; 2011). The methodology appears highly suitable to determine population size and trends using capture-recapture methodology (Williams et al. 2002). More importantly, the DNA method can be used to estimate the sex ratio of deer in the study area. Sex ratio is a notoriously difficult parameter to estimate in black-tailed deer using direct observations due to their generally forested habitat, observed sexual segregation and often nocturnal behaviour. However, in the absence of any data on male survival, sex ratio cannot be inferred from survival estimates for male fawns. Thus we are seeking funding to conduct a detailed DNA study based on pellet surveys. The described DNA analyses will be conducted in Dr. Ben Sacks lab at UC Davis.

4) *Mountain lions*: A major objective of our current project is to determine kill rates of black-tailed deer from mountain lions. The mountain lion component was delayed due to our difficulties capturing and collaring lions in our study area. However, we now have a total of 6 lions fitted with satellite collars (5 of which are still alive) and have begun in

earnest with our lion study. A 2-year extension for our project would ensure that we are able to accurately determine the effect of lion predation on black-tailed deer in the Mendocino National Forest. Funding requested in this proposal will be used to purchase 8 replacement batteries for our collars and to contribute to capture related costs.

Objectives:

- 1) Fawn survival: To capture and monitor up to 50 additional fawns for 1 more year to determine fawn survival rates and refine estimates of causes of mortality.
- 2) Adult survival: To capture and monitor 20 additional female deer older than 1 year for up to 18 months to determine survival rates and causes of mortality.
- 3) Fertility/fecundity estimates: To determine pregnancy rates from blood samples using progesterone levels and to determine number of fawns in uteri using ultrasonography.
- 4) Population size & sex ratio: To determine population size using capture-recapture methodology based on DNA from pellets and to determine the current sex ratio of the population.
- 5) Mountain lions: To determine kill rates of deer fawns and adults by mountain lions in our study area as well as better understand overall diet composition.

Methods:

The project is conducted on approximately 800 square miles of the Mendocino National Forest in Glenn, Mendocino, Lake, Tehama and Colusa counties. Elevation ranges from approximately 1,000 to nearly 7,000 feet. Habitat types (CWHR) in the study area include: blue oak woodland, mixed chaparral, montane chaparral, montane riparian, montane hardwood, montane hardwood conifer, ponderosa pine, and Douglas fir. Topography is moderately rolling at lower elevations to moderately steep at higher elevations. Climate is mild, with mean annual temperatures ranging from the 30s (F) to the 70s (F) depending upon elevation. Mean annual precipitation is around 50 inches but can be highly variable and occurs primarily in the form of rain with snow common at the higher elevations during winter. Approximately 85-90% of the annual precipitation occurs in winter.

Deer (fawns and adults) will be captured and fitted with VHF ear-tag transmitters (fawns) and GPS collars (adults). Capture methods will follow methods described in the initial capture plan reviewed and approved by CDFG veterinarians and approved by an independent Animal Care & Use protocol at UC Davis (#15341). The fawn study will be conducted from June 2012 to June 2013. Adult deer will be captured in May/June 2012 and collars will be scheduled for automatic release in September/October 2013. Most equipment for the study is either available or funding from external sources has already been received (from the CDA). Pellet sampling for the DNA study will be conducted in summer 2012 and summer 2013 with a possible final sampling interval conducted in spring 2014. Capture and monitoring of mountain lions will be completed by September 2013. Although there is an MOU in place between CDFG and Heiko Wittmer (valid until December 2013) lion captures have been and will continue to be conducted by qualified and experienced CDFG personnel. In general, fieldwork for the project will be largely finished by fall 2013 allowing sufficient time to analyse data and write up reports by the proposed end date of June 2014.

Products (and estimated dates of completion):

We will continue to submit quarterly reports to CDFG Contract Manager, David Casady, as required under the current contract. A final project report will be submitted by June 30, 2014 including a summary and analysis of all data for the entire project. In addition, final copies of all PhD dissertations, and all manuscripts prepared utilizing this project's data publication in peer-reviewed journals will also be submitted to CDFG contract manager.

This project is largely driven by 2 PhD students. Tavis Forrester (UC Davis) is the lead biologist of the deer component and Max Allen (Victoria University of Wellington) is the lead biologist of the mountain lion component. A requirement for both students is to publish their results in peer-reviewed journals – otherwise there won't be a PhD. As a standard, 3 publications are expected from each. Heiko Wittmer is leading preparation of 2 additional peer-reviewed publications. Publications will cover a variety of topics including habitat use and population dynamics of black-tailed deer, and kill rates/diet of mountain lions in the Mendocino National Forest. In addition, a review of the dynamics of mule and black-tailed deer in western North America has been written (Forrester & Wittmer, unpublished report) and will be submitted to a journal early in 2012.

Collaborators:

CDFG lead biologist is David Casady. Multiple CDFG scientific aides have and are anticipated to continue contributing to the success of the project (e.g., Bryn Evans, Ryan Carruthers).

Program Planning:

We will continue to meet at least once every year to ensure project is on track.

Personnel Requirements and Funding from CDFG:

The involvement of David Casady is vital for this project since CDFG is responsible for captures of adult deer and mountain lions. A houndsman (currently Blue Milsap) also needs to be provided by CDFG for upcoming captures of mountain lions. David Casady and Max Allen are both associated with CDFG thus captures meet requirements that CDFG personnel be present at all times.

Funding in the amount of \$26,500 has already been secured from the California Deer Association. Here we request funding in the amount of **\$254,595** to be added to the existing contract with UC Davis.

Category	2012-2013	2013-2014
Salary	\$56,964	\$43,536
Benefits	\$5,250	
Supplies*	\$52,700	\$47,700
Vehicles/mileage	\$12,650	\$12,650
Indirect costs (10%)	\$12,756.40	\$10,388.60
Total	\$140,320.40	\$114,274.60

*including \$35,000 per year for DNA project.

Other Resources requested from CDFG:

David Casady has already provided data from previous deer study conducted between 2004 and 2007. The following resources are requested from CDFG:

- Continued provision and maintenance of two 4WD trucks including gas;
- Continued support for adult deer (David Casady) and mountain lion captures (David Casady, Blue Milsap);
- Ultrasound to allow estimating number of fetuses in uteri (David Casady);
- Continued employment of Max Allen and Bryn Evans as CDFG Scientific Aides.

Issues to be Resolved:

Administrative approval for contract extension has been submitted to UC Davis on October 14th.

Preparation and approval of extension for current contract.

Expected Products

- Quarterly Progress Reports starting October 10, 2012;
- Final report due on June 30, 2014.
- Publications will be submitted as they become available with the first deer manuscripts expected to be submitted in 2012 and the first mountain lion manuscripts submitted in 2014.

References:

Brinkman, T.J., Person, D.K. et al. 2010. Individual identification of Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) using DNA from fecal pellets. Conservation Genetics Resources 2: 115-118.

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Forrester, T.D. & Wittmer, H.U. unpublished. A review of the population dynamics of mule and black-tailed deer in western North America.

Pollock, K.H., Winterstein, S.R., Bunck, C.M., and Curtis, P.D. 1989. Survival analysis in telemetry studies: the staggered entry design. Journal of Wildlife Management 53: 7–15.

Poole, K.G., Reynolds, D.M., Mowat, G. & Paetkau, D. 2011. Estimating mountain goat abundance using DNA from fecal pellets. Journal of Wildlife Management 75: 1527-1534.

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