APPENDIX A. NON-NATIVE DEER POPULATION MODEL (BARRETT)

A. Deer Harvest Models:

POPMODFD (for fallow deer) and POPMODAD (for axis deer), version 12-13-2000, are spreadsheet models developed by Reginald Barrett (Gogan et al. 2001). The models' primary use is to determine the effects of any proposed harvest schemes on axis and fallow deer populations. The mathematical formulas are based on published literature and expert opinion. They assume that survival rates and recruitment of young into the population are all density dependent. In other words, as deer populations increase towards carrying capacity (K), survival of various age groups decreases, as do the birth rate and survival of fawns. The patterns of density dependence were derived from field observations, necropsy data and the published literature on both species. Simulation of future population scenarios requires input from the user of estimates for starting population, carrying capacity and lethal removals (if any).

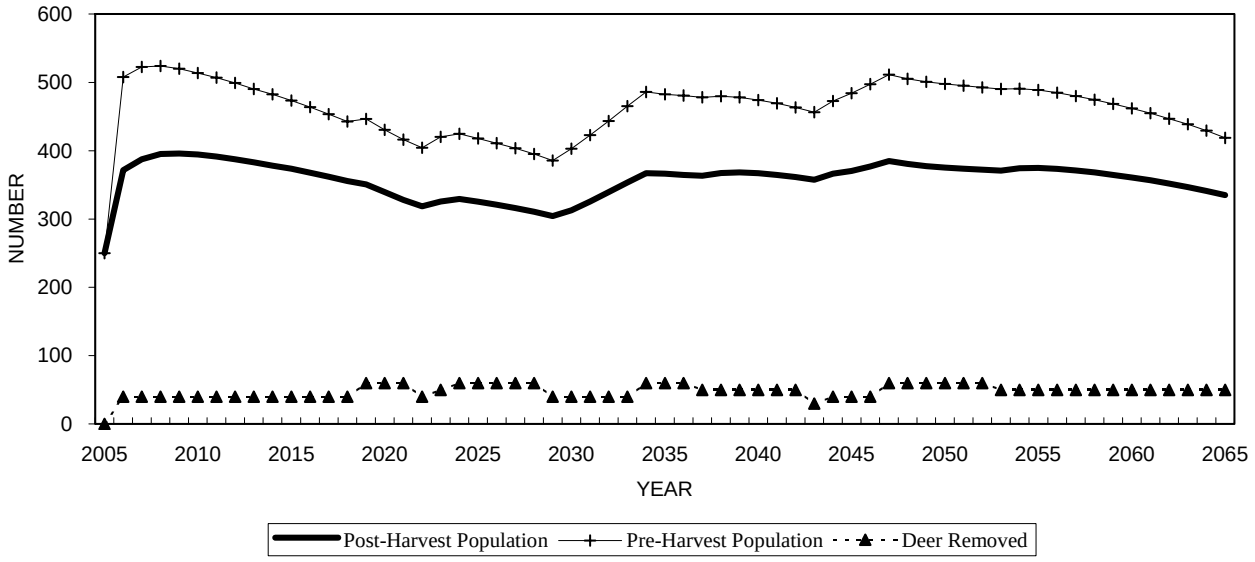
By using past numbers of animals culled as well as populations estimates from the 1970s, Gogan et al. (2001) derived values for carrying capacity of 455 and 775 for axis and fallow deer respectively. These are the population sizes at which population growth essentially stops. It should be noted that in the case of fallow deer, PRNS estimates of the current numbers (N = 859, 90% Confidence Interval = 547-1170) slightly exceed the Gogan et al. estimates for carrying capacity (PRNS unpublished data). Wildlife population numbers should always be interpreted as estimates within a confidence interval. As in all empirical models based on such estimates, the Barrett models are best used to detect future trends rather than exact numbers.

Using the Barrett models, we can investigate the effects of culling on either species. If we input current estimates for axis and fallow deer numbers and use the above values for carrying capacity, the following scenarios result.

1. Alternative B - Remove 25-50 axis deer yearly, once the population surpasses 350:

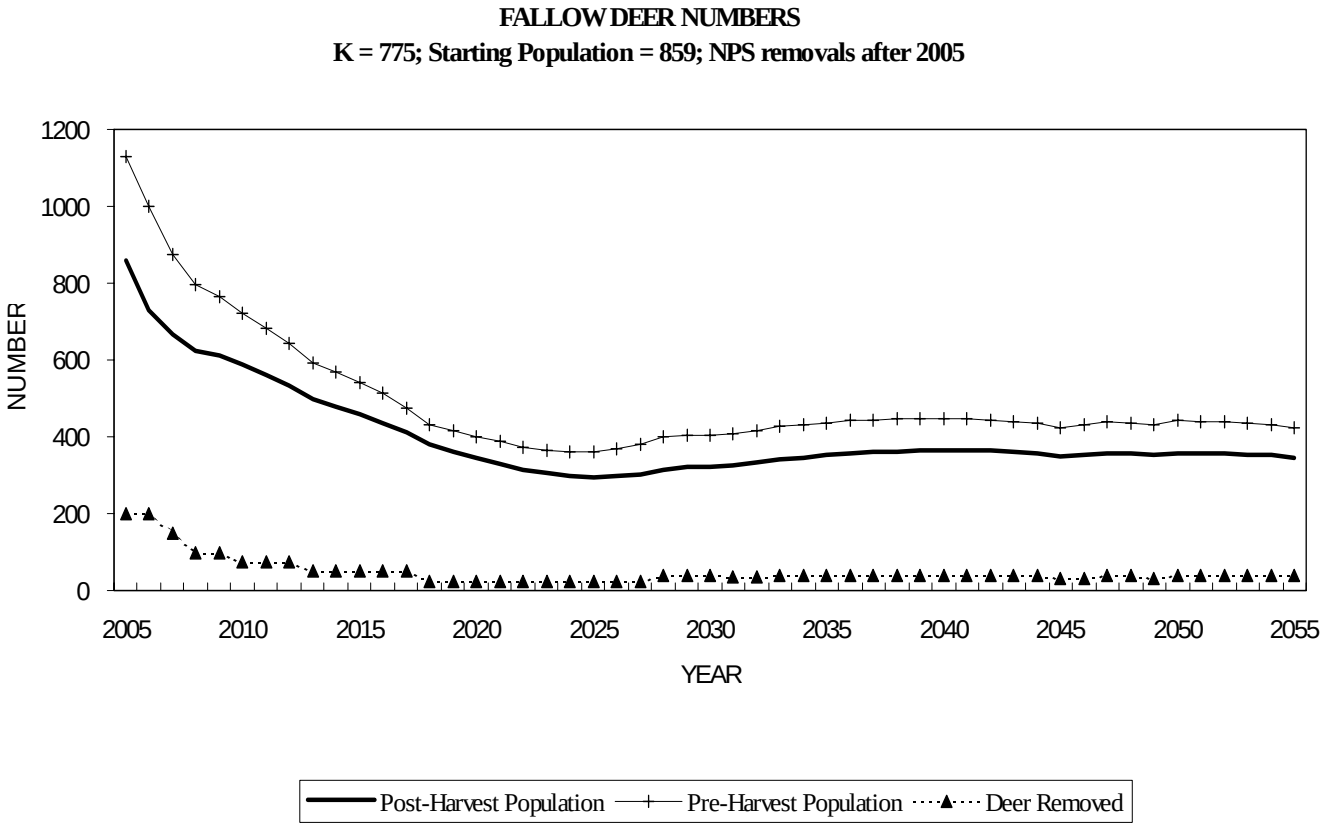
AXIS DEER NUMBERS

K = 445; Starting Population = 250; NPS removals after population reaches 350 (illustrated here as occurring in 2006)



Approximate number of axis deer removed by 2020 = 650
Approximate number of axis deer removed by 2050 = 2,200

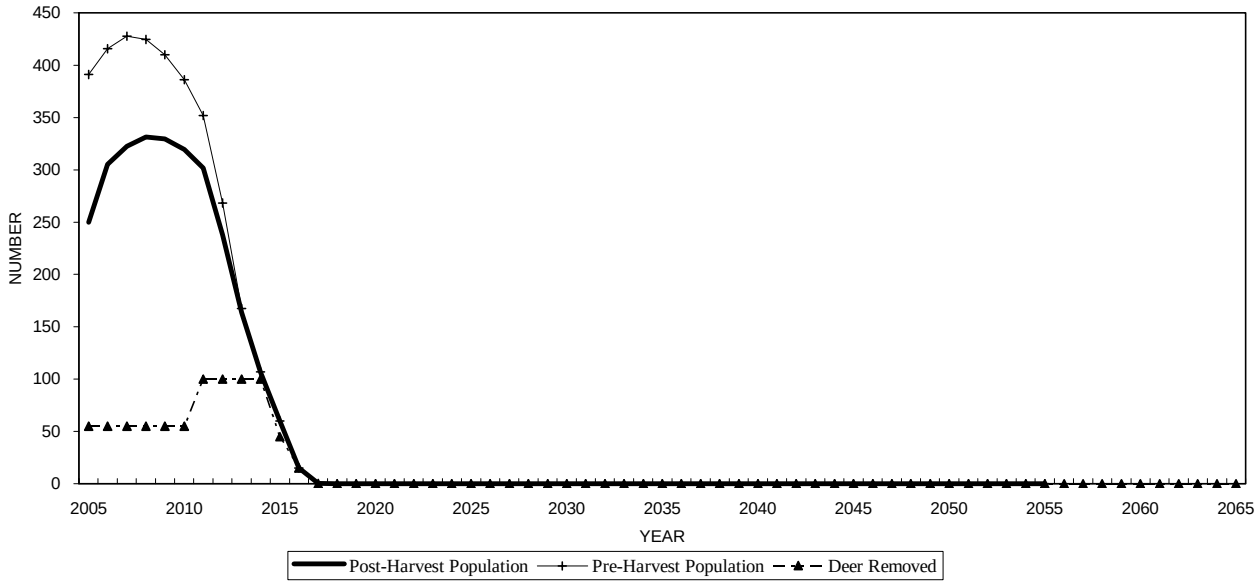
2. Alternative B – Remove 100-200 fallow does yearly until the population reaches 350, and remove 50-75 deer yearly thereafter:



Approximate number of fallow deer removed by 2020 = 2,400
Approximate number of fallow deer removed by 2050 = 5,500

3. Alternative D – Remove 50-100 axis deer yearly until eradication:

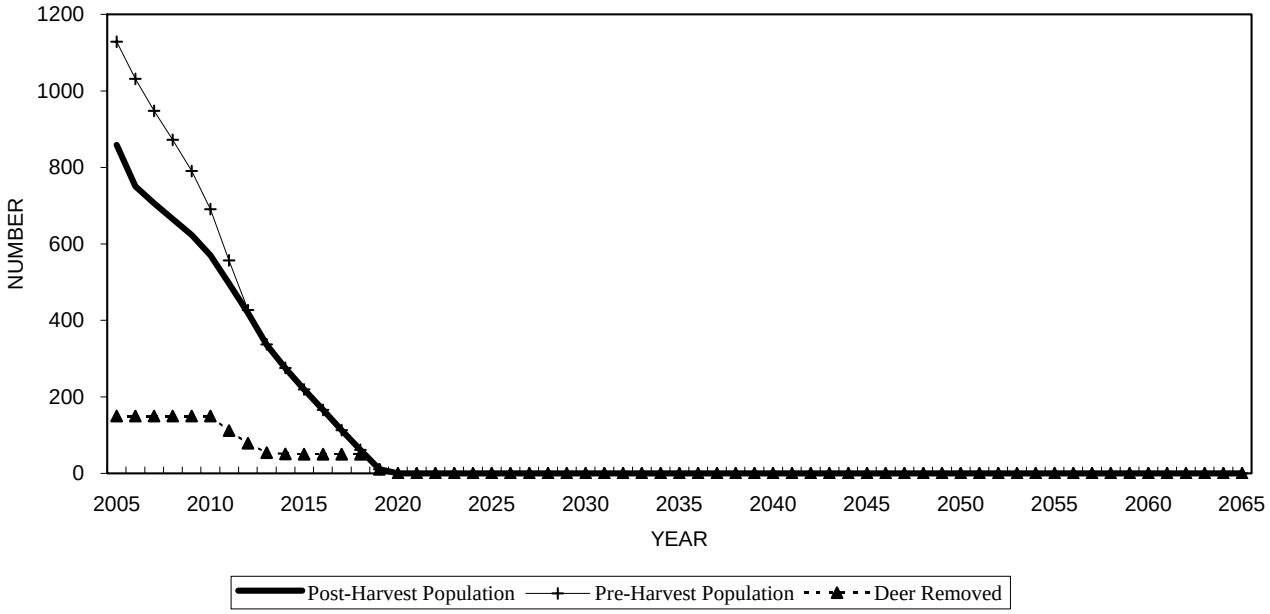
AXIS DEER NUMBERS
K= 445; Starting Population = 250; NPS removals after 2005



Approximate number of axis deer removed until eradication (in ~2017) = 800

4. Alternative D – Remove 150-200 fallow deer yearly until eradication:

FALLOW DEER NUMBERS
K=775; Starting Population = 859; NPS removals after 2005



Approximate number of fallow deer removed until eradication (in ~2020) = 1,400

Yearly Contraception Model

In 2002, Barrett also incorporated fertility control, without lethal removal, into the above fallow deer model (POPMODFD) to simulate the use of yearly contraception as the sole method of population control for fallow deer (Barrett 2002, unpublished data). The model assumes use of a contraceptive agent that is 100% effective in preventing pregnancy for up to 12 months, and that all treated animals can be marked to avoid double treatment. The model uses the above values for fallow deer carrying capacity (K = 775) and starting population size (N = 859).

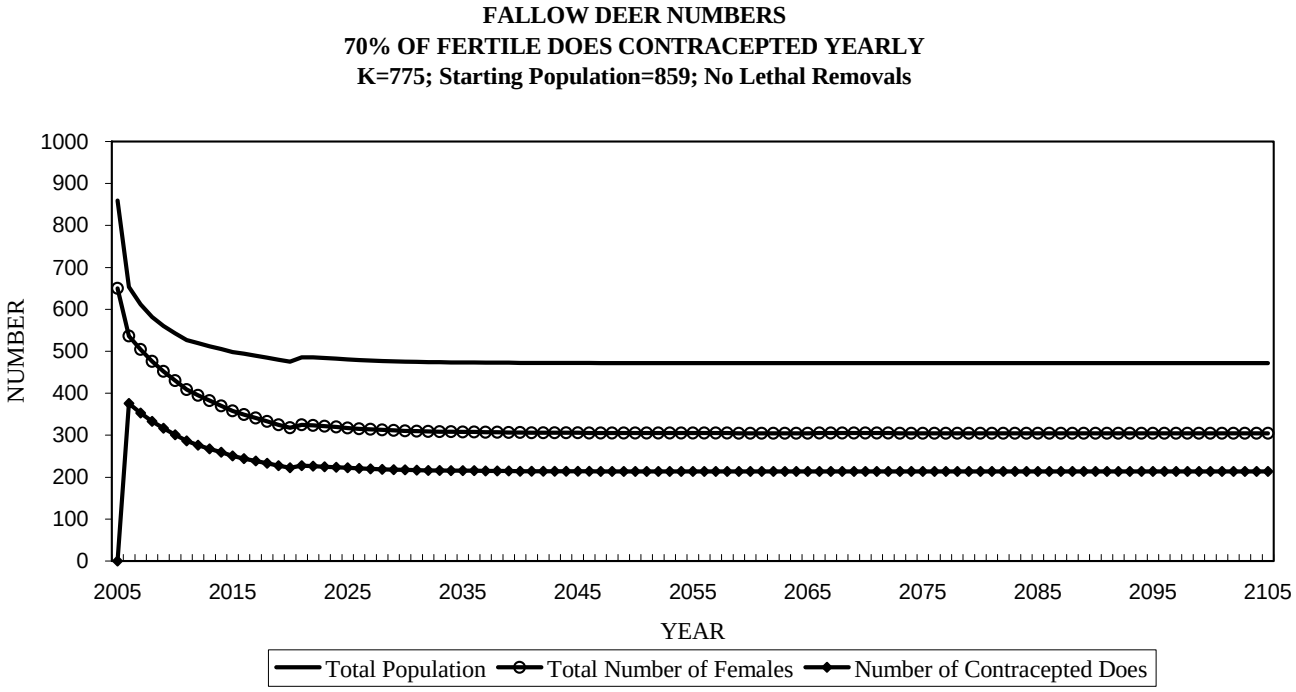
Barrett found that yearly contraception of at least 80% of does was required to reduce the population to 350 within 25 years. This represents a treatment group size of over 300 animals yearly for the first 6 years. Barrett also found that, in the absence of lethal removal, 99% of reproducing females would require treatment with a 100% effective yearly contraceptive in order to eradicate all fallow deer in 20 years. This would constitute a treatment group size of up to 550 animals per year during the first 5 years of the program.

The following projections simulate treatment of various proportions of the fallow doe population with a yearly contraceptive "vaccine" similar to that which has been used in tule elk at Point Reyes National Seashore. For a discussion of current wildlife contraceptive technology, refer to the discussion of contraceptives under Alternative C. It should be noted that the currently available wildlife contraceptive vaccine (porcine Zona Pellucida) requires a second booster injection during the first year of administration to be effective in preventing pregnancy in tule elk and other cervids (Kirkpatrick et al. 1996b, Shideler 2000). A second treatment is not included in the following projections; therefore, projected numbers of treatments should be considered minimum figures.

The action alternatives that include the use of yearly contraceptives to either control the fallow deer population at a pre-determined level or to eradicate the fallow deer from the Seashore are further discussed in the section *Alternatives and Actions Considered but Rejected*. Because of the numbers of animals that would require capture, handling and treatment, these alternatives were dismissed from consideration due to infeasibility.

1. Contraception of 70% of fallow does yearly, beginning in 2006, with no lethal removals:

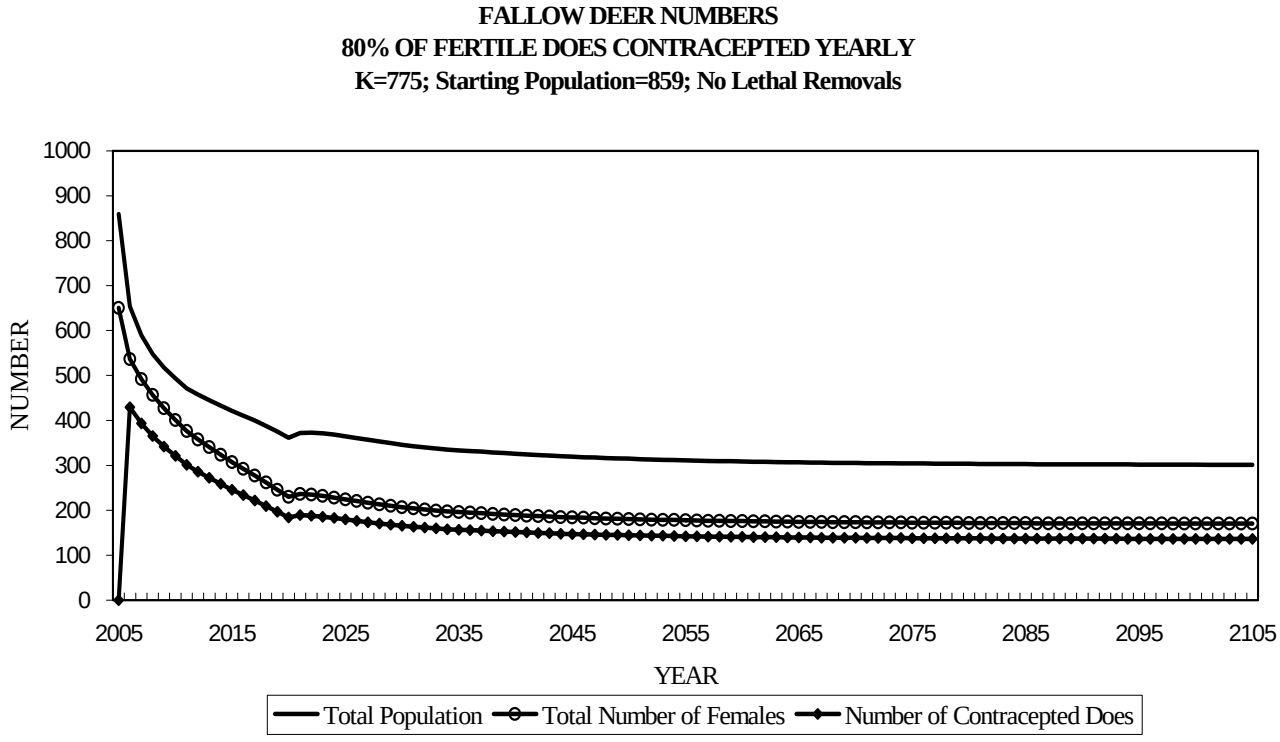
In this scenario, with 200-400 does treated every year, the total population never drops below 470 animals.



Approximate number of treatments by 2020 = 4,200
Approximate number of treatments by 2050 = 11,000

2. Contraception of 80% of fallow does yearly, beginning in 2006, with no lethal removals (Alternative and Action Considered but Rejected) :

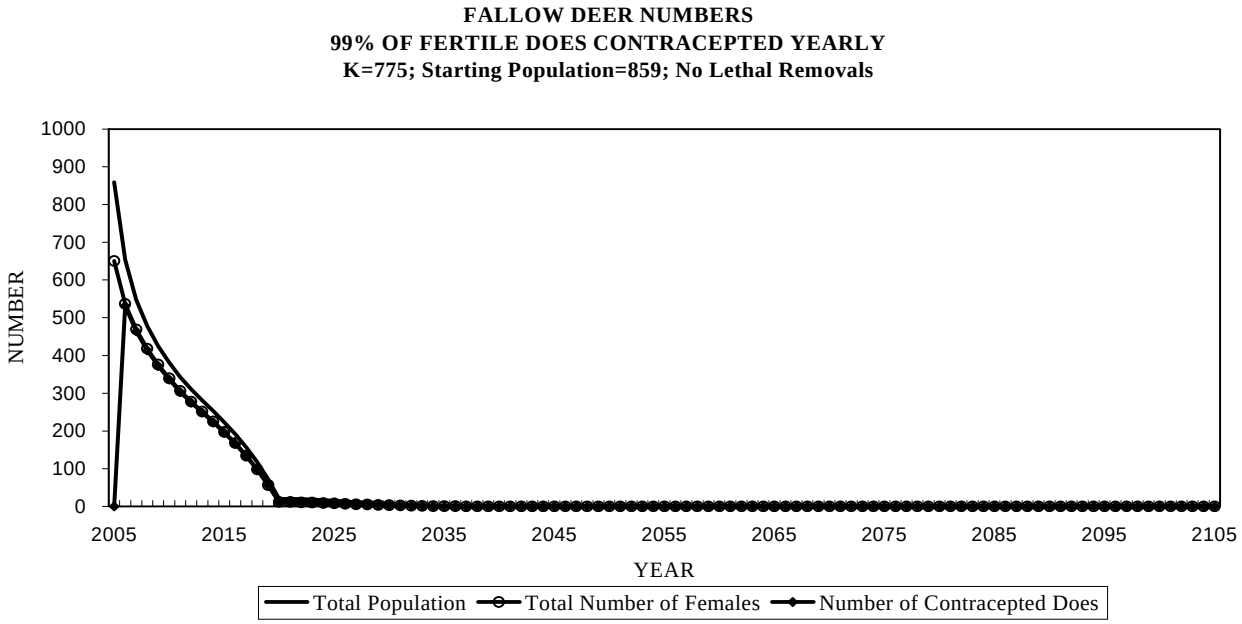
In this scenario, the population reaches 350 in 2030, with up to 450 females treated yearly. Here, total numbers treated are less than in the 70% treatment scenario because the number of fertile females and the total population are both reduced more rapidly.



Approximate number of treatments by 2020 = 4,300
Approximate number of treatments by 2050 = 9,100

3. Contraception of 99% of fallow does yearly, beginning in 2006, with no lethal removals (Alternative and Action Considered but Rejected):

In this scenario, up to 500 does are treated yearly during the first 10 years of the program. The population decreases rapidly but is not eradicated until the last doe dies of old age in approximately 2035. Again, total numbers treated are less than in the 70% or 80% treatment scenarios because the number of fertile females and total population are both reduced more rapidly. Most of the population effect of the treatment takes place in the first few years of the program when over 400 does per year are treated.



Approximate number of treatments by 2020 = 3,800
Approximate number of treatments by eradication (~2035) = 3,900