CHAPTER 2: ALTERNATIVES

Introduction

Alternatives are the different ways of meeting park objectives that resolve most, if not all, of the environmental issues associated with the proposal. As stated in the Purpose and Need section, the objectives of the Seashore's non-native deer management plan are: 1) to correct past and ongoing disturbances to Seashore wilderness ecosystems in the form of introduced non-native ungulates, 2) to prevent spread of both species beyond Seashore and GGNRA boundaries, 3) to reduce impacts to agricultural permitees, and 4) to minimize long-term diversion of staff time and Seashore resources from other resource management projects. The action alternatives discussed below substantially further each of these project objectives. Reasonable alternatives are those which, as defined by the Council on Environmental Quality: "are economically and technically feasible, and show evidence of common sense" (DO-12 handbook, Section 2.7) in addition to resolving need and meeting project objectives.

The Process for Formulating Alternatives

The National Environmental Policy Act (NEPA) and its regulations envision a multi-step environmental planning process to produce an EIS. The NPS has taken the language of NEPA and regulations governing all agencies and produced its own set of NEPA policies in its Director's Order 12 "Conservation Planning, Environmental Impact Analysis and Decision Making" (NPS 2001). In DO 12, the NEPA planning process that all parks are required to follow is set out in detail (sec 2.1), including when and how to formulate alternatives. The Seashore followed this process in first defining its need for action and its purpose in taking action. These are identified in Chapter One. Specific goals are listed as objectives. Also as explained in Chapter One, the park is required by its own governing laws, regulations, and policies to take certain actions, and constrained by these same laws in some cases from taking other actions. In this case, the NPS laws and policies direct the park to restore natural conditions, favor native species, and eliminate or control non-native species that adversely affect the natural ecological balance. In other words, the laws and policies became part of the need for action. All alternatives analyzed by the NPS in an EIS must resolve the need for action, meet the purpose of taking action and meet the stated objectives to a large degree. This is an essential component of the reasonableness of any alternative; therefore, those that are unable to resolve need or meet the purpose of action are eliminated from further analysis by the NPS interdisciplinary team.

Within the framework provided by purpose, need, objectives, laws, and policies, the interdisciplinary team is tasked with creating a full range of options aimed at resolving any identified environmental issues. Many of the issues were identified during public scoping, conducted between May and July of 2002. This included a public meeting in Point Reyes Station in May 2002. The NPS team reviewed all public comments (see Chapter 5 of this EIS for more detail) to help define the list of issues, and it considered any alternatives suggested by the public during scoping.

In addition to analysis of public comment, all federal, state, and local agencies with jurisdictions and policies affected by non-native deer were consulted as part of an extended exotic deer interdisciplinary team (see Section 5.2).

The No Action alternative and two categories of action alternatives were analyzed. The No Action alternative (Alternative A) is identified in the NEPA regulations as the continuation of existing management practices. As explained in Chapter One, the Seashore has historically managed deer through an informal management plan in which both species have been limited to 350 individuals since 1976. Since 1995, when ranger culling was discontinued, there has been no active management of either species. The No Action alternative in this EIS is therefore the continuation of no active management or control of the non-native deer populations.

The action alternatives are divided into two categories – control and eradication of non-native deer. The first category of action alternatives (Alternatives B and C) would focus on the reduction and long-term management of population sizes by the Seashore to a level that has historically kept non-native deer from expanding to habitat outside the Seashore. The alternatives explore a range of techniques to accomplish this reduction. The other category of action alternatives (Alternatives D and E) would result in the removal of all non-native deer from the Seashore and GGNRA. As in Alternatives B and C, removal would be accomplished with various wildlife management techniques, either alone or in combination.

The remainder of this chapter is devoted primarily to a description of these alternatives. A discussion of alternatives eliminated from further study, along with reasons for their elimination, follows the description of alternatives analyzed in this EIS. In addition, two required summary tables are presented at the end of the chapter: 1) a summary of the features of each alternative, and 2) a summary of the impacts of each alternative.

Actions Common to All Alternatives

In order to ensure protection of native species and ecosystems and to assess success of any management program, continued monitoring for at least 15 years would be an integral part of any alternative chosen. In some alternatives, monitoring would continue for a longer period. For example, monitoring of non-native deer would not be required in perpetuity if both species were eradicated in 15 years (Alternatives D and E), whereas there is no such time limit for monitoring of non-native deer in cases where both species remain in the Seashore indefinitely (Alternatives A, B, and C). Monitoring and data collection activities common to all alternatives could include any or all of the following:

- Monitoring of native and non-native deer numbers through park-wide aerial and/or ground censusing, indirect indices (pellet group or spotlight counts) or area sampling, performed at intervals of 1-3 years. Any use of aircraft to monitor deer would comply with Office of Aircraft Safety (OAS) regulations and policies for all NPS aerial operations (Director's Order #60).
- Monitoring of native and non-native deer population growth rates through composition counts, with or without multi-year surveillance of marked animals for determination of survival and fecundity rates.
- Monitoring of non-native deer range year-round with special emphasis on identifying expansion of non-native deer range beyond Seashore boundaries and alteration of range as a reaction to management actions. Should exotic deer expand outside the park, the Seashore would provide assistance to California Department of Fish and Game to conduct monitoring programs outside its borders.
- Monitoring of the diets of native and non-native deer to assess dietary overlap given the new ranges occupied by exotic deer and new deer herd sizes since the previous dietary studies of 1973-1976 (Elliott 1983). Particular attention would be given to assessing the importance of threatened and endangered plant species in the diets of all deer species as well as dietary overlap between non-native deer and native tule elk, re-introduced to the Seashore in 1978.
- Surveillance for evidence of deer overgrazing in natural or wilderness areas in which non-native deer are found in high densities. This could include the erection of deer-proof exclosures, as experimental controls, in wilderness areas.
- Monitoring of disease in all non-native deer found: 1) in high densities within pastoral areas, and 2) in direct contact with livestock, within Seashore boundaries. Such periodic (every 1-3 years) screening would attempt to identify any threats of disease transmission between deer and livestock. Disease testing would entail collection and complete necropsy of a sample of any deer

species for which the two above requirements were satisfied, along with laboratory analysis of appropriate biological samples.

- Monitoring of the costs of the management program including: staff time, training, administrative, legal, and public relations costs and the costs of monitoring as described above.
- Formal or informal surveys of visitor response to non-native deer management. Periodic monitoring of park visitation with special attention to changes in visitation during or after specific management actions.

All actions which involve direct management of individual animals, ranging from aerial surveillance to live capture and lethal removal, will be conducted in a manner which minimizes stress, pain, and suffering to every extent possible. Culling would be conducted by NPS staff specifically trained in wildlife sharpshooting. Efforts would be made to deliver immediately lethal shots to target animals and sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers. NPS will use recommendations of the American Veterinary Medical Association (AVMA) for humane treatment of animals (please see the AVMA website for examples: www.avma.org/resources/euthanasia.pdf.). As such, every effort will be made to minimize the degree of human contact during all procedures that require handling of wild ungulates. In addition, an attempt will be made, in all pertinent alternatives (B, C, D, and E) to "reduce pain and distress to the greatest extent possible during the taking of an animal's life" (AVMA 2001).

All actions occurring in designated wilderness, from monitoring to active deer management, would be consistent with the "minimum requirement" concept. This concept is a documented process used to determine whether administrative activities affecting wilderness resources or the visitor experience are necessary, and how to minimize impacts. Such activities could include use of motorized transport or aircraft in wilderness areas. Instructions and a worksheet for the Minimum Requirement Analysis are attached in Appendix C.

Where fallow and axis deer carcasses can be easily moved, they would be donated to charitable organizations as food for the needy. In remote and sensitive locations where removal of a carcass is difficult, it will be left to recycle nutrients into the ecosystem.

Alternative A: No Action

This alternative would perpetuate the non-native deer management practices undertaken since 1995, when ranger culling was discontinued. No actions to control the size of non-native deer populations would be taken. In this alternative, as in current Seashore practice, once or twice per year, approximately four non-native deer would be removed by lethal means by NPS resource management or law enforcement staff for ceremonial use in Native American festivals. Monitoring activities, as outlined above in *Actions Common to All Alternatives,* would continue in perpetuity.

Current estimates indicate approximately 250 axis deer and 860 fallow deer occupy the study area (NPS 2003 and PRNS unpublished data). In their deer population models, Gogan et al. (2001) and Hobbs (2003) both considered current numbers to be below the carrying capacity of the habitat. Using a combination of predictions from these models, census data, information from monitoring, and the literature, it is likely that the numbers and range of both species would increase over the lifetime of this planning effort (20 years). Modeling shows that populations of axis and fallow deer would likely increase to an equilibrium level on parklands. This means non-native deer would occupy existing lands at higher densities. In other words, larger groups of non-native deer would be present on pastoral lands, in Olema Valley and in wilderness areas of the Seashore. Figure 1 shows the likely increases in several categories of fallow deer over the lifetime of this plan without any changes in current management.

They would also likely extend their range, both within the parks and outside. To date, fallow deer have occasionally been sighted as far east as Nicasio Reservoir (PRNS, unpublished data). Monitoring of herd movements over the past 10 years suggest that they would continue this expansion to the east as well as to the south, eventually spreading beyond Seashore boundaries into private lands and lands administered by California State Parks and Marin Municipal Water District. Favorable non-native deer habitat (interspersed grasslands and forests) exists in close proximity to PRNS, GGNRA, and throughout Marin and Sonoma Counties. This expansion could occur relatively soon and continue quickly. Fallow deer in New Zealand have been documented to spread at rates of up to 4.5 miles per year (Mungall and Sheffield 1994).

Historically the population of axis deer in the study area boundary has been larger than it is currently. Given this, it is considered likely that this species would also increase in range and total number under a No Action alternative. Although it is impossible to predict whether or not either species would spread to other areas of Marin or Sonoma Counties, the successful colonization of axis and fallow deer over a broad area within the Seashore suggest that range expansion throughout at least some of those counties is likely. Expansion rates of non-native deer would depend on a number of factors beyond the control of PRNS, namely, range conditions and hunting pressure outside the park.

Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal

As noted in other sections of this document, this planning effort is being undertaken to accomplish four objectives:

- To correct past and ongoing disturbances to Seashore ecosystems from introduced non-native ungulates and thereby to contribute substantially to the restoration of naturally functioning native ecosystems;
- To minimize long-term impacts, in terms of reduced staff time and resources, to resource protection programs at the Seashore, incurred by continued monitoring and management of non-native ungulates;
- To prevent spread of populations of both species of non-native deer beyond Seashore and GGNRA boundaries; and
- To reduce impacts of non-native ungulates through direct consumption of forage, transmission of disease to livestock and damage to fencing to agricultural permittees within pastoral areas.

The interdisciplinary team examined several methods of accomplishing these goals, but agreed that a reduction in numbers was an essential component of any reasonable alternative. Alternatives such as fencing to restrict deer to a particular location were considered but rejected (see *Alternatives and Actions Considered but Rejected*). The two strategies the team felt were reasonable to consider to reduce ungulate populations were lethal removal and decreasing reproductive rates with fertility control. Alternative B would focus on the use of lethal control to reduce the size of the non-native deer populations. This alternative includes the monitoring listed in section 2.3 (Actions Common to All Alternatives).

Non-native deer populations would be maintained at a level of 350 for each species (700 total axis and fallow deer). Because fallow deer concentrations are higher than this currently, and axis deer populations are lower than this target, the focus of initial reductions would be on fallow deer. This target population level was chosen because of its history, and for the management reasons listed below. However, the number would be re-evaluated by resource managers regularly and could be changed based on results of ongoing monitoring programs as described below. Efforts would be made to reach target (reduced) levels in 15 years and to ensure continued presence of both species in the Seashore. Because fallow deer currently exceed 350 animals, and axis deer have historically done so, any chosen population control method would need to be used in perpetuity to maintain each species at this population size.

As noted in Chapter One, 350 individuals of each species is the level that was named in an informal 1976 management plan, with the stipulation that future research and monitoring could change the number. Since 1976, the following information has been collected:

- Data on the success and cost of controlling both species to this level is available for determining the impacts of this alternative and ability to satisfy project goals. For 1983-1995, records exist of how many deer were culled and how many ranger hours were expended. Data also exists on current minimum numbers for non-native deer 6 years after discontinuation of the control program. This constitutes some level of knowledge on expected cost, effort and likelihood of long-term success in limiting exotic deer populations to levels of 350 for each species.
- Based on non-native population models developed by Gogan et al. (2001) and Hobbs (2003), controlling non-native deer to these levels is unlikely to result in a natural decrease to extirpation of either species from the Seashore or GGNRA.
- To date, historical information suggests that neither population of non-native deer has moved out of the park at these (350 animals in each species) population levels.
- Historical records indicate populations of this size do not cause more than negligible damage to forage and fencing to ranches inside the park.

It is important to note that deer population goals might change if monitoring data warrants re-evaluation. For example, as populations of deer are reduced to below carrying capacity, the increased nutrition available to each adult can result in an increase in birth rate. Eventually, the Maximum Sustained Yield (MSY) is reached, where the population level is such that the output of young is at its highest. In deer, the MSY is usually reached when the population equals 50% – 65% of the carrying capacity. If deer herds are culled to the level of MSY, future culling to maintain numbers at this level will require the maximum effort, with the maximum number of animals being removed on a regular basis (McCullough 1987). Carrying capacities of non-native deer in the study area are estimated at 775 fallow and 455 axis (Gogan et al. 2001, Hobbs 2003). MSY populations and carrying capacities for axis and fallow deer at PRNS are currently unknown, but have been estimated at 62% of carrying capacity, or approximately 280 axis deer and 480-620 fallow deer (Gogan et al. 2001; see Appendix B for an explanation of non-native deer population models).

Non-native deer would be culled (shot) by trained Seashore staff. The timing and location of culling as well as age, sex, and numbers of deer culled would be determined by resource managers to ensure that populations are maintained at desired levels and to reduce risks of range expansion beyond Seashore boundaries.

Culling would be conducted by NPS staff specifically trained in wildlife sharpshooting. Efforts would be made to deliver immediately lethal shots to target animals and sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

Culling would take place year-round, weather permitting, and throughout the Seashore, with the exception of northern spotted owl breeding areas during owl nesting season (February 1 – August 1), and a ¼-mile coastal buffer zone, to minimize disturbance to marine mammals and protected shorebirds. Shooting would be limited to non-peak times in high-visitation areas – ideally, early and late in the day.

Sharpshooters would occasionally need to use vehicles to access deer for culling and carcass removal, but would attempt to remain on roads and trails whenever possible. Particularly in wilderness and sensitive areas, cross-country use of vehicles would take place only if absolutely necessary.

During the first several years, the focus of culling would be on fallow deer, as population numbers are significantly higher in this species. This initial "reduction" phase is predicted to last 8 years, during which culling of fallow deer would be intense. Thereafter, park management of fallow deer would enter its maintenance phase, where a much smaller number of deer each year would be taken. Because the population of axis deer is currently under the target of 350, culling in this population would remain very low initially, but would increase as the population surpassed 350.

An estimate of the number, sex, and age of deer that would be removed is based on predictions by Gogan et al. (2001) and Barrett (2000) regarding the response of the populations to culling. As noted above, when the population is decreased and food and shelter are relatively more abundant for the remaining animals, birth rate and recruitment (e.g., the successful addition of newborns to the population, or the survival rate of newborns) increase. When a population is close to its biological "carrying capacity," birth rate and recruitment decrease. Carrying capacity is defined as the maximum number of animals of a species that can live in a given environment (Shaw 1985). It is not a fixed number, but rather varies with changes in climate and habitat. Gogan et al. (2001) and Hobbs (2003) estimated carrying capacities for Seashore axis and fallow deer by modeling population parameters and using cited species population parameters, along with past PRNS census and PRNS deer removal data. For purposes of discussing potential control scenarios, fixed carrying capacities were assumed to be static numbers, and the Gogan et al. estimates for fallow and axis deer carrying capacity (775 and 455 animals, respectively) were used in this analysis. However, because of the variables mentioned above, the actual response to culling and precise harvest numbers are unknown and would be adjusted based on the results of future monitoring efforts such as those described in the *Actions Common to All Alternatives* section.

Using a PRNS fallow deer harvest model developed by Barrett (2000), and assuming the constant carrying capacity of 775 for PRNS fallow deer as estimated by Gogan et al. (2001), the annual removal of 100-200 fallow deer beginning in 2005 for 10 years, followed by culling of between 50 and 100 deer from 2016 on, would reduce the fallow population to 350 by 2020 (see Appendix A).

To predict axis deer response to harvest using the Barrett model, and assuming the constant carrying capacity of 455 for PRNS axis deer proposed by Gogan et al. (2001), the current population of ~250 axis deer will reach 350 in a few years. At this point, culling 25-50 axis deer per year thereafter would allow the population to remain stable at 350. See Appendix A for an illustration of the axis deer population trajectory under this scenario.

Because the focus of this alternative is the maintenance of axis and fallow deer at a specified level and not their eradication from PRNS, annual culling would continue indefinitely, and total numbers of animals removed over the lifespan of deer management is very high. As an example, although the exact number of fallow deer in the study area is unknown, counts indicate a reliable estimate is approximately 859 (90% Confidence Interval = 547 – 1170). Given fluctuations in climate, habitat conditions, and the response of deer to culling, Alternative B could result in the removal of over 2,000 axis deer and over 5,000 fallow deer by 2050. If current numbers and true carrying capacities were higher than postulated by Gogan et al. (2001), total numbers of non-native deer removed would be higher.

Where fallow and axis deer carcasses can be easily moved, they would be donated to charitable organizations as food for the needy. In remote and sensitive locations where removal of a carcass is difficult, it will be left to recycle nutrients into the ecosystem.

Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control

As in Alternative B, non-native deer populations would be maintained at a level of 350 for each species (700 total axis and fallow deer) through a combination of lethal removals and fertility control. Because fallow deer concentrations are higher than this currently, and axis deer populations are lower than this target, the focus of initial reductions would be on fallow deer. As noted above, this target population level was chosen because of its history and for the management reasons listed. However, the number would be re-evaluated by resource managers regularly and could be changed based on results of ongoing monitoring programs, described below. Efforts would be made to reach target (reduced) levels in 15 years and to ensure continued presence of both species in the Seashore. Because fallow deer currently exceed 350 animals, and axis deer have historically done so, any chosen population control method would need to be used in perpetuity to maintain each species at this population size.

The number of deer that require removal and those that can be treated through contraception depends on several variables, including carrying capacity, birth rate, climate, forage conditions, and in this alternative, the effectiveness of the contraceptive method selected. Fallow deer populations would be reduced using a combination of fertility control and shooting. The assumption used in modeling was that 25% of fertile females would be treated with a long-term contraceptive every four years and marked, effectively removing a quarter of the females as targets for shooting. Over the 15-year time period of this plan, about 345 deer would be shot to bring the population to 350 by year 15. Thereafter, 12-14 deer would be shot and another 25% of the fertile females would be given contraception every four years (Hobbs 2003).

Although axis deer populations are currently below the 350 target, past history suggests they will increase to this level. Because no prospective sterilant has ever been tested in axis deer, Alternative C assumes between 25 and 50 axis deer would be shot each year after the population reaches 350.

As in Alternative B, non-native deer would be removed (shot) by Seashore staff. The timing and location of culling as well as age, sex, and numbers of deer culled would be determined by resource managers in future years and would depend on the effectiveness and availability of long-term contraception. The objective of both the culling and contraceptive programs would be to ensure that populations are maintained at desired levels and to reduce risks of range expansion beyond Seashore boundaries.

Culling would be conducted by NPS staff specifically trained in wildlife sharpshooting. Efforts would be made to deliver immediately lethal shots to target animals and sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

The same conditions as described in Alternative B for when and where culling would take place would apply in Alternative C; that is, it would occur year-round and away from protected species. Off-trail vehicle use would take place only when absolutely necessary, particularly in wilderness and sensitive areas.

The goals of the contraceptive program would be to incorporate the latest contraceptive technologies to safely prevent reproduction for as long as possible and with minimal treatments per animal. This is because the potential for failure increases with each additional required per-animal contraceptive treatment. Failure can result from incomplete administration of the contraceptive or lack of physiological response. Potential for collateral effects to other species or to the environment from the treatment would be considered in choosing a contraceptive.

Because both species of non-native deer are polygynous and a small proportion of bucks accomplish a large proportion of breeding, male contraception is inefficient and impractical (Warren 2000). Surgical sterilization, because of the time and cost required to accomplish safely, is impractical for large numbers of wild ungulates and is discussed in *Alternatives and Actions Considered but Rejected*. The options that are available or are likely to become available during the life of this plan for female deer are described below, and include contraceptive vaccines, synthetic steroids, and hormonal agonists. Information about contraceptives that would last for only one season is presented only as background, since the application of one-year duration contraceptives has been shown to be impractical in either reducing the populations to 350 or for eradicating them (Hobbs 2003).

Contraceptives

There is currently no FDA-approved contraceptive for deer that does not require yearly boosters. Contraceptives, as used for female ungulates, prevent pregnancy in one of several ways: 1) by causing the treated animal to mount an immune response to its own ovum or egg (immunocontraceptive vaccines); 2) by acting as a hormonal agonist or tissue-specific toxin and thereby directly acting to prevent the secretion of an animal's own reproductive hormone (GnRH agonists, pituitary toxins); and 3) by mimicking a reproductive hormone and thereby blocking secretion of the animal's own hormones (synthetic steroids).

These latter synthetic steroids, such as melangestrol acetate, megestrol acetate, or diethylstilbestrol are generally not considered a practical and safe option because of the potential for entry into the food chain via scavengers and predators. However, norgestomet, a synthetic progestin approved for use in food animals, has minimal potential for food chain effects and has been found to prevent pregnancy in black-tailed deer for 1 year when used in a biobullet form (Jacobsen et al. 1995). Its effectiveness in fallow or axis deer is unknown.

Immunocontraception with the porcine Zona Pellucida (pZP) vaccine has also been shown to prevent conception for 1 year in a variety of deer species, including axis deer (Kirkpatrick et al. 1996). No published reports exist of pZP's effectiveness in preventing fallow deer from reproducing; however, Kirkpatrick concludes from unpublished data that a yearly pZP vaccine would be "ineffective in fallow deer" (Kirkpatrick et al. 1996a and b).

A GnRH agonist, leuprolide, has been tested in elk and has been found to cause infertility for one breeding season (Baker et al. 2002). Because leuprolide is a neuropeptide or protein, and is broken down by digestion, it poses no risks of passing into the food chain. Its effectiveness in axis or fallow deer is currently unknown.

All of these contraceptives, should they indeed prove effective in preventing pregnancy in axis or fallow deer, would likely require two initial injections, 3 weeks apart, and yearly re-inoculations to remain effective. In order to locate treated does for annual retreatment, all individuals given contraception would have to be captured in the first year and permanently marked with ear tags or radio telemetry collars. For reasons described below and in the section *Actions and Alternatives Considered but Rejected*, contraception that only provides annual or short term protection against pregnancy is unworkable as a solution by itself. Even as an adjunct to lethal controls, cost and logistic difficulties of capturing, holding, injecting, and marking treated animals would likely make annual contraception infeasible.

Sterilants and Long-Acting Contraceptives

A sterilant is defined, for the purposes of this discussion, as a drug that will prevent reproduction for a doe's reproductive life with one administration and would not require yearly "boosters." Because no such drug has been approved for use in wildlife by the FDA, studies on safe and efficacious use of a candidate drug would have to be conducted at PRNS before it could be used for management and population control.

Currently only one product, Spayvac®, a long-acting formulation of porcine Zona Pellucida (pZP), has been tested in fallow deer (Fraker et al. 2002). Preliminary results are encouraging, and indicate that 3 years after a single inoculation, Spayvac® prevented pregnancy in 100% of a small number of fallow does tested (n=5). The anti-Zona Pellucida antibodies required to prevent pregnancy were still high in test animals at that time (Fraker, personal communication), indicating the effectiveness of Spayvac® is likely to continue beyond 3 years. Spayvac®'s efficacy in axis deer is unknown. The alternatives in this EIS assume the use of Spayvac®, and assume the duration of action to be four years. If it is longer, deer may either need to be treated less frequently, fewer deer may need to be treated or the same number treated with fewer culled over time. If Spayvac®'s duration of action is shorter, the converse would be true.

Modeling Results Using Lethal Controls and Contraception

Axis Deer

As noted above, no long-acting contraceptive currently exists for axis deer. Therefore, Alternative C and E assume lethal controls would be used to maintain the axis deer population at 350. To predict axis deer response to culling using the Barrett model, and assuming the constant carrying capacity of 455 for PRNS axis deer proposed by Gogan et al. (2001), the current population of ~250 axis deer will reach 350 in a few years. At this point, culling 25-50 axis deer per year would allow the population to remain stable at 350. See Appendix A for an illustration of the axis deer population trajectory under this scenario.

As described in the section *Alternatives and Action Considered but Rejected*, annual contraception is ineffective in reducing the population of axis deer to 350. Should long-acting contraceptive technology for axis deer become available, its practicality and effectiveness in controlling PRNS axis populations at 350 animals would be evaluated. Use of long-duration contraceptives in axis deer would reduce the number of axis deer that would require culling in order to achieve control.

Fallow Deer

Estimated fallow deer numbers in 2003 were approximately 860, and 43% of animals observed in a January 2002 census were adult females (NPS 2002). As with axis deer, numbers of fallow deer treated would depend on: 1) drug efficacy in preventing pregnancy, 2) the relative proportion of reproductive females in the population, and 3) the rate of population growth. Efficacy is unknown, and fecundity, sex ratios, and population growth are subject to change. Using assumptions about each of these factors, Hobbs modeled the effect of treating large numbers of fallow does with long-acting contraceptives.

Hobbs modeled four different scenarios that differ in the percentage of deer treated for three different durations of effectiveness. These were one year, four years, and lifetime (10-12 years). The percentages of fertile females treated were assumed by Hobbs to be 0%, 25%, 50%, and 75%. If 75% of all fertile female deer were treated with 4-year contraceptives, it would reduce the number shot to 93 over the 15-

year period of this plan. However, it would require the capture, treatment, and marking of a total of about 740 deer over 15 years. If 50% of fertile female deer were given contraception, the number that would require lethal removal would rise to about 250 and the number captured, treated with a contraceptive and marked over 15 years would be about 360. If 25% of fertile female deer were treated with contraceptives, Hobbs' model indicated about 150 would be treated over the 15-year period, and about 360 would be shot. In other words, modeling showed that although combining fertility control with culling meant fewer deer would be shot, it also showed an increase in the total management effort and number of animals that required handling by humans. The Seashore staff believes that logistics, the ruggedness of the wilderness area, costs and deer behavior would make capture and treatment of more than 25% unlikely, and more than 75% impossible.

Because the goal of this alternative would be to control axis and fallow deer at a specified level and not to eradicate them from PRNS, annual culling and fertility control would continue indefinitely. Because of the long time period involved, the total numbers of deer removed with lethal controls and treated with contraceptives could be very high. Given current fallow deer estimates, the estimate of carrying capacity, and the need to continue removals indefinitely beyond the 15 year lifetime of this plan, at least 3,000 (2,200 axis and 750 fallow) would be removed by 2050 should Alternative B be implemented, using a 4-year duration contraceptive. If current numbers and true carrying capacities are higher than postulated by Gogan et al (2001) and Hobbs (2003), or if the contraceptive lasts less than four years, total numbers of non-native deer given contraception and removed will be higher.

If a lifetime contraceptive, rather than the modeled 4-year contraceptive, becomes available, the number of fertile does treated over this same time period would be 200-300. The number would vary depending on overall sex ratios and density dependent factors.

Alternative D: Removal of All Non-Native Deer by Agency Personnel

In Alternative D, all axis and fallow deer inhabiting the Seashore and the GGNRA lands administered by the Seashore would be eradicated through lethal removal (shooting) by 2020. The management actions included in this alternative would continue until both species were extirpated, with a goal of full removal within 15 years. This time frame minimizes the total number of deer removed (a longer period of removal would mean more fawns are born and more total deer are killed) and is reasonable from a cost and logistics standpoint.

Because of their current large numbers (~250 axis deer and ~860 fallow deer), it is expected that total removal of both species would require a minimum of 13 years. Monitoring during program implementation would be done to assess success of the program and to guide adjustments in the location, and intensity of removal. Such monitoring programs are integral components common to all alternatives and are listed in the *Actions Common to All Alternatives* section. Alternative D would include some or all of the previously described monitoring.

Seashore staff would remove non-native deer. Resource managers would determine timing and location of culling as well as age, sex, and numbers of deer culled. Although complete removal would take longer than removing 350 as in Alternatives B and C, removing as many deer as quickly as possible would accomplish several goals: It would minimize impacts non-native deer are currently having on native species, reduce the risk of non-native deer ranging beyond the Seashore boundaries, minimize the total number of deer removed over the lifetime of the management plan, and increase overall culling efficiency. The latter is true because, as deer become less numerous and more wary, culling success per unit effort typically decreases. Herds may split and deer densities throughout the Seashore may change, also slowing removal efforts.

Culling would be conducted by NPS staff specifically trained in wildlife sharpshooting. Every effort would be made to deliver immediately lethal shots to target animals. To this end, sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

As in other alternatives, culling would take place year-round, weather permitting, and throughout the Seashore, with the exclusion of areas requiring special resource protection, such as northern spotted owl nesting areas.

Both Hobbs (2003) and Barrett (2000) modeled the effect of culling fallow deer over time, although Hobbs assumed a higher initial rate of removal than Barrett. Both modelers extrapolated removal over a period of 15 years.

Barrett incorporated the age and sex-specific survival and reproductive rate assumptions described in Gogan et al (2001) (see Appendix A for an explanation of Barrett's model). As noted in other sections of this EIS, because exact fallow deer numbers are unknown and carrying capacity fluctuates with changing climate and vegetation patterns, projections should be interpreted as general trends rather than as specific numerical predictions. Assuming a 2005 fallow deer population of approximately 860 (PRNS unpublished data) and a carrying capacity of 775 (Gogan et al 2001), the model predicts that the annual removal of 150-200 animals over the 15-year life of the plan would result in the eradication of the fallow deer population from the Seashore. (see Appendix A). Over the 15-year management period, the total number of fallow deer removed in this scenario would be approximately 1,400.

Hobbs analyzed the effect of culling on fallow populations using a simulation model (Hobbs 2003, see Appendix B for an explanation of the model) that assumed an initial removal of 300 reproducing fallow female deer and 50% of all remaining fertile does each year after that. He assumed a carrying capacity of 1000 and found the total number of fallow deer removed over the 15-year management period would be less than half the slower removal scenario described above, or about 650 (Hobbs 2003).

The comparison of the results of each of these eradication models demonstrates the effect of pace. In other words, initially removing fertile females in larger numbers reduces the total number of deer culled over the lifetime of the plan.

Barrett also developed a model to study the effects of harvesting on axis deer and the number of deer that would require lethal removal to eradicate the population from the Seashore (Barrett 2000). He used the age and sex-specific survival and reproductive rate assumptions for PRNS axis deer described in Gogan et al. (2001). The model assumes that the Seashore carrying capacity for axis deer is 455. Given an estimated 2005 axis deer population of 250, removal of 50-100 deer per year beginning in 2005 would result in eradication by 2017. Under this scenario, a total of 800 axis deer would be removed over the management period (Appendix A).

In summary, culling approximately 250-300 non-native deer per year (or, following Hobbs' model, up to 300 fallow deer initially and 50-100 axis deer each year) would likely result in eradication of both axis and fallow deer by 2020. Total numbers of deer removed in this alternative would depend on variables such as carrying capacities for each species, year-to-year program effectiveness, and starting population size and composition. Continued monitoring, as described in the *Actions Common to All Alternatives* section would refine population estimates and account for changes in carrying capacity. Total numbers of non-native deer removed could range from 1,400 to 2,200.

Where deer carcasses could be moved with reasonable effort, they would be donated to charitable organizations as food for the needy. In remote or sensitive locations where removal of a carcass is difficult, it would be left to recycle nutrients into the ecosystem.

Alternative E (Preferred Alternative): Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control

In Alternative E, all axis and fallow deer inhabiting the Seashore and the GGNRA lands administered by the Seashore would be eradicated by 2020. Management techniques would include lethal removal and fertility control (long-lasting contraception or sterilization of deer). Both actions would continue until both axis and fallow deer have been extirpated. Because of their current large populations (~250 axis deer and ~860 fallow deer), it is expected that total removal of both species would require a minimum of 13 years, regardless of the technique(s) used. This alternative proposes to use both lethal removal and fertility control to eradicate both axis and fallow deer within 15 years. Monitoring during program implementation would be done to assess success of the program and to guide adjustments in the management techniques used. Provisions for monitoring are described in the section of actions components common to all alternatives and are listed in the *Actions Common to All Alternatives* section. Alternative E would include some or all of these measures.

As in other alternatives, Seashore sharpshooters would conduct the lethal removal of deer. Natural resource managers would determine timing and location of culling as well as age, sex, and numbers of deer culled. As with Alternative D, the Seashore would initially attempt to reduce the populations as quickly as possible to initially minimize impacts on native species, minimize the risk that axis and fallow deer would expand their range outside the park, minimize the total number of deer removed, and maximize the overall culling efficiency. With time, as deer become less numerous and more wary, culling success per unit effort typically decreases. Herds may split and deer densities throughout the Seashore may change, also slowing removal efforts.

Culling would be conducted by NPS staff specifically trained in wildlife sharpshooting. Every effort would be made to deliver immediately lethal shots to target animals. Sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

Culling would take place year-round, weather permitting, and throughout the Seashore, with the exclusion of northern spotted owl breeding areas during owl nesting season (February 1 – August 1) and a ¼-mile coastal buffer zone, to minimize disturbance to marine mammals and protected shorebirds. Shooting would be limited to non-peak times in high-visitation areas – ideally, early and late in the day.

Sharpshooters would occasionally need to use vehicles to access deer for culling and carcass removal, but would attempt to remain on roads and trails whenever possible. Particularly in wilderness and sensitive areas, cross-country use of vehicles would take place only when necessary.

As in Alternative C (Control of Non-Native Deer at Pre-Determined Levels by Agency Shooting and Fertility Control), the contraceptive program would incorporate the latest contraceptive technologies to safely prevent reproduction for as long as possible with minimal treatments per animal. This is because each per-animal treatment required in order to ensure contraception increases the likelihood of treatment failure due to incomplete administration or lack of physiological response. Specificity of treatment to non-native deer and collateral effects to other species would be considered in choosing a contraceptive. As noted in the description of Alternative C, male contraception is inefficient and impractical (Warren 2000). Surgical sterilization, because of the time and cost required to accomplish safely, is impractical for large numbers of wild ungulates. Therefore, the focus of any contraception effort would be fertile female deer using the best technology available. Short-term contraceptives for fallow deer have not yet been tested and approved, but some contraceptive vaccines, synthetic steroids, and hormonal agonists are known to prevent pregnancy in other ungulates, including axis deer, black-tailed deer, and elk. The cost and logistics of applying short-term contraceptives are likely to limit or prevent their use at PRNS.

Contraceptives that last a single season or a single year are described in Alternative C for information purposes, although modeling has indicated that the population cannot be feasibly reduced using such short duration products.

As noted above, one produce, Spayvac®, a long-lasting formulation of porcine Zona Pellucida (pZP), has been found to provide at least 3 years of pregnancy prevention in fallow deer (Fraker et al. 2002). Spayvac®'s effectiveness in axis deer is unknown.

Modeling Results

Fallow Deer

Hobbs (2003) analyzed a scenario in which long-acting contraceptives (sterilants) were combined with lethal removal to extirpate the non-native deer populations in the Seashore. As noted in Alternative C, Hobbs concluded that including long-acting fertility control would reduce the total number of animals that would need to be culled to achieve extirpation. However it also increased the total number of deer that would require handling or treatment of some kind over the scenario involving only lethal removal. In other words, if 25% of the fertile females were treated with a long-lasting contraceptive, 567 deer would need to be culled and 129 treated over the 15-year life of the plan. This is fewer than the 653 deer that would need to be culled without any fertility control (using Hobbs' assumptions and model rather than Barrett's; see above), but requires the capture, treatment, or culling of a total of 696 animals. This pattern holds true if more deer were given contraception; at 75% of deer treated with contraceptives, only 374 deer would require lethal removal over the lifetime of the plan, but a total of 914 would require capture, treatment, handling or shooting. Because of the logistic difficulty of capturing free-ranging deer in the 92 km^2 range they are known to inhabit, it is unlikely that treating more that 25% of all existing fertile fallow does in the Seashore is feasible. If the contraceptive duration of effect was shorter than four years (requiring more treatments during an animal's life), more fallow does would require treatment and culling to achieve eradication by 2020.

The treatment of more fertile does early in the planning effort, whether by culling or chemical sterilization, would mean the ultimate treatment of fewer animals over the lifetime of the plan, as well as an earlier final date of eradication. For example, giving contraception to a young doe at the end of the 15-year plan would mean she would be able to live her full lifetime, which could extend well beyond the intended end of the management effort. Therefore, to achieve the goal of eradication by 2020, the bulk of deer on contraception that would need to be treated would be treated as early as possible.

Axis Deer

Because the effectiveness of long-term contraceptives on axis deer is unknown, similar models have not been developed for this species. Should such contraceptive technology become available, its practicality and effectiveness in eradicating axis populations would be evaluated. Use of long-duration contraceptives in axis deer would reduce the number of axis deer that would require culling in order to achieve eradication. If no long-acting or sterilant technology should prove effective in eradicating axis deer within the lifetime of this management plan, lethal control would be used as described in Alternative D.

If only lethal removal is available as a tool for eradication of axis deer, the modeling results described above under Alternative D would apply. In this case, modeling by Barrett (2000) shows that, assuming a carrying capacity for axis deer of 455 and an estimated 2005 axis deer population of 250, removal of 50-100 deer per year beginning in 2005 would result in eradication by 2017. This scenario would require the removal of a total of 800 axis deer over the lifetime of the management effort (Appendix A).

As noted in other alternatives, current non-native deer numbers are only estimates and carrying capacity for both species fluctuates with changing climate and vegetation patterns, therefore projections should be interpreted as general trends rather than as specific numerical predictions. Given the assumptions stated in the Hobbs and Barrett models (see Appendixes A and B), the total numbers of both species of non-native deer that would be removed by culling over the lifetime of this management plan under Alternative E would be about 1,300 (800 axis and 550 fallow deer).

Total numbers of fallow does treated by 2020 with a lifetime contraceptive, should one exist, would vary depending on overall sex ratios and density dependent factors, but would likely approach 150 over the life of the plan. The number of fertile females either treated with contraceptives or culled early in the program will markedly effect the final date of eradication. If the contraceptive technology used is effective for less than the lifetime of a treated animal, retreatment of these individuals or treatment of more animals would be necessary. If current numbers and true carrying capacities were higher than postulated by Gogan et al. (2001) and Hobbs (2003), total numbers of fallow deer given contraception and removed would be higher.

Alternatives and Actions Considered but Rejected

Some alternatives were considered and dismissed from detailed study. In general, reasons for dismissing these actions included:

- Technical or economic infeasibility.
- Inability to satisfy guidance criteria, meet project goals, or resolve park planning needs.

Public Hunting to Control or to Eliminate all Non-Native Deer

Under this scenario, reduction of non-native deer numbers would have been accomplished by opening the Seashore to public hunting. Public hunting could have been either the sole control method or used in combination with ranger shooting of deer year-round. The deer-hunting season for Marin County (zone A) begins the second Saturday of August and extends for 44 consecutive days thereafter (California Department of Fish and Game 2002 Hunting Regulations). All hunters would have been required to receive a deer-hunting permit from CDFG and to abide by California deer hunting laws.

This alternative was rejected for several reasons. First, although the Point Reyes National Seashore Act (Public Law 87-657, 76 Stat. 538, 16 USC) allows for public hunting, the Compendium of Superintendent's Orders for Point Reyes National Seashore and Golden Gate National Recreation Area (36 CFR 1.7 (b)) specifies that the taking or hunting of wildlife by members of the public is prohibited within the boundaries of the park. There is also no provision in GGNRA legislation allowing public hunting, and public hunting within GGNRA is prohibited. Second, the limited hunting season and restricted hunting zone, along with the large number of fallow deer, make it extremely unlikely that reduction of the population to a manageable number (like 350) or eradication of either species could be accomplished solely by public hunting. Hunting could theoretically be used in combination with agency sharpshooting if it were something the public was highly interested in, but it would require changes in legislation for GGNRA. In addition, the logistics of providing a safe hunt in a national park would be difficult. Third, public comments received during the initial scoping process do not indicate that the public favors increased hunter access to the park. Historically, local communities have responded unfavorably to any PRNS ungulate management plans that included public hunting (NPS 1976).

In summary, public hunting conflicts with applicable laws pertaining to PRNS and GGNRA and is unlikely to resolve the objectives of significantly reducing numbers of non-native deer. Because of its inability to satisfy guidance criteria, meet project goals, or resolve park planning needs, this alternative was eliminated from further consideration.

Control or Extirpation Using Only Contraceptives

Control by Yearly Contraception

This alternative would have used annual contraception by itself to control populations of axis and fallow deer at 350 each. Because of the logistical difficulties of treating such large numbers of animals and the uncertainty of effectiveness, wildlife biologists generally agree that controlling large free-ranging populations of ungulates solely with annual contraception is impractical and unlikely to succeed (McCullough 1996, Garrott 1991and 1995, Curtis et al. 1998, Warren et al. 1992 and 2000). The following discussion explains why this is so.

Breeding in both axis and fallow deer is done by a small number of bucks; therefore, male contraception would need to be applied to nearly all or all males in a population to be effective, as even one or a few remaining males could impregnate a very large number of females. The current research in female ungulate contraception has focused on immunocontraceptive vaccines and synthetic steroids administered by injection to female deer and/or elk. Immunocontraception with porcine Zona pellucida (pZP) has been shown to prevent conception for 1 year in a variety of deer species, including axis deer (Kirkpatrick et al. 1996). No published reports exist of pZP's effectiveness in preventing fallow deer from reproducing, however Kirkpatrick concludes from unpublished data that the yearly formulation of pZP is "ineffective in fallow deer" (Kirkpatrick et al. 1996).

Use of most steroid contraceptives (such as melangestrol acetate, megestrol acetate, or diethylstilbestrol), because of the potential for entry into the food chain via scavengers and predators, is not considered a practical and safe option. However, Norgestomet, a synthetic progestin approved for use in food animals, has minimal potential for food chain effects and has been found to prevent pregnancy in black-tailed deer for 1 year when used in a biobullet form (Jacobsen et al. 1995). Its effectiveness in fallow or axis deer is unknown.

The yearly formulation of PZP requires 2 injections, 3 weeks apart, during the first year. Both pZP and Norgestomet, should they indeed prove effective in preventing pregnancy in axis or fallow deer, would require yearly re-inoculations to remain effective. This means all treated does would need to be captured and permanently marked with ear tags or radio collars, and that these same individuals would need to be re-located each time a booster is administered. There is currently no FDA-approved contraceptive for deer which does not require yearly boosters.

Because current estimates suggest axis deer now number approximately 250, control of the axis population would entail use of pZP or Norgestomet only in future years to prevent numbers from exceeding the 350 level (National Park Service 2002a). It has been estimated that 60-80% of adult females would require effective annual contraceptive treatment in order to stabilize wild ungulate populations below their biological carrying capacity (Garrott 1995, and McCullough 1996). In field monitoring by Seashore staff between January and May 2002, an average of 50% of observed axis deer were adult females (PRNS, unpublished data). If this demographic picture persists over the near future, a minimum of 80-110 Axis does per year would have to be given contraception in order to stabilize the axis deer population at 350 animals. Actual required numbers of treated animals may be up to 15% higher because 15% of axis deer fawns have been found to breed at the Seashore (Gogan et al. 2001). In addition, because axis deer breed year-round, a significant but unknown proportion of does treated at any one time would already be pregnant and therefore be treatment failures. A larger number of does would need treatment to account for these treatment failures.

Estimated fallow deer numbers in 2003 were 859 (90% CI = 547 - 1170), and 43 % of animals observed in a January 2002 census were adult females (NPS 2002). In order to reduce the population to 350 animals solely with yearly contraception, the total number of fawns produced would have to be less than the total number of animals dying each year. As in axis deer, numbers of fallow deer treated would depend on: 1) drug efficacy in preventing pregnancy, 2) the relative proportion of reproductive females in the population, and 3) the rate of population growth. Efficacy of available contraceptives is unknown, and fecundity, sex ratios and population growth are subject to change. This means any predictions using models are not precise, but give only an idea of trends. Using current estimates for population size, along with the assumptions of a fallow population model developed by Barrett (see Appendix A for a detailed explanation of the model), approximately 80% of all fallow does would have to be effectively given contraception yearly in order to reduce the fallow population to 350 within 25 years[1]. This would require treatment of at least 300 fallow does per year for at least 6 years, and fewer each year after. A minimum total of 400-500 fallow and axis does would require yearly contraception over the next decade in order to control total numbers to 350 within 25 years, in the absence of any other control method (see Barrett model, Appendix A).

Another fallow population model developed by Hobbs (see Table 2 below) used simulations to project the results of treatment, every 4 years, of large numbers of fallow does with contraceptives, including agents lasting only one year. For economic and logistic reasons, Hobbs assumed treatment (even with contraceptives that provide only one season or year of pregnancy prevention) only every four years. Simulations revealed that treatment of 75% of all fertile does with single year duration agents every 4 years "allowed the population to *increase* slightly" and would be unsuccessful in reducing the population (Hobbs 2003). Further complicating this scenario is the knowledge that although yearling fallow does breed less often that older does (50% of yearlings versus 75% of older does were found to be pregnant in 1976-1980, Gogan et al. 2001) they cannot be reliably differentiated in the field and both age classes would have to be treated without discrimination.

Past experience with contraception of tule elk at Point Reyes National Seashore indicates that, excluding the significant costs of the first year's capture and marking of treated animals (up to $1,500/animal depending on the capture and marking method), yearly re-inoculations of each elk cow with pZP requires at least 6 hours of labor and costs approximately $340 (Point Reyes National Seashore unpublished databases). Elk at Tomales Point are found in relatively open habitat, are limited in their movements by an elk-proof fence, can be located with radio-transmitter collars and present a relatively large target for remote inoculation via dart gun. It is expected that annual re-inoculations of fallow and axis does, particularly if they were not collared with radio telemetry collars, would be considerably more difficult. Therefore the feasibility of treating 75% of does, as modeled by Hobbs, is extremely low.

If time and labor records for tule elk contraception are used, it is estimated that inoculation of the required minimum number of exotic deer would necessitate at least 300 man-days[2] and $136,000 per year for the

[1] According to the same model, if 99% of all fallow does were effectively contracepted, it would take only 20 years to reduce the total population to 350. For a discussion of the Barrett fallow population model, see Appendix A.
[2] One man-day is defined as 8 hours. (400 does X 6 hours per innoculation)/8 hours per man-day = 300 man-days. $340 per doe per year X 400 does = $136,000 per year.

first 6 years of the program. All does treated would have to be inoculated in the 2-3 months prior to the rut, or reproductive season. Timing would be particularly difficult or impossible for axis deer contraception, as this species breeds year-round at PRNS and blood or fecal tests to determine the stage of reproductive cycle for a particular doe. Cost and difficulties of the initial capture and marking of treated animals plus additional effort to locate animals for yearly retreatment would add considerably to these minimum estimates.

As noted above, these logistical difficulties of treating such large numbers of animals and the uncertainty of effectiveness have led most wildlife biologists to conclude that controlling large free-ranging populations of ungulates solely with annual contraception is impractical and unlikely to succeed (McCullough 1996, Garrott 1991and 1995, Curtis et al. 1998, Warren et al 1992 and 2000). Treating a minimum of 400 deer per year with even the most effective, remotely delivered contraceptive is beyond the logistic capabilities of most commercial deer ranching facilities or zoos. The capture, treatment, marking and re-treatment of deer at the Seashore is significantly more difficult than this, and well beyond the financial, logistic and operational abilities of park staff, especially given the many concurrent demands of resource management placed on these individuals. Given the uncertainty of being able to deliver contraceptives to the required number of does in the 2-3 months prior to the rut every year, the changing breeding season, and these logistic and cost constraints, control of non-native deer at levels of 350 for each species solely with yearly contraceptives is very unlikely to succeed. This alternative has been eliminated from further consideration because of its technical infeasibility and inability to meet project goals.

Extirpation by Yearly Contraception

Contraception, by its very nature, prevents reproduction but does not remove adults from the population. In fact, life expectancy of treated females can increase as a result of reduced energetic costs of pregnancy and lactation (Warren 2000b, Hone 1992) and increased resources in populations with strong density-dependent responses (Garrott 1995). Therefore, only if at least 95% of females were treated and the yearly contraceptive was 100% effective for each year in the reproductive lifetime of each female (8-10 years), could a population size would fall to 0 by attrition (see Barrett model, Appendix A).

It is impractical to expect that almost all of the free-ranging non-native does of reproductive age (estimated at approximately 470 animals) within 100 square kilometers of known non-native deer range, could be located and treated every year during the 2-3 months before rut season. It is also impractical, given current literature on porcine Zona Pellucida, to expect that any field-administered contraceptive will be 100% effective every year (Kirkpatrick et al. 1996, Garrott 1995, Shideler et al. 2002, National Park Service 2002b). Further, determining effectiveness of treatment would entail fecal or blood hormone analysis on all treated does during the second or third trimesters of pregnancy, again an impractical task for free-ranging ungulates in an area the size of the Seashore.

This alternative was removed from further study because of its technical infeasibility and inability to meet project goals.

Control with Long-Acting Contraceptives ("Sterilants")

While the discussion above focuses on the reasons why it is not feasible to use yearly contraception to reduce non-native deer populations to a reasonable number (350), this discussion explains why long-lasting contraceptives or sterilants are not able to achieve this control without some lethal removals. A sterilant is defined, for the purposes of this discussion, as a drug that will prevent reproduction in a doe for its entire reproductive life with one administration and would not require yearly "boosters." Because no such drug has been approved for use in wildlife by the Food and Drug Administration, studies on safe and efficacious use of a candidate drug would have to be conducted at PRNS before it could be used for management and population control. Currently only one product, Spayvac®, a long-acting formulation of porcine Zona Pellucida, has been tested in fallow deer (Fraker et al. 2002). Preliminary results indicate that 3 years after inoculation, Spayvac® prevented pregnancy in 100% of a small number of fallow does tested (n=5), and that the anti-Zona Pellucida antibodies required to prevent pregnancy were still high in test animals at that time (Fraker, personal communication).

Because no prospective sterilant has ever been tested in axis deer and because insufficient information currently exists about the efficacy of Spayvac® on free-ranging fallow deer, it is not possible to predict with certainty the costs, impacts or likelihood of success of a program in which Spayvac® alone would be used to control non-native deer populations. Accurate estimates of the treatment effort needed to control the populations at 350 would require accurate knowledge of reproductive rates, age and sex composition of both species as well as known effectiveness of the treatment in preventing pregnancy in each species.

No population models incorporating sterilant treatment of axis deer populations have ever been developed. Hobbs (2003) analyzed the effect of culling and fertility control on fallow populations using a simulation model. In order to reduce the current PRNS fallow deer population to 350 animals, approximately 75% of fallow does, or approximately 270 animals, would initially require treatment with a lifetime-effect sterilant (Hobbs 2003). With time, remaining fertile females would produce additional female fawns that would grow to adulthood and replace the sterilized females. At least 75% of these fertile does would also require treatment with a lifetime-effect sterilant to bring the population to 350. Sterilants would be periodically required as long as some fertile does remain to maintain the population at this size. If the contraceptive agent used was effective for less that a doe's lifetime, more animals would require treatment to control total numbers at 350 for each species.

The few known requirements of this alternative render it impractical. Initial treatment of 270 free-ranging fallow does with any sterilant would require capture and permanent marking of the animals to allow monitoring and to prevent inadvertent re-treatment. Treatment would have to be repeated at regular intervals as numbers of fertile does grew. Capture and handling of wild deer will result in some unavoidable deaths. Such a large-scale capture and treatment operation is not feasible for a population of wild deer that range over 100 square kilometers within the Seashore. Also, no sterilant for axis deer is available or being tested at this time. Without lethal controls as an option, the population of axis deer would continue to grow until such a sterilant is found and approved for use. When and if this happens, the logistic difficulties associated with finding and capturing enough axis deer to apply the contraceptive so that the population is maintained at 350 would apply. Because even the minimum requirements of this alternative are technically infeasible and unlikely to meet project goals, control of non-native deer at 350 of each species with sterilant treatment alone has been eliminated from further consideration.

Extirpation Using Long-Acting Contraceptive Administration ("Sterilants")

This option would have used long-acting contraceptives or sterilants to eradicate both axis and fallow deer. As noted above, no approved sterilant exists for either species, although the apparently long-acting contraceptive Spayvac is currently being studied for FDA approval and widespread use in fallow deer. Because no prospective sterilant has ever been tested in axis deer and because Spayvac® has been tested only on a small number of free-ranging fallow deer, it is not possible to predict with certainty the costs, impacts or likelihood of success of a program in which Spayvac® alone would be used to control non-native deer populations. Accurate estimates of the treatment effort needed to eradicate the populations would require accurate knowledge of reproductive rates, age and sex composition of both species as well as known effectiveness of the treatment in preventing pregnancy in each species. No population models incorporating sterilant treatment of axis deer populations have ever been developed, although Hobbs analyzed the effect of culling and fertility control on Seashore fallow populations using a stage-based simulation model (Hobbs 2003).

In his simulation model of fallow deer populations at PRNS, Hobbs found that lifetime-effect sterilant treatment of 75% of all fertile females, along with treating missed females every 4 years, failed to achieve eradication in even 15 years (Hobbs 2003). Hobbs determined that it would not be possible to eradicate the PRNS fallow deer population in this time period using fertility control alone. He explained this lack of success in the following way: "The inability of fertility control alone to reduce the population is easy to understand. Even when 100% of the females are maintained infertile, the maximum rate of decline of the population is no greater than the maximum mortality rate, which, in a long lived species like fallow deer, is quite small, approximately 10% per year " (Hobbs 2003, page 12). Hobbs concludes that "…attempting to eradicate the population using fertility control alone is futile."

Even if treatment of over 75% of all fertile axis and fallow females with a sterilant were possible, delivery problems decrease the likelihood of treating sufficient numbers of animals in a population (Hobbs et al. 2000). Delivery problems include: 1) does breeding as fawns[3] or yearlings, 2) inability to ensure treatment before breeding has occurred, especially with species such as axis deer that exhibit year-round breeding, and 3) the necessity of permanently marking all treated animals in order to avoid double-treating. A significant proportion of axis and fallow does at PRNS have been found to breed as yearlings (Gogan et al. 2001). These yearling does would have to be included in the pool of potential treatment animals. Breeding occurs year-round in axis deer at PRNS therefore an unknown number of treated axis does might be pregnant, regardless of what time of year treatment was administered. Finally, because permanent marking requires capture, this alternative would require capture of all treated animals. Capture and handling of wild deer will result in some unavoidable deaths.

In summary, capture, permanent marking and treatment of even the minimum numbers required for the first year of an eradication program, using sterilants alone, is impractical for free-ranging deer in a 70,000-acre park. This alternative is eliminated from further consideration because of infeasibility and likelihood of failure in meeting project goals or resolving park planning needs.

Surgical Sterilization

Surgical sterilization is defined, for purposes of this document, as the irreversible alteration of the male or female reproductive tract, via surgery, in order to prevent future conception. Surgical sterilization of wild ungulates, either castration or vasectomy for males, and ovariectomy or tubal ligation for females, would be performed in the field with animals restrained under general anesthesia. The surgical procedures are simpler, faster and safer for males than females but as in all polygamous, polyestrous species, sterilization of axis or fallow bucks is inefficient and less effective for population control than sterilization of does. Although a small proportion of the bucks are responsible for a large proportion of the breeding, these "breeder" bucks are not readily identifiable. In addition, should these "breeder" males be sterilized, the polyestrous nature of deer would ensure that does would repeatedly return to estrus and the sterile bucks would eventually be replaced by a fertile male (Garrott 1995).

Ovariectomy and tubal ligation of does would entail surgical entry into the animal's peritoneal cavity and consequently would require aseptic conditions, often difficult to achieve outside a veterinary clinical facility. Does would have to be captured and permanently marked. Capture and handling of wild deer would result in some unavoidable deaths. General anesthesia would have to be induced and maintained for the duration of the procedure, which can last 2-4 hours from start to finish. Surgery and anesthesia,

[3] Axis deer have also been found to breed as fawns at PRNS and elsewhere (Gogan et al. 2001, Wehausen and Elliott 1982, Graf and Nichols 1966, Kramer 1971).

administered by a trained veterinarian and staff, would entail life-threatening risks for the animal due to anesthetic, surgical or post-surgical complications (U.S. Geological Survey 1999).

Hobbs et al. (2000) found that, without lethal removals, at least 50% of breeding females in an ungulate population must be rendered infertile in order to achieve significant reductions in population size. Surgical sterilization has been used to control a small herd of deer (<20 animals) in a Wisconsin zoo (Frank et al. 1993). Because of the time and labor involved with surgical sterilization of does, as well as the large number of does that would require treatment in order to control the axis and fallow deer populations at PRNS, the technique would be impractical at the scale required. It would be unlikely to be useful in limiting population growth or in eradicating either species.

This alternative is eliminated from further consideration because it is infeasible and unlikely to accomplish the objectives of the project.

Relocation

Relocation is the capture, transport and release of non-native deer at one or more sites outside of PRNS and GGNRA. Fallow and axis deer are not native to California. Title 14 §671.6 of the Californian Code of Regulations states: "No person shall release into the wild without written permission of the commission any wild animal…which: (1) is not native to California." In addition, paratuberculosis, or Johne's disease, has been documented in non-native deer at PRNS (Riemann et al. 1979b). Johne's disease is a chronic, incurable and transmissible diarrheal disease of domestic and wild ruminants. Culture of the causative organism, *Myocbacterium avium ss. paratuberculosis*, in feces, or from tissues on postmortem examination, is presently considered the best method for diagnosis (Riemann et al. 1979b, Manning et al. 2003). However, carriers can shed the organism sporadically and Johne's disease can be difficult to diagnose in infected cervids. Because of the difficulty of accurately screening deer for Johne's disease and the infection risk that carrier animals would pose to livestock, farmed deer, and other wildlife, California Department of Fish and Game has communicated to NPS that movement of non-native deer to other parts of the state is undesirable. Permission to relocate non-native deer would require a permit from the Department.

Before transfer of cervids out of California can occur, U.S. Department of Agriculture (USDA) specifies that "whole herd" tuberculosis tests, of all cervids older than 12 months of age, must be performed (9 CFR Part 77). Such testing actually requires two single cervical tuberculin (SCT) skin tests, at least 90 days apart, with the second test conducted at least 90 days prior to movement. Tuberculin tests for each animal entail intradermal injection of tuberculin and inspection of the injection site by an accredited veterinarian 72 hours later. Consequently, tested animals must be captured, permanently marked and held for two 72-hour periods in a corral or pen. In all, animals to be relocated out of state would require 3 separate captures, 2 for tuberculin testing and one final capture before transport. Alternatively, animals to be relocated would be marked and maintained in an enclosure for the required minimum of 180 days.

Estimated population sizes for axis and fallow deer as of 2003 are 250 and 860, respectively. Relocation would entail repeated captures of free-ranging or enclosed deer. Capture and handling of wild deer would result in some unavoidable deaths. In light of current numbers of both species, it is unlikely that enough deer could be captured and relocated to control or eradicate non-native deer at PRNS.

This alternative is eliminated from further consideration because it is infeasible, unlikely to accomplish the objectives of the project, incompatible with state wildlife policy and poses risks to wildlife, livestock and farmed deer outside of the Seashore.

Restricting Deer to a Fenced Area

In this alternative, non-native deer would be restricted to a portion of PRNS in order to reduce impacts to wilderness areas and to prevent movement of deer outside NPS boundaries. Deer-proof fencing with gates allowing entrance to visitors, agricultural permittees, or NPS staff, measuring at least 8 feet high, would be required to entirely surround those areas containing non-native deer. Archaeological investigations and assessments would be required before ground breaking for fence construction to ensure no archaeological resources would be affected. Depending on the size of the non-native deer area and the density of non-native deer within, supplemental feeding as well as monitoring for overgrazing impacts would likely be required. Also depending on the size of the enclosure and non-native deer density, future control of the enclosed herd, either by lethal means or with fertility control, could be required.

Although historic precedent exists for NPS maintaining enclosed wildlife (tule elk at Yosemite NP from 1921-1935, bison at Yellowstone NP from 1935 – 1943) the primary mission of NPS is: "…to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Although wildlife have been fenced in NPS units (including the Seashore) as a first step towards restoration of native species, maintaining wildlife in enclosed areas for a long period of time or permanently is more in keeping with private game farms, game parks or zoological collections.

Tule elk were re-introduced to PRNS in 1978, after a century of absence, to the 2,600-acre Tomales Point elk reserve, bounded on 3 sides by water and to the south, by an 11-foot high, elk-proof fence. The purpose of this re-introduction was to restore the dominant native herbivore to the Tomales Point wilderness ecosystem. The fence was erected to prevent elk from wandering on to neighboring ranchlands where they might interfere with agricultural operations by feeding on silage or hay, or by damaging fences. In 1999, tule elk from Tomales Point were translocated to the Limantour wilderness area and released. This second step in the restoration of tule elk to the Seashore, as a free-ranging herd in unfenced wilderness, was made possible by 20 years of management and research on the Tomales Point elk herd. Fencing non-native deer would never constitute a first step in native species restoration because axis and native deer are exotic to the California coastal ecosystem.

Because of the large populations of both axis and fallow deer at PRNS and their extensive ranges (6 km^2 and 92 km^2 respectively), erection of fences around current non-native deer ranges is impractical. Confinement of only a portion of each population would allow continued growth and range expansion of the unconfined deer.

This alternative is eliminated from further consideration because it is infeasible, inconsistent with the mission of the National Park Service, and unlikely to accomplish the objectives of the project.

Trapping and Euthanasia by Lethal Injection

Euthanasia is the act of inducing death in a humane fashion. The means available to euthanize wild deer would be chemical immobilization with dart guns, or trapping in corral traps, Clover traps, or with net guns and manual restraint. In all cases, immobilized deer would then be injected intravenously with irreversible barbiturates.

The purpose behind using lethal injection in domestic animals, usually pets, is to induce death without causing stress and pain. Pets, however, are by nature, comfortable being handled and approached by humans. According to the American Veterinary Medical Association *Report of the A.V.M.A. Panel on Euthanasia* (AVMA 2001), "aggressive, fearful, wild or feral animals should be sedated or given a nonparalytic immobilizing agent prior to intravenous administration of the euthanasia agent and collapse." Capture and anesthesia of wild deer, even before lethal injection, would result in stress to all handled animals and some unavoidable injuries due to trauma. Because of the time required to immobilize animals and induce death via intravenous injection, the humaneness of this alternative is debatable.

Administration of immobilizing and barbiturate euthanasia drugs renders deer carcasses unfit for human consumption and poses a risk to scavengers via the food chain. Carcasses would therefore require disposal by rendering or incineration. Capture of wild animals is difficult and poses safety risks to humans and wildlife. Because of the large populations of non-native deer at PRNS, capture and immobilization of sufficient numbers to eradicate them or control them at 350 of each species is infeasible.

This alternative is eliminated from further consideration because it offers no advantages, threatens safety of humans, is logistically very difficult and is unlikely to accomplish the objectives of the project.

Alternative Summary Matrices

Two tables summarize the impacts of each alternative, and the actions of each. The actions table also summarizes how each alternative meets the laws and policies discussed in chapter one.

Table 1. Summary of Alternatives

	Alternative A: No Action	**Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal**	**Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control**	**Alternative D: Removal of All Non-Native Deer by Agency Personnel**	**Alternative E: Removal of All Non-Native Deer by Agency Removal and Fertility Control**
Management Actions	No actions would be taken to control non-native deer numbers.	Yearly culling of deer by trained NPS staff would continue indefinitely in order to maintain non-native deer numbers at predetermined levels. These levels would be chosen by NPS managers to ensure that: 1) adverse impacts to resources were acceptable, 2) the risk of non-native deer expansion beyond NPS boundaries was minimized, and 3) neither species was likely to be extirpated. Carcasses would be donated to charity, rendered or left to recycle nutrients into the ecosystem.	Yearly culling and long-lasting contraception of deer by trained NPS staff would continue indefinitely in order to maintain non-native deer numbers at predetermined levels. These levels would be chosen by NPS managers to ensure that: 1) adverse impacts to resources were acceptable, 2) the risk of non-native deer expansion beyond NPS boundaries was minimized, and 3) neither species was likely to be extirpated. Carcasses would be donated to charity, rendered or left to recycle nutrients into the ecosystem.	Culling by trained NPS staff would occur over the next 15 years in order to eradicate both species of non-native deer from PRNS-administered lands. Carcasses would be donated to charity, rendered or left to recycle nutrients into the ecosystem.	Culling and long-lasting contraception by trained NPS staff would occur over the next 15 years in order to eradicate both species of non-native deer from PRNS-administered lands. Carcasses would be donated to charity, rendered or left to recycle nutrients into the ecosystem.
Duration of Actions	Indefinitely	Indefinitely	Indefinitely	Approximately 15 years	Approximately 15 years

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Approximate Total Number of Animals Removed	None	Incalculable (culling continues indefinitely) By 2020: 650 axis, 2,400 fallow. By 2050: 2,200 axis, 5,500 fallow.	Incalculable (culling continues indefinitely) By 2020[1]: 650 axis, 350 fallow. By 2050[1]: 2,200 axis , 750 fallow.	800 axis, 1,400 fallow	800 axis, 550 fallow [1]
Approximate Total Number of Animals Treated with Lifetime Duration Contraceptives[2]	None	None	Incalculable (contraception continues indefinitely) By 2020: 200 fallow By 2050: 200-300 fallow	None	100-150 fallow
Relationship of Alternative to Purpose and Need	None of the 4 stated objectives would be accomplished.	Two of the 4 stated objectives would be accomplished, to some degree. Alternative B would curtail spread of non-native deer beyond NPS boundaries and reduce impacts to agricultural permittees.	Same as Alternative B.	All 4 of the stated objectives would be fully accomplished. Alternative D would prevent spread of non-native deer beyond NPS boundaries and eliminate impacts to agricultural permittees. It would also correct past and ongoing disturbances to Seashore ecosystems from non-native deer and contribute substantially to restoration of naturally functioning native ecosystems. Long-term diversion of staff and funds from other natural resource priorities would by prevented.	Same as Alternative D.

[1] These numbers assume that no lifetime duration contraceptive has been developed for axis deer and that up to 50% of all fallow does can be removed yearly. If axis deer can be effectively contracepted with a long duration treatment, the total number of axis deer lethally removed will decrease. If fewer than 50% of all fallow does can be removed yearly, the total number of fallow deer removed will increase.

[2] These numbers assume the existence of a contraceptive treatment that is effective for 4 years. If a treatment is found that maintains infertility for the reproductive life of a doe (~10 years), the total number of animals treated and the total number of treatments will decrease. Again should an effective "sterilant" become available for axis deer, this species will also be treated under Alternatives C and E.

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Relationship of Alternative to Federal and State Laws, Policies and Plans	Alternative A is in compliance with the National Environmental Policy Act (NEPA) of 1969 and the Wilderness Act of 1964.	Alternative B is in compliance with: NEPA, the Wilderness Act, the NPS Organic Act of 1916, NPS Management Policies (NPS 2001), Executive Order 13112, and the 1980 PRNS General Management Plan (GMP). The alternative is also in compliance with California Department of Food and Agriculture Code and California Department of Fish and Game Code.	Same as Alternative B.	Same as Alternative B. In addition, Alternative D complies with Public Law 94-544 and 94-567, amending the Seashore's enabling legislation, and NPS Management Policies (2001) regarding exotic species management.	Same as Alternative B. In addition, Alternative E complies with Public Law 94-544 and 94-567, amending the Seashore's enabling legislation, and NPS Management Policies (2001) regarding exotic species management.
Management and Governance	NPS would provide management and oversight of continued resource monitoring within NPS boundaries. On lands outside of NPS jurisdiction, California Department of Fish and Game would manage all issues relating to non-native deer.	NPS would provide management and oversight of culling operations and resource monitoring within NPS boundaries. Agricultural permittees would be responsible for monitoring non-native deer depredation to ranches within PRNS boundaries. Outside of NPS jurisdiction, California Department of Fish and Game (CDFG) would manage all issues relating to non-native deer.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
Legislative Authorities	No new legislation would be required.	No new legislation would be required.	No new legislation would be required.	No new legislation would be required.	No new legislation would be required.

Table 2: Estimated cumulative total deer removals for Alternatives A-E (based on population models by Barrett 2000, and Hobbs 2003).

Estimate										
Year	**Alternative A**		**Alternative B**		**Alternative C**[1]		**Alternative D**		**Alternative E**[1]	
	Fallow	Axis	Fallow	Axis	Fallow	Axis	Fallow	Axis	Fallow	Axis
2005	0	0	0	0	0	0	0	0	0	0
2020	0	0	2,400	650	350	650	1,400	800	550	800
2035	0	0	3,900	1,400	550	1,400	1,400	800	550	800
2050	0	0	5,500	2,200	750	2,200	1,400	800	550	800
2065	0	0	7,100	3,000	1,000	3,000	1,400	800	550	800

[1] These numbers for Alternatives C and E assume that no lifetime duration contraceptive has been developed for axis deer and that up to 50% of all fallow does can be removed yearly. If axis deer can be effectively given contraception with a long duration treatment, the total number of axis deer lethally removed will decrease. If fewer than 50% of all fallow does can be removed yearly, the total number of fallow deer removed will increase.

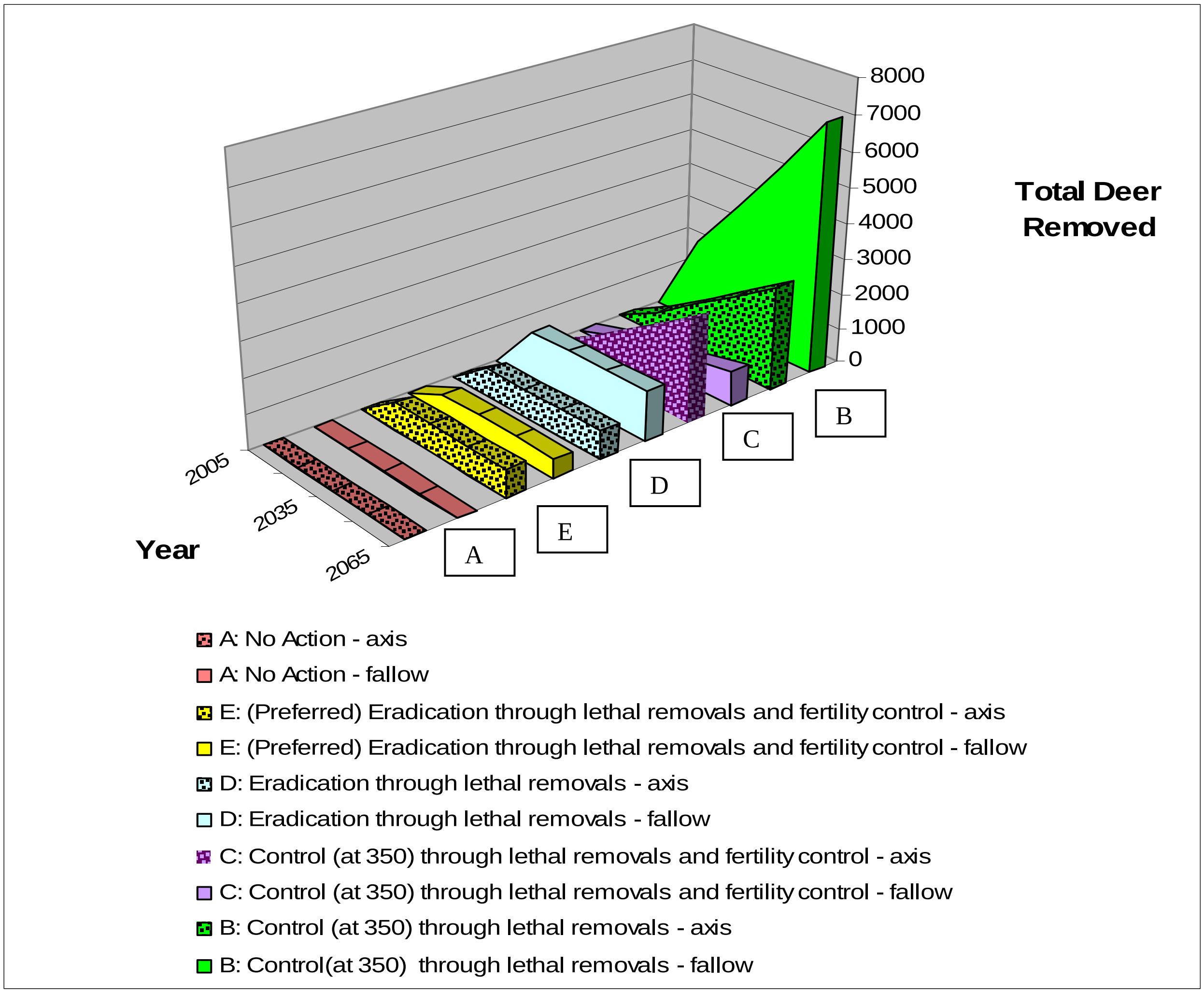

Figure 1: Estimated cumulative total deer removals for Alternatives A-E (based on population models by Barrett, 2000, and Hobbs, 2003).

Environmentally Preferable Alternative

The environmentally preferable alternative is the alternative that will promote national environmental policy as expressed in NEPA and causes the least damage to the biological and physical environment. Such an alternative should contribute to restoration of natural ecological processes and best protect, preserve, and enhance historic, cultural, and natural resources.

Alternatives A, B and C would continue ongoing impacts to park natural and physical resources. These include trampling and browsing of riparian vegetation, with loss of soils, wildlife habitat and increased erosion and degraded water quality as a result. Large herds of fallow and axis deer would continue to return to certain pastures and riparian forests, with locally severe losses of vegetation. Because the diets of fallow deer and axis deer overlap with native ungulates and fallow deer are thought to be more aggressive than native deer and elk, they compete for and occupy their habitat. Competition can result in reduced productivity and lower fawn survival in native black-tailed deer when forage is scarce. Fallow and axis deer may also serve as reservoirs of paratuberculosis, to which both black-tailed deer and tule elk are susceptible. Non-native deer also eat the same food as several native PRNS small mammal and bird species, and may indirectly affect other wildlife through the loss of habitat from deer browsing or trampling of vegetation.

Exotic deer compete for food with prey species of the federally threatened northern spotted owl. They can also occupy beach habitat used by western snowy plovers (federally threatened) as nesting habitat. In addition, fallow deer frequent riparian areas and may trample, thrash and browse vegetation, resulting in the removal of habitat for threatened California red-legged frog, coho salmon, steelhead trout, and the endangered California freshwater shrimp. Non-native deer may also browse plants used by the endangered Myrtle’s silverspot butterfly for nectar or as larval hosts.

Although they do not have special federal status, several rare or unique bird species in the park occupy habitat in brush or nest on the ground in areas where non-native deer might browse. Deer may eat or trample special status plant species as well.

Monitoring and managing exotic deer by park staff is expensive, and non-native deer may also cause damage to private property.

Although eliminating axis and fallow deer would adversely affect some visitors, this adverse impact is not part of the natural or physical environment and so does not contribute to the environmental preferability of an alternative.

In contrast, either Alternative D or E would eliminate these impacts on natural and physical resources and either is considered environmentally preferred.

Section 101 of NEPA

The Council on Environmental Quality regulations requires that an EIS discuss how each alternative achieves the requirements of sections 101 and 102(1) of the National Environmental Policy Act. These sections state that federal agencies should, through the selection of the alternative to be implemented, attempt to:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. Assure for all visitors safe, healthful, productive, aesthetically and culturally pleasing surroundings;

3. Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;
4. Preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
5. Achieve a balance of population and resource use which would permit high standards of living and a wide sharing of life's amenities; and
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Alternatives D and E perform best on criteria 1-4, as each of these alternatives maximizes the potential for restoring the wilderness ecosystem at the Seashore and so promotes sustainability (criterion 1), reduces the degradation non-native deer cause now (criterion 3) and best preserves the important natural aspects of the national heritage represented by Point Reyes National Seashore and Golden Gate National Recreation Area. Criteria 5 and 6 are less applicable, although some visitors might believe that the viewing axis or fallow deer in the park is one of life's amenities. For these visitors, Alternatives A, B and C may be better. For others who prefer to recreate in the most natural environment possible, the elimination of non-native deer in Alternatives D and E would better represent one of life's amenities. Criterion 6 is not applicable to this planning effort.

Section 102(1) of NEPA indicates alternatives should follow laws and policies of the land. This is addressed in the table "Summary of Alternatives."

Park's Preferred Alternative

NEPA requires an agency to identify its preferred alternative, if one exists, in the draft EIS. The park's superintendent, in consultation with park staff, makes this identification. It is the alternative that will best fulfill the park's statutory mission and responsibilities, considering economic, environmental, and technical factors. It is also the alternative that best accomplishes the purpose and need for federal action (as stated in the Purpose and Need section).

Although both Alternatives D and E accomplish all four of the Seashore's stated objectives for non-native deer management, eradicating axis and fallow deer from the park by 2020, and complying with all relevant legislation and policies, Alternative E is the park's preferred alternative. Through the use of experimental long-acting contraceptives, Alternative E may reduce the total number of deer requiring lethal removal. Lower levels of culling would mitigate some, though not all, of the concerns of animal rights proponents who consider the killing of animals to be morally offensive. This mitigation comes at the price of slightly increased safety risks to NPS staff responsible for capturing and treating animals on contraception.

Alternative E also results in increased costs to the park over Alternative D. However, Alternative E will expand current knowledge about long-term reproductive intervention in wild ungulates. The preferred alternative presents an opportunity for long-term study of the use of potential sterilants in controlling overabundant or unwanted ungulates under free-ranging conditions. Issues of wildlife overabundance often arise in areas where lethal removal is difficult or impossible because of firearms restrictions or public safety concerns. Information obtained from Alternative E could benefit land-management agencies and zoological parks nationwide.

Table 3. Summary of Impacts of Each Alternative

	Alternative A: No Action	**Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal**	**Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control**	**Alternative D: Removal of All Non-Native Deer by Agency Personnel**	**Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control**
Water Resources and Water Quality	Reduced riparian vegetation will lead to increased streambank erosion, banking and sedimentation.	Short-term, lower total non-native deer numbers will alleviate current adverse impacts.	All impacts would be the same as Alternative B.	Short-term, lower total non-native deer numbers will alleviate current adverse impacts within Seashore boundaries.	All impacts would be the same as Alternative D.
	Ultimate results are moderate and localized, long-term decreases in water quality and degraded aquatic habitat over larger areas of the Seashore and outside NPS boundaries.	Continued destruction of riparian vegetation, albeit at lower levels than currently observed, will lead to long-term streambank erosion, banking and sedimentation.		Short-term expansion of deer populations into private inholdings could result from NPS culling operations.	
	Adverse cumulative impacts throughout Marin and Sonoma Counties could possibly increase in intensity over time to major levels.	Ultimate results are minor long-term adverse impacts in the form of decreased water quality and degraded aquatic habitat.		Long-term, non-native deer eradication could result in moderate beneficial impacts on hydrologic process, aquatic habitat, and water quality in the Seashore.	
		Cumulative impacts are adverse, and minor.		No cumulative impacts would occur	
Soil	In areas where deer congregate, increased compaction and erosion will result in minor, adverse, long-term impacts over larger areas of the Seashore and outside NPS boundaries.	Short-term, lower total non-native deer numbers will alleviate current adverse impacts.	Same as Alternative B.	Short-term, lower total non-native deer numbers will alleviate current adverse impacts.	Same as Alternative D.
		In areas of high deer density, continued denudation and compaction will result in erosion.		Short-term expansion of deer populations into private inholdings could result from NPS culling operations.	

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
	Adverse long-term cumulative impacts throughout Marin and Sonoma Counties could possibly increase in intensity over time to major levels.	Ultimate results are adverse, minor and long-term.		Long-term, soil in the Vedanta property, like those within the Seashore, will benefit to a minor extent from non-native deer eradication.	
		Cumulative impacts are adverse, minor and long-term.		No cumulative impacts to soils would occur	
Vegetation	Increased loss of understory and riparian vegetation, and reduced vegetative biomass in areas of high deer density will result in moderate, long-term adverse impacts over larger areas of the Seashore and outside NPS boundaries.	Because it will reduce total numbers and range of non-native deer in the Seashore in the short-term, Alternative B will result in some reduction of current minor localized adverse impacts to vegetative processes, habitat, and plant diversity.	Same as Alternative B.	In both the short-term and long-term, Alternative D will result in minor localized beneficial impacts to vegetative processes, habitat, and plant diversity.	Same as Alternative D.
	Adverse long-term cumulative impacts throughout Marin and Sonoma Counties could possibly increase in intensity over time to major levels.	Long-term, maintaining non-native deer in the Seashore will result in persistence of these adverse impacts at a minor level.		A short-term influx of non-native deer populations into the Vedanta Property from NPS lands as a result of the lethal removal program could cause minor adverse impacts to riparian vegetation there.	
		Cumulative impacts are adverse, minor and long-term.		Cumulative impacts are beneficial.	

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
Wildlife	Increased resource and behavioral competition with native cervids will result in decreased herd growth and reduced range of native species.	If chosen target levels are 350 for each species, axis deer populations and range will increase and fallow deer populations and range will decrease from current levels.	Same as Alternative B. This alternative would cause less pain and suffering to deer from culling than Alternative B. However, pain and suffering would result from some level of culling and the capture required for reproductive intervention.	Overall, Alternative D would result in moderate, long-term beneficial impacts to most native species by reducing current levels of competition for food, by decreasing direct behavioral competition, and by reducing habitat destruction.	Same as Alternative D. This alternative would cause less pain and suffering to deer from culling than Alternative D.
	Increased resource competition with some small mammal species will lead to decreased numbers as well as reductions in predators dependent on those species.	The shooting of non-native deer would cause a measure of pain and suffering to culled animals.		The shooting of non-native deer would cause a measure of pain and suffering to culled animals.	However, pain and suffering would result from some level of culling and the capture required for reproductive intervention.
	Localized reduction of forest understory, riparian and grassland cover will reduce nesting success in some bird species and adversely impact some herpetofauna.	Because it will reduce total numbers and overall range of non-native deer in the Seashore, Alternative B will result in some short-term reduction in current impacts to native species, by reducing competition for food, decreasing direct behavioral competition, and reducing habitat destruction.		Short-term, it is likely that deer densities on the Vedanta Property would increase as a result of lethal removals in the Seashore.	
	Increased non-native deer range would have negligible or beneficial impacts on a few bird and small mammal species however; "losers" would substantially outnumber "winners".				
	Adverse long-term cumulative impacts throughout Marin and Sonoma Counties could possibly increase in intensity over time to major levels.	Long-term, maintaining non-native deer in the Seashore will result in persistence of these moderate impacts, adverse for a preponderance of species and beneficial for a few species.		Short-term, native species richness and diversity would likely decrease in those high-density areas.	

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
	Overall, impacts are adverse, moderate and long-term.	Cumulative impacts are adverse, moderate and long-term.		No cumulative impacts would occur	No cumulative impacts would occur
Special Status Species	Adverse impacts to northern spotted owls are possible because of forage competition between non-native deer and owl prey species.	Because it will reduce numbers and range of fallow deer in the Seashore in the short-term, Alternative B will result in some reduction of current minor to moderate, localized adverse impacts to listed plants, northern spotted owls, California red-legged frogs, Coho salmon, California freshwater shrimp, steelhead trout and listed songbirds.	Same as Alternative B.	Alternative D will result in elimination of impacts (due to habitat alteration and forage competition) from non-native deer on listed plants, California red-legged frogs, northern spotted owls, snowy plovers, Coho salmon, steelhead trout, California freshwater shrimp, Myrtle's silverspot butterflies and listed songbirds.	Same as Alternative D.
	Disturbance and alteration of habitat by deer could adversely impact California freshwater shrimp, snowy plovers, California red-legged frogs, Coho salmon, steelhead trout and listed songbirds.	Adverse impacts to Myrtle's silverspot butterfly through destruction of larval host plants will likely continue if axis deer numbers increase (i.e. to 350).		Beneficial impacts of this alternative are long-term, and depending on the species of concern, are considered minor to moderate in intensity.	
	Increased grazing of larval host plants will adversely impact Myrtle's silverspot butterflies. Trampling and grazing in high deer density areas could adversely impact listed plant species.				

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
	Adverse long-term cumulative impacts throughout Marin and Sonoma Counties could possibly increase in intensity over time to major levels.	Long-term, maintaining non-native deer in the Seashore will result in persistence of minor to moderate adverse impacts to special status species.			
	Overall, impacts are adverse, moderate and long-term.	Depending on the species, adverse, long-term cumulative impacts could range from mild to moderate.		Cumulative impacts would be the same as No Action	
Human Health and Safety	Increasing densities of non-native deer could increase the risk of deer-vehicle collisions.	Decreased total numbers of non-native deer will decrease the risk of deer-vehicle collisions.	Decreased total numbers of non-native deer will decrease the risk of deer-vehicle collisions.	Eradication of non-native deer will decrease the risk of deer-vehicle collisions.	Eradication of non-native deer will decrease the risk of deer-vehicle collisions.
	Use of aircraft to monitor deer numbers or range expansion will increase the risk of aircraft accidents.	Use of firearms to control deer could pose an increased risk of injury to staff and visitors.	Use of firearms to control deer could pose an increased risk of injury to staff and visitors.	Use of firearms to control deer could pose an increased risk of injury to staff and visitors.	Use of firearms to control deer could pose an increased risk of injury to staff and visitors.
			Capturing deer for contraceptive treatment could result in injuries to park staff.		Capturing deer for contraceptive treatment could result in injuries to park staff.
	Impacts are adverse, minor and long-term.	Overall impacts are adverse, minor and short-term although they recur indefinitely.	Overall impacts are adverse, minor to moderate and short-term although they recur indefinitely.	Overall impacts are adverse, short-term and minor.	Overall impacts are adverse, minor to moderate and short-term.
	No cumulative impacts.	No cumulative impacts	No cumulative impacts	No cumulative impacts would occur	

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
Visitor Experience	Native deer viewing opportunities will decrease while non-native deer viewing opportunities will increase.	Opportunities for viewing non- native deer will decrease while opportunities for viewing native deer will likely increase.	Same as Alternative B.	Opportunities for viewing non-native deer will decrease while opportunities for viewing native deer will likely increase.	Same as Alternative D.
		Loss of peace and quiet resulting from deer control operations may result.		Loss of peace and quiet resulting from deer control operations may result.	
		Temporary area closures may inconvenience visitors.		Temporary area closures may inconvenience visitors.	
		Visitors to wilderness may encounter deer carcasses.		Visitors to wilderness may encounter deer carcasses.	
	Viewsheds will be adversely impacted from increased non-native deer grazing.	Visitors adhering to belief in animal rights will be adversely affected, to varying degrees and for varying periods of time, by lethal removal of non-native deer.	In addition, visitors may object to seeing permanently marked deer in the wilderness.	Visitors adhering to belief in animal rights will be adversely affected, to varying degrees and for varying periods of time, by lethal removal of non-native deer.	In addition, visitors may object to seeing permanently marked deer in the wilderness.
	Impacts are both adverse and beneficial, minor and long-term.	Impacts are both adverse and beneficial, minor and long-term.		Adverse impacts are minor and short-term. Beneficial impacts are minor and long-term.	
	No cumulative impacts	Cumulative impacts are adverse, minor and long-term.	Cumulative impacts are adverse, minor and long-term	Cumulative impacts are adverse.	Cumulative impacts would be the same as Alternative D
Park Operations	Increased costs of monitoring non-native deer and their impacts to natural resources will greatly exceed current levels of $140,000 per year, indefinitely.	Costs of monitoring non-native deer and their impacts to natural resources will continue indefinitely at current levels of $140,000 per year.	Costs of monitoring non-native deer and their impacts to natural resources will continue indefinitely at current levels of $141,000 per year.	The costs of culling deer are estimated to be $115,000 per year until eradication in or before 2020.	The costs of culling deer are estimated to be $115,000 per year until eradication in or before 2020.

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
		The costs of culling deer yearly for the first 3-5 years of the program are estimated to be $187,000 per year. Thereafter, costs of removing up to 65 animals per year would be approximately $52,000 per year in perpetuity.	The costs of culling deer yearly during the first 3-5 years of the program are estimated to be $ 135,000 per year. Thereafter, costs of removing up to 25-50 animals per year could reach $ 45,000 per year in perpetuity.	The costs of monitoring non-native deer and mitigating their impacts ($141,000) will be incurred initially, then decrease to 0 as non-native deer are eradicated.	The costs of treating does with a lifetime-effect contraceptive (if available) in year 1 of the program are estimated to be $210,000.
	Continued costs of mitigating non-native deer impacts to natural resources are unknown and will continue indefinitely.	Continued costs of mitigating non-native deer impacts to natural resources are unknown and will continue indefinitely.	Continued costs of mitigating non-native deer impacts to natural resources are unknown and will continue indefinitely.		Costs of monitoring treated animals in future years would be approximately $45,000 per year for the next 6-12 years (lifetime of treated animals).
					Should contraceptive agents remain effective for less than the reproductive life of the does, the cost of treating animals will be significantly higher.
			Treating 176 does at 350 with a lifetime-effect contraceptive (if available) by 2020 would cost approximately $400,000. Thereafter, treatment of up to 25-50 does periodically (every 4-8 years indefinitely) would cost up to $105,000 per treatment period.		The costs of monitoring non-native deer ($141,000) will be incurred initially, then decrease to 0 as non-native deer are eradicated.

	Alternative A: No Action	**Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal**	**Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control**	**Alternative D: Removal of All Non-Native Deer by Agency Personnel**	**Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control**
	Because of limited resources, increased expenditures for deer management could adversely impact other natural resource programs. Increased risk of litigation due to expansion of non-native deer outside park boundaries could cost at least $50,000.	Because of limited resources, increased expenditures for deer management could adversely impact other natural resource programs.	Because of limited resources, increased expenditures for deer management could adversely impact other natural resource programs.	Because of limited resources, increased expenditures for deer management could adversely impact other natural resource programs.	Because of limited resources, increased expenditures for deer management will likely adversely impact other natural resource programs.
	Minimum total cost = $2.1 million by 2020. Thereafter, minimum yearly costs = $140,000 to $280,000, indefinitely.	Minimum total cost = $3.5 million by 2020. Thereafter yearly costs > $190,000 , indefinitely	Minimum total cost = $3.6 million by 2020. Thereafter yearly costs > $200,000, indefinitely.	Minimum total cost = $3.8 million by 2020. Thereafter yearly costs = 0.	Minimum total cost = $4.5 million by 2020. Thereafter yearly costs = 0.
	Costs will increase to 5% of total PRNS budget.	Costs will constitute an increase of 3%-6% of total PRNS budget.	Costs will constitute an increase of 3%-12% of total PRNS budget.	Costs will constitute an increase of 4.6 % of total PRNS budget.	Costs will constitute an increase of 5%-9% of total PRNS budget.
				Short-term impacts are minor and adverse.	Short-term impacts are moderate and adverse.
	Impacts are adverse, long-term and moderate.	Impacts are adverse, moderate in the short-term and minor in the long-term.	Impacts are adverse, moderate and long-term.	Long-term impacts are minor and beneficial.	Long-term impacts are moderate and beneficial.

	Alternative A: No Action	Alternative B: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal	Alternative C: Control of Non-Native Deer at Pre-Determined Levels by Agency Removal and Fertility Control	Alternative D: Removal of All Non-Native Deer by Agency Personnel	Alternative E: Removal of All Non-Native Deer by a Combination of Agency Removal and Fertility Control
	Cumulative impacts are adverse, long-term and moderate.	Cumulative impacts are adverse.	Cumulative impacts are adverse.	Cumulative impacts are adverse.	Cumulative impacts are adverse.
Regional Economy	Costs to ranchers and farmers within and outside NPS boundaries will exceed current levels due to increased forage competition with livestock, damage to fences and increased risk of disease transmission from high deer densities.	Adverse impacts of fallow deer to agricultural operations inside and outside of NPS boundaries could be expected to decrease.	Same as Alternative B.	Current adverse impacts of fallow deer to agricultural operations inside and outside of NPS boundaries could be expected to decrease until eliminated.	Same as Alternative D.
	Depredation of crops outside the Seashore will increase.	Conversely, if axis deer numbers increase (i.e. to 350), increased competition for pasture forage with livestock, damage to fences and depredation of agricultural products would result.		The elimination of forage competition with livestock, damage to fencing, and disease transmission risk would constitute minor, long-term, beneficial impacts to agricultural permitees within and adjacent to NPS boundaries.	
	Impacts are adverse, moderate and long-term.	Impacts are both adverse and beneficial, long-term and minor.			
	Adverse long-term cumulative impacts throughout Marin and Sonoma Counties could possibly increase in intensity over time to major levels.	Cumulative impacts are adverse, minor and long-term.		No cumulative impacts would occur	