CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Introduction

This chapter provides detailed discussion of the probable environmental consequences, or impacts, of implementing each of the five alternatives. The chapter begins with an explanation of how the impact topics were chosen, which impacts were dismissed from consideration and why. Terms used to define impact levels are defined. This is followed by a discussion of methods used to conduct the analysis and a description of the methods used to assess impacts for each impact topic (e.g., water quality, visitor experience, etc.), including relevant policies, regulations, and assumptions. Individual analysis of the impacts related to each alternative (A, B, C, D, and E) will include:

- identification of impacts associated with the various actions comprising the alternative;
- characterization of impacts, including their duration and intensity;
- available mitigation measures and the effectiveness of these measures on reducing impacts;
- assessment of cumulative impacts; and
- a summary of the impacts and an assessment of the potential for an alternative to impair resources (based on the National Park Service policy on impairment).

Impact Topics and Their Derivation

Resources for analysis were selected primarily because the actions in the alternatives have the potential to affect them, both in adverse and beneficial fashion. The impact topic is a very short summary (see Chapter 1) of the relationship between an action in a given alternative (capturing deer to treat with a contraceptive, for example) and a resource (water, air, etc.). Although impact topics are initially presented in the first chapter, the extent of damage or benefit from this relationship is analyzed in Environmental Consequences. In addition to Seashore staff developing impact topics, laws, regulations, and policies may require their discussion, and/or the public may have raised them during scoping. Impacts to the following resources will be addressed for each of the five alternatives:

- Water Resources and Water Quality
- Soils
- Vegetation
- Wildlife
- Special Status Species (e.g., threatened, endangered, rare or sensitive species)
- Human Health and Safety
- Visitor Experience
- NPS Management and Operations
- Regional Economy

All of these topics, with the exception of Human Health and Safety, were raised during public scoping from May 4, 2002 to July 5, 2002. For details on the particulars of public concerns, see Section 5.1 (History of Public Involvement).

Definition of Terms

The environmental analysis in this chapter includes the direct, indirect, and cumulative effects of the alternative actions on the environment.

Direct impacts - occur as a result of the alternative in the same place and at the same time as the action.

Indirect impacts - are reasonably foreseeable impacts that occur removed in time or space from the proposed actions. These are "downstream" impacts, future impacts, or the impacts of reasonably expected connected actions.

Cumulative impacts - are actions that, when viewed with other actions in the past, the present, or the reasonably foreseeable future, regardless of who has undertaken or will undertake them, have an additive impact on the resource this project would affect.

Impacts are described in three ways for each alternative: by impact type, impact duration, and impact intensity. For purposes of this analysis, these impact characteristics are defined as follows:

Type of impact - describes the specific elements that could be subject to impacts and the nature of those impacts. Impacts can be either beneficial or adverse.

Duration of impact - describes the relative length of time the impact would affect a given resource. Impacts can be either short-term or long-term, and are defined for some impact topics by a range of years. It is important to note that an action that has short-term adverse impacts on a resource may have long-term beneficial impacts on the same resource.

Intensity of impact - The intensity of impact provides a way to assess the relative importance of the impact. Each impact is described as negligible, minor, moderate, or major. These four qualitative designations are used for beneficial as well as adverse impacts.

Resource Impairment - At the end of each impact topic assessment is a statement regarding whether or not implementing the alternative would cause resource impairment. The NPS Organic Act of 1916 and the NPS General Authorities Act 1970, as amended, require park managers to ensure that park resources and park values remain unimpaired. Section 1.4.5 of the NPS Management Policies (2001) states: "The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values." The Management Policies further state:

> "An impact to any park resource or value may constitute an impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:
>
> > Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
> > Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
> > Identified as a goal in the park's general management plan or other relevant NPS planning documents.
>
> An impact would be less likely to constitute an impairment to the extent that it is an unavoidable result, which cannot reasonably be further mitigated, of an action necessary to preserve or restore the integrity of park resources or values."

Methodology

The methodology used to assess impacts will be discussed by resource. All impacts not dismissed from consideration will be discussed.

Water Resources and Water Quality

The water resources within the project area include a significant number of perennial and intermittent streams, human-made impoundments, wetlands, natural lakes and sag ponds. They support a variety of threatened and endangered species including coho salmon, steelhead trout, California freshwater shrimp, and California red-legged frog. Watershed storage capacity and water quality can be impacted by soil erosion and compaction caused by non-native deer and their management. Off road vehicles and stream or pond usage by large concentrations of deer can cause altered drainage patterns, degraded water quality, and increased sedimentation.

Policies, Regulations, and Assumptions

The Clean Water Act requires the NPS to "comply with all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution." The NPS Freshwater Resource Management Guidelines (found in NPS-77) requires the NPS to "maintain, rehabilitate, and perpetuate the inherent integrity of water resources and aquatic ecosystems."

NPS Management Policies 2001 states: "The Service will manage watersheds as complete hydrologic systems, and will minimize human disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams. These processes include runoff, erosion, and disturbance to vegetation and soil caused by fire, insects, meteorological events, and mass movements…The Service will achieve the protection of watershed and stream features primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded."

Assessment Methodology

The following three primary aspects of water resources were assessed when considering potential impacts:

- hydrology of the project area,
- aquatic habitat within the project area, and
- water quality.

Hydrology refers to hydrologic processes such as flooding, erosion, deposition, and maintenance of channel patterns. Aquatic habitat refers to the attributes that support or provide habitat within stream or pond systems. Water quality refers to the suitability of surface water for beneficial use, including cold-water or warm-water aquatic wildlife habitat and recreational use. Relative to water quality, Tomales Bay and Lagunitas Creek have been listed as impaired (impaired has a different meaning in the National Park Service) by the San Francisco Regional Water Quality Control Board for sediment, nutrients and pathogens. Particular consideration was given to actions with potential to affect the natural hydrology, aquatic habitat features, and surface water quality of cold-water streams. Specific watersheds supporting cold-water aquatic habitat include Lagunitas Creek, Olema Creek, Pine Gulch Creek, and most coastal

drainages originating from Inverness Ridge. Also of concern are pond features that are considered breeding habitat for the California red-legged frog. Ponds are located throughout the project area.

Generalized information from the literature regarding the types of effects and their magnitude to water quality and streamflow characteristics from ungulate grazing were used to estimate impacts to park water quality or hydrology from non-native deer. Anecdotal information from observations by park staff on the impacts of non-native deer congregating near streams was also used. Data on the presence or absence of species sensitive to sedimentation in Seashore streams was integrated into the analysis to show where particular concerns to water quality or aquatic habitat from grazing by non-native deer are likely.

Type of Impact

Adverse: would alter natural hydrologic conditions (e.g., impede flood flows, cause unnatural erosion or deposition, etc.), degrade water quality (e.g., increase pollution or bacteria levels from recreational use), or degrade aquatic habitat.

Beneficial: would restore natural hydrologic conditions (e.g., remove impediments to flood flows, stabilize riverbanks, etc.), improve water quality (e.g., reduce non-point source pollution), or improve or maintain aquatic habitat

Duration of Impact

Short-term: would last two years or less.

Long-term: would last longer than two years.

Note: Since full implementation of an alternative would take place over a number of years, this section considers the duration of individual actions within each alternative (e.g., control of non-native deer by lethal means or reproductive control) as well as full implementation of the alternative (e.g., eradication of non-native deer from the Seashore).

Intensity of Impact

Negligible: would be imperceptible or not detectable.

Minor: would be slightly perceptible, without the potential to expand if left alone; and would be localized (i.e., would occur in the immediate vicinity of an action).

Moderate: would be apparent locally and would have the potential to become larger or regional.

Major: would be substantial, highly noticeable, and regional (i.e., would occur over a large area, such as the Tomales Bay watershed, or Point Reyes National Seashore).

Soils

Soils might be affected through direct mechanical compaction, and indirectly through reduction of overlying vegetation.

Policies, Regulations, and Assumptions

NPS Management Policies 2001 states "The Service will actively seek to understand and preserve the soil resources of parks, and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil…." In addition, NPS-77 (Natural Resource Management Guidelines) lists the following objectives for the protection of soils within different management zones:

Natural zone:	preserve natural soils and the processes of soil genesis in a condition undisturbed by humans.
Cultural zone:	conserve soil resources to the extent possible consistent with maintenance of the historic or cultural scene and prevent soil erosion wherever possible.
Development zone:	ensure that developments and their management are consistent with soil limitations and soil conservation practices.
Special use zone:	minimize soil loss and disturbance caused by special use activities, and ensure that soils retain their productivity and potential for reclamation.

In addition, soils that are identified as "hydric," which often are a feature of wetlands, are protected by policies such as Director's Order #77-1, Wetland Protection. Hydric soils usually form under wet conditions sufficient to develop anaerobic conditions and support hydrophytic vegetation.

Assessment Methodology

The methodology for assessing impacts to soils was to use the scientific literature and information on the soils in the Seashore that might be affected by non-native deer. No information on the specific impact of axis or fallow deer on soils in the Seashore is available, therefore, information on impacts of other species of deer or ungulates on soils generally was used. Soil types and characteristics of soil in the area of the Seashore occupied by fallow and axis deer was information folded into the analysis to determine broadly where erosion or compaction might be more likely.

Type of Impact

Beneficial:	would protect or restore chemical, physical, abiotic, or biotic soil components.
Adverse:	would result in degradation of chemical, physical, abiotic, or biotic soil components.

Duration of Impact

Short-term:	could be restored when project activities are completed and would last 10 years or less.
Long-term:	would last more than 10 years.

Intensity of Impact

Negligible:	would be imperceptible or not detectable.

Minor: would occur on less than 100 acres of ground.

Moderate: would occur on 100-500 acres of ground.

Major: would occur on over 500 acres of ground.

Vegetation

Vegetation can be impacted directly by non-native deer management; as a result of trampling, grazing or browsing by deer or as a result of human or vehicular trampling in large-scale deer capture or culling operations. Vegetation can also be indirectly impacted by deer effects on competition between plant species, dispersion of weeds via deer gastrointestinal tracts, and changes in grazing pressure that might alter vegetative landscapes. Indirect impacts from capture or culling operations would also include increased potential for the dispersal of non-native plant seed and vegetative propagules.

Policies and Regulations

NPS Management Policies 2001 state "The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The policies go on to state that the above statement includes flowering plants, ferns, mosses, lichens, algae, fungi, and microscopic plants. The NPS is to preserve and restore the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of these native species. In addition, the NPS is mandated to prevent the introduction of exotic (non-native) species into units of the National Park System. The policy manual NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on vegetation management.

Assessment Methodology

Vegetation in the park was digitally mapped using aerial photographs in 1999/2000 as part of the development of a park-wide vegetation map. Field data on plant species composition were subsequently collected to characterize and classify the plant communities delineated in this mapping effort. The classification describes the vegetation alliances and associations found in the park (including all acreage delineated as non-native deer range), and are based on the classification system under National Vegetation Classification Standards (NVCS). For purposes of this document, alliances and associations found in the study area have been grouped together into 10 broad vegetation classes that are described in Chapter 2.

Vegetation communities utilized by axis and fallow deer was calculated using the park vegetation map Geographic Information System (GIS) coverage in combination with the most recent non-native deer range maps. The current range maps were developed using non-native deer sightings from 2000-present. By overlaying each coverage, each vegetation community could be quantified by acreage. Again, this does not provide any temporal information specific to how intensely each community is used, only the types of communities where non-native deer have been observed.

In addition, in a study conducted by Humboldt State University since 2000, analysis of ungulate fecal pellets will allow description and comparison of tule elk and fallow deer diets in the Limantour area of the Seashore. Description of the vegetation types used as forage by these species, as well as information obtained in the literature, should allow a determination of impacts to vegetation.

Beyond this site-specific information, the literature was consulted for information generally about the impacts of deer on vegetation communities.

The following parameters were used in the evaluation of impacts on vegetation:

- the vegetation class that would be affected (e.g., Bishop pine forest);
- the abundance or rarity of the vegetation class in the study area and in the region; and
- the presence, abundance, and species richness of non-native plants within, or adjacent to the vegetation classes affected.

The abundance, or areal extent, of the vegetation class is important when considering project impacts because the Seashore is mandated to protect and maintain all native plant communities. If a vegetation class is very rare in the project area or the region, such as riparian woodland, adverse impacts to the vegetation class become more significant.

Type, duration, and intensity of vegetation impacts are described as follows:

Type of Impact

Beneficial: would increase the size, continuity, or native species richness of a plant community, or would decrease invasive non-native plant species abundance or richness.

Adverse: would decrease the size, continuity, or native species richness of a plant community, or would increase invasive non-native plant species abundance or richness.

Duration of Impact

Short-term: would be measurable for less than two years; plant composition, productivity, and reproduction would change initially, then return to pre-project conditions.

Long-term: would be detectable for longer than two years; plant composition, productivity, and reproduction would change and these changes would persist post-project.

Intensity of Impact

Negligible: would result in no measurable or perceptible changes in plant community size, continuity, of native or non-native species richness.

Minor: would be measurable or perceptible but would be localized within a relatively small area; the overall viability of the plant community would not be affected.

Moderate: would cause a measurable and perceptible change in the plant community (e.g., size, continuity, or native or non-native species richness), but the impact would remain localized and the change could be reversed.

Major: would be substantial, highly noticeable, and could irreversibly change (i.e., be permanent) plant community size, continuity, or species richness.

Wildlife

Wildlife can be impacted in a number of ways by non-native deer management. Directly, wild animals can be injured or killed during deer capture, monitoring or management operations. Indirectly, through destruction of habitat and competition for required resources, animals can be impacted by changes in the abundance and range of non-native deer.

Policies and Regulations

NPS Management Policies 2001 state: "The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The policy statement includes bacteria, mammals, birds, reptiles, amphibians, fishes, arthropods, worms, and microscopic animals. The NPS is to preserve and restore the natural abundance, diversities, dynamics, distributions, habitats, and behaviors of these native species. Maintaining of genetic diversity "to increase the variability of the park gene pool" is required. In addition, the NPS is mandated to prevent the introduction of exotic (non-native) species into units of the National Park System.

The policy manual NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on wildlife management. Management should strive to perpetuate natural ecosystems through maintaining or restoring natural processes to the extent practically feasible. Specifically, " maintaining, restoring, or simulating natural processes is a more realistic goal than is the pursuit of a hypothetical static situation that is unachievable and may even be undesirable."

The NPS also is required to comply with the Fish and Wildlife Coordination Act; the Marine Mammal Protection Act; the Bald and Golden Eagles Protection Act; the Wilderness Act; the Convention on International Trade in Endangered Species; and maritime and other international agreements. The NPS also is required to comply with The Migratory Bird Treaty Act (1918), which prohibits taking, killing or possessing migratory birds, nests or eggs. And, as a refuge for tule elk, Point Reyes National Seashore is directed to participate in a Federal/State cooperative program for preservation and enhancement of tule elk in California under the Tule Elk Preservation Act (1976)

The 1978 Tule Elk Preservation Act (16 USC 673d) is a state-specific act that directs a Federal/State cooperative program for preservation and enhancement of tule elk in California. It requires the Secretary of the Interior to "cooperate with the State of California in making lands under (his/her jurisdiction) reasonably available for the preservation and grazing of tule elk in such manner and to such extent as may be consistent with Federal Law."

Assessment Methodology

Impacts on wildlife, within Point Reyes National Seashore have been assessed in terms of the following:

- changes to wildlife habitat, including food source, water source and cover or nesting habitat;
- changes in the number of wildlife species (species richness);
- changes in the number of individuals in a wildlife species;
- changes in the productivity or growth of a species;
- changes in the range of a species; and
- changes in the genetic variability within a population or sub-population.

Some information specific to this analysis has been collected for wildlife at the Seashore; for example, dietary overlap information for non-native deer and black-tailed deer is available. However, the literature

was consulted for information about the effects of fallow and axis deer on wildlife and wildlife habitat when site specific data were not available.

Type of Impact

Adverse: would result in unnatural changes in survival or reproduction, viability of a population or species, unnatural distribution of available resources or habitat.

Beneficial: would result in protection or restoration of viability of a population or species, or natural distribution of available resources or habitat.

Duration of Impact

Long-term: would last two years or longer. This represents two breeding cycles for native ungulates, many bird species and most medium and large carnivores in the Seashore, all of which will be considered in the impact discussion. Two years represents at least two breeding cycles for most small mammals, amphibians and reptiles, which will be considered in the impact discussion. Impacts to more than two breeding cycles is considered long-term.

Short-term: would be expected to last for less than two years. See rationale for the two year definition above.

Intensity of Impact

Negligible: would not be measurable or perceptible.

Minor: would be measurable or perceptible and would be localized within a relatively small area or portion of the species range within the Seashore. The overall viability of the resource or population would not be affected. After the initial occurrence, the adverse effects would be fully reversible.

Moderate: would be sufficient to cause a change in the resource or population (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized in the Seashore. The change would be measurable, but negative effects could be reversed with active management, and the resource or population could recover within the Seashore.

Major: would be substantial, highly noticeable, measurable, and potentially irreversible (permanent). The resource or population would be unlikely to recover within the Seashore with or without active management.

Species and Habitats of Management Concern

Numerous species of plants and animals have undergone local, state, or national declines, which has raised concerns about their possible extinction if they are not protected. Many of the plant and wildlife species, and habitats present in the project area are granted special protection through listing by the US Fish and Wildlife Service (USFWS) and/or the State of California. The Marine Mammal Protection Act and the Migratory Bird Treaty Act afford additional protection.

Policies and Regulations

The U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) have established lists that reflect the species' status and the need for monitoring, protection, and recovery. In addition to federal and state-listed species, potential impacts to plants listed by the California Native Plant Society (CNPS) also are considered for all programs and activities that the Seashore undertakes. The Seashore also recognizes a number of species as locally rare or of special concern, even though they are not officially listed. Collectively, species in all of these categories are referred to in this document as "special-status species."

The Federal Endangered Species Act (ESA) of 1973, as amended, requires federal agencies to consult with the USFWS before taking actions that (1) could jeopardize the continued existence of any federally listed plant or animal species (e.g., listed as threatened or endangered) or species proposed for listing, or (2) could result in the destruction or adverse modification of critical or proposed critical habitat. The USFWS provided upon request a list of species that must be considered for this DEIS.

The Council of Environmental Quality Regulations for Implementing the National Environmental Policy Act (Section 1508.27) also requires federal agencies to consider if an action could violate federal, state, or local laws or requirements imposed for the protection of the environment. For this reason, species listed under the California Endangered Species Act (i.e., those considered endangered or threatened) by the California Department of Fish and Game are included in this analysis. Species proposed for listing in either of the two categories are also included.

NPS Management Policies (2001) state: "The National Park Service will identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats.... The National Park Service also will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks, and their critical habitats.... All management actions for protection and perpetuation of special status species will be determined through the park's resource management plan."

In addition, park managers are to ensure that park operations do not adversely impact endangered, threatened, candidate, or sensitive species and their critical habitats, within or outside the park and must consider federal and state listed species and other special-status species in all plans and NEPA documents (NPS-77 Natural Resource Management Guidelines).

NPS-77 states: "The following legislation, policies, and agreements provide the authority for NPS policies on management of threatened and endangered species: the Endangered Species Act; state-specific endangered species acts; other state wildlife statutes or agreements pursuant to Section 6, ESA; the Migratory Bird Conservation Act; the Fish and Wildlife Coordination Act; the Wild and Scenic Rivers Act; the Marine Mammal Protection Act; the Bald and Golden Eagles Protection Act; the Wilderness Act; the Convention on International Trade in Endangered Species; and maritime and other international agreements."

The USFWS usually takes lead Departmental responsibility for coordinating and implementing provisions of the Endangered Species Act for all listed endangered, threatened, and candidate species, particularly for all terrestrial plants and animals and freshwater aquatic species. The National Marine Fisheries Service (NMFS) is responsible for listed marine mammals such as Cetacea (all whales and porpoises), Pinnipedia (Steller sea lions, Hawaiian monk seals, etc.), and anadromous fish (steelhead, coho salmon, etc). In each instance discussed below, where the listed species in question is a fish, whale or pinniped, the term "FWS" might more accurately read "NMFS" or "NMFS and FWS." This is particularly true for

any activity that may involve the "taking" of a marine mammal of special status fish species such as threatened coho salmon and steelhead trout.

The federal, state, and CNPS categories for special-status species are defined as:

Federal endangered: Any species that is in danger of extinction throughout all or a significant portion of its national range.

Federal threatened: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its national range.

California endangered: Any species that is in danger of extinction throughout all or a significant portion of its range in the state.

California threatened: Any species that is likely to become an endangered species with the foreseeable future throughout all or a significant portion of its state range.

California rare (plants only): A native plant that, although not currently threatened with extinction, is present in small numbers throughout its range, such that it may become endangered if its present environment worsens.

CNPS List 1A	Presumed Extinct in California
CNPS List 1B	Rare or Endangered in California and Elsewhere
CNPS List 2	Rare or Endangered in California, More Common Elsewhere
CNPS List 3	Need More Information
CNPS List 4	Plants of Limited Distribution

Assessment Methodology

Grazing by wild ungulates plays a role in the life history of many special-status species by removing understory and maintaining open habitat, encouraging reproduction in some species, and affecting competing species. Grazing can be detrimental to native plant species, especially when timing, frequency, and intensity are outside of the natural cycle to which the species is adapted (Archer and Smeins 1991). Grazing in California grasslands has been found to differentially affect various native life-history guilds such as annual or perennial forbs and grasses (Hayes and Holl 2003). Grazing can also indirectly affect protected wildlife at the Seashore by trampling and increasing the potential for siltation.

The following parameters have been used to evaluate the consequences of the various alternatives on special-status species:

- The species affected and its degree of local, regional, nationally and global rarity.
- The rarity of the genotype or subspecies, regionally, nationally, or globally.
- The numbers of animals or proportion of the species range affected by the action.

Type of Impact

Adverse:	likely to result in unnatural changes in the abundance or distribution of a special-status species. This could occur through direct disturbance, mortality, decreased reproduction, or through destruction or alteration of habitat.
Beneficial:	likely to protect and/or restore the natural abundance and distribution of a

special-status species. This could occur through increased survival, reproduction, or through increased availability of habitat or required resources.

Duration of Impact

Short-term: would immediately affect the population or species, but would have no long-term effects to population trends or species viability and a return to the original condition would occur within two generations of that species.

Long-term: would result in changes in the abundance and distribution of a special status species that persist for greater than two generations of that species or would lead to a loss in population or species viability—exhibited by a trend suggesting decline in overall species aerial extent or abundance.

Intensity of Impact

Negligible: imperceptible or not measurable (undetectable).

Minor: slightly perceptible and localized in extent; if inciting stimulus ceased (i.e., browsing of riparian vegetation by non-native deer), adverse impacts would reverse and the resource would recover.

Moderate: apparent, measurable, or sufficient to cause a change in the resources (e.g., abundance, distribution, quantity, or quality). Less localized within the Seashore than a minor impact. Adverse impacts would eventually reverse with cessation of inciting stimulus and the resource would recover.

Major: substantial, highly noticeable, or with the potential for landscape-scale effects and major irreversible population effects with or without cessation of inciting stimulus.

Human Health and Safety

Management of park wildlife, whether on federal lands or on private property, can involve inherent risks to the human health and safety to both visitors and staff. In a national park, wild animals can potentially cause disease transmission, vehicular accidents, or bodily injury to visitors or staff who come in direct contact with them. These risks are present whether or not wildlife are actively managed or not. These risks vary with the wildlife management technique used. Proposals analyzed ranges, ranging from capture, immobilization and treatment of animals to use of aircraft and culling with firearms, all of which can cause increased safety risks to managers and visitors. Management of deer also influences their population numbers and could contribute to the increase or reduction of auto/deer collisions.

Policies and Regulations

The National Park Service has a continuing concern about the health and safety of its employees and others who spend time in the parks. Several proposed deer management actions have the potential to increase risk to human health and safety; policies and regulations related to this proposal are summarized below. NPS Management Policies (2001) provide general guidance related to providing safe facilities and experience for the visiting public and park employees. The policy of the NPS is to protect the health and well-being of NPS employees and park visitors through the elimination or control of disease agents and

the various modes of their transmission to man and to ensure compliance with applicable Federal, State, and local public health laws, regulations and ordinances.

Implementation of this policy will be qualified by the Organic Act's requirement that the NPS conserve the scenery and natural and historic objects and the wildlife therein in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Various NPS Director's Orders (described below) provide specific policy guidance for specific components of park operations and management, some of which are specifically related to risk management (occupational safety and health of employees and visiting public) (see http://data2.itc.nps.gov/npspolicy/DOrders.cfm).

The primary focus of Director's Order #50B is the occupational safety and health of NPS employees. Visitor safety and health is the focus of Director's Order #50C.

Director's Order #83 outlines what the NPS will do to ensure compliance with prescribed public health policies, practices and procedures. This order establishes NPS policy with respect to all public health activities within areas of NPS jurisdiction, regardless of whether those activities are carried out by NPS or other Federal employees, or by other organizations, including the U.S. Public Health Service (PHS). Public health includes illnesses associated with drinking water, wastewater, food safety, animal vectors, animal reservoirs, hazardous wastes, indoor air pollution, institutional sanitation, radiation safety, medical wastes, solid wastes, air pollution, and other related areas of environmental health.

Use of firearms by NPS Law Enforcement and Resources Management staff is directed by Director's Order #9, Law Enforcement Program, and Director's Order #77, Natural Resources Management Guidelines, respectively. NPS requires firearms training and certification for all employees authorized to use firearms in the performance of their natural resource management duties. Firearms training must include safety, marksmanship, maintenance, storage, accountability, control, and security. Risk to human safety is further mitigated by the limiting of shooting operations to non-peak times in high-visitation areas—ideally, early and late in the day, an potentially, area closures.

The use of chemical sterilant drugs in wildlife has safety implications for staff that administer the drug and humans that inadvertently consume treated animals. Use of chemical sterilants and other experimental drugs is outlined in Director's Order #77, Natural Resources Management Guidelines, regulated by 21 CFR 511ff, and allowed only after New Animal Drugs for Investigational Use (INAD) permits have been issued by the Food and Drug Administration. NPS staff administering the drugs must receive a course of training as specified in Director's Order #77.

Director's Order #60 provides park managers direction on conducting a legal, safe, and cost effective aviation program, while minimizing adverse impacts that National Park Service (NPS) aviation activities may impose on park resources and visitor enjoyment. In addition, the use of aircraft in national parks for wildlife monitoring or management activities is in accordance with Federal Aviation Administration (FAA) regulations, as described in the 350-354 Department of the Interior Departmental Manuals.

Assessment Methodology

The effects of each alternative are evaluated by analyzing potential impacts to the health and safety of park visitors and employees. Specifically, the analysis assesses risks to human safety from the use of capture techniques, aircraft, firearms and contraceptive drugs and deer/vehicle collisions. The analysis does not review impacts to water systems that may be affected by sedimentation caused by increased

numbers of non-native deer with a No Action alternative or decaying carcasses as a result of management action. These impacts are discussed under the heading of Impacts on Water Resources and Water Quality.

Type of Impact

Beneficial: result in a reduction in human health and safety risks; or would improve human health or safety.

Adverse: result in additional or exacerbated human health and safety risks.

Duration of Impact

Long-term: have a permanent effect on human health and safety (i.e., contamination of a water source for domestic use).

Short-term: are temporary (less than one month) and are associated with transitional types of impacts (e.g., safety concerns related to risks of helicopter overflights of ranches or dwellings).

Intensity of Impact

Negligible: would not be detectable; increased safety risks are not measurable.

Minor: would be slightly detectable; increased safety risks are measurable but small and limited to few individuals.

Moderate: would be clearly detectable; increased safety risks could have an appreciable effect on human health and safety, in terms of magnitude of risk and number of people affected.

Major: would be clearly introducing a significant health hazard to large numbers of people, such as the introduction of a new disease or source of water pollution to a community.

Visitor Experience

This impact topic concerns not only the recreational opportunities at Point Reyes National Seashore (visitor access, permitted types of recreation) but also the character of the visitor experience as it pertains to what visitors perceive during their time at the Seashore. This experience can be affected by noise, visual distractions or other sensory intrusion resulting from project actions. Visitor experience can also be affected by perceived conflict between NPS management of resources and the social and ethical values of some visitors. An example of such a conflict is NPS wildlife control activities offending visitors who are animal welfare or animal rights proponents.

Visitor experience is also directly affected by actions influencing natural resources that constitute scenic resources (e.g., degradation of native plant communities could impact the visitor experience). Though impacts to these resources are not repeated in the analysis of visitor experience, enhancement or degradation of these resources also enhances or degrades the quality of the visitor experience. Impacts to

viewsheds are discussed under this impact topic. Grazing or the absence of grazing can change the vegetation in an area, affecting the visual appearance of a landscape.

Policies and Regulations

Soundscape preservation and noise management activities are subject to the policies contained in NPS *Management Policies* (2001). The portions of *Management Policies* that are most pertinent to this topic are: Chapter 1, Introduction; Chapter 4, Natural Resource Management; Chapter 5, Cultural Resource Management; Chapter 6, Wilderness Preservation and Management; and Chapter 8, Use of the Parks. Policies in the form of regulations covering general audio requirements are published in title 36, section 2.12, of the Code of Federal Regulations.

Director's Order #47, Soundscape Preservation and Noise Management, addresses the problem of excessive/inappropriate levels of noise. It directs park managers to: 1) measure baseline acoustic conditions, 2) determine which existing or proposed human-made sounds are consistent with park purposes, 3) set acoustic management goals and objectives based on those purposes, and 4) determine which noise sources are impacting the park and need to be addressed by management. Furthermore, it requires park managers to evaluate and address self-generated noise.

NPS *Management Policies* also specify that visitor activities that are appropriate to the park environment will be encouraged, whereas those that would impair park resources or are contrary to the purposes for which the park was established, will not be permitted. In reference to area closures, the *Management Policies*, as well as 36 CFR 1.5, allow superintendents to temporarily or permanently close a specific area to prevent unacceptable impacts to park resources and to protect visitor safety. Section 8.4 of the NPS *Management Policies* (2001) mandates that all necessary steps be taken to avoid or mitigate adverse effects from aircraft overflights in order to reduce adverse effects on resources and visitor enjoyment.
The issue of social values is a component of the visitor experience, as it relates to wildlife management actions ranging from behavior modification techniques to capture or killing of animals. It is an important and complex topic as the interpretation of what constitutes harm or suffering to an animal varies from person to person, with different people perceiving the humaneness of any given action differently (USDA 1997). In the past, some individuals and interest groups have objected to certain management techniques proposed by NPS units for management of non-native wildlife (Sellars 1997). A number of animal rights and welfare organizations and private individuals raised issues during public scoping for this document (see Chapter 5, Consultation and Coordination). All action alternatives contain options for proposed management of non-native deer within the Seashore and include either lethal removal through the use of firearms or the combination of the use of contraceptive and lethal removal techniques. Some members of the public may find proposed options objectionable for a variety of reasons related to social values (e.g., techniques are inappropriate; techniques are inhumane; management is not necessary). All alternatives considered in this DEIS require measures to minimize animal suffering and eliminate unnecessary pain and suffering to every extent possible (see Actions Common to All Alternatives).

There are no specific federal directives for NPS regarding social values related to animal welfare or animal rights. NPS management of wildlife, as described in *Management Policies* (NPS 2001), is based on a biocentric ethic and not on single animals. The role of animal populations and species within the ecosystem, rather than individuals, is the focus. This "land ethic", as described by Aldo Leopold, can be seen as: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1970). NPS *Management Policies* mandate that NPS will maintain all native plants and animals as parts of the natural ecosystems of parks (NPS 2001). In addition, rather than managing to preserve individual species, NPS will try to maintain all the

components and processes of naturally evolving park ecosystems while keeping all intervention to the "minimum necessary" to achieve stated management goals (NPS *Management Policies*, Section 4.1).

NEPA does not consider animal rights or animal welfare to be an environmental issue or resource element. However, animal welfare issues were raised during public scoping. As an ethic held by a certain segment of the public, belief in animal rights and animal welfare can be considered part of the human environment and are therefore discussed as a part of the visitor experience. In addition, pain and suffering caused by proposed actions to individual animals are considered in the analyses of impacts to wildlife.

Assessment Methodology

The effects of each alternative are evaluated by analyzing potential impacts to visitor experience. The analysis assesses impacts to visitor recreation and enjoyment of the Seashore from the use of aircraft, firearms, and various wildlife management techniques.

Type of Impact

Beneficial: result in an increase in visitor enjoyment and recreational opportunities.

Adverse: result in a decrease in visitor enjoyment and recreational opportunities.

Duration of Impact

Long-term: have a permanent effect on visitor enjoyment of the Seashore.

Short-term: are temporary (less than one month) and are associated with transitional types of impacts (e.g., temporary area closures).

Intensity of Impact

Negligible: would not be detectable by the vast majority of visitors.

Minor: would be detectable by a few visitors; impacts to the visitor experience are measurable but considered mild.

Moderate: would be clearly detectable by many visitors; impacts to the visitor experience are measurable and considered mild to moderate.

Major: would be clearly detectable by many visitors; the impacts to the visitor experience are considered to be major and would clearly affect visitation rates at the Seashore.

NPS Management and Operations

This topic addresses the effects on PRNS from the costs and staffing requirements of the proposed actions. It also addresses energy consumption and conservation potential of each alternative. Direct impacts are due to changes in funding and personnel while indirect impacts are caused by requirements for administrative support, office space, vehicles and energy use. PRNS currently has about 116 full-time employees (FTEs) and a total operations budget of $5.67 million

The operating budget for the PRNS ungulate management program in FY 2002 was $113,000. An additional $100,000 was made available through fee funds and grants earmarked for specific management projects. Staffing for the ungulate management program is 3.0 FTE's.

Policies and Regulations

Congress established the National Park Service (NPS) in 1916. To fulfill its mission, the NPS receives funding from both the federal appropriations process and other federal revenue sources.

Like most federal agencies, the NPS relies on federal appropriations to fund its core activities, although there is increasing use of alternative revenue sources, such as fees, to supplement operations. The NPS requests direct congressional funding and reports on the use of other federal funds through an annual budget document submitted to Congress entitled "Budget Justifications," or more popularly called, the "Green Book."

The implementing regulations of the National Environmental Policy Act (NEPA) require that environmental impact statements address the energy requirements and conservation potential of project alternatives. The National Park Service *Management Policies* require that all facilities be managed, operated, and maintained to minimize both energy consumption and development of nonrenewable fuels. The policies also require that new energy-efficient technologies be used where appropriate and cost effective.

Assessment Methodology

Impacts were evaluated by assessing changes that would be required to meet the operational requirements outlined in each of the alternatives. Relative costs were generated, using staff estimates of funding, labor and energy required to implement these actions. These effects were compared to existing operations, staffing, funding, and energy requirements at the Seashore.

Existing staffing levels were inventoried and assessments were made of current park operations. In addition, professional judgments by individuals who are most knowledgeable about various activities were used to anticipate the operational changes that would be needed under each action alternative.

Between 1972 and 1995, non-native deer were lethally removed by NPS staff as part of a control program intended to limit each species to 350 animals. From 1995 to 1998, a small number of animals were removed yearly for Native American festivals. Records of costs per deer culled, based solely on staff time and vehicle mileage, are available for 1984-1998 (NPS unpublished data).

Estimates were made of the personnel and energy required to:

- provide education and information services to the public regarding deer management activities;
- provide law enforcement and aviation safety services during deer management activities;
- provide administrative support for deer management activities;
- provide training in deer management techniques and aviation safety; and
- conduct deer management activities.

These assessments were compared to existing staffing levels and energy use. It should also be noted that staffing funding and energy impacts for the action alternatives are difficult to project until final plans are completed. Thus, the estimates are intended to provide a general description of potential effects, considering the variability within the range of possible operational scenarios.

The discussions of impacts are for operations that would be new, undergo major change, or show susceptibility to increases or decreases in operational activity.

Type of Impact

Adverse: would represent an increase in operating costs and/ or energy usage.

Beneficial: would represent a decrease in operating costs and/ or energy usage.

Duration of Impact

Short-term: would last only until all actions are completed.

Long-term: would have a permanent effect on operations.

Intensity of Impact

Negligible: there would not be a measurable difference in costs and/ or energy usage from existing levels.

Minor: additions or reductions in cost and/ or energy usage would be less than 5% of existing parkwide budget (currently $5.6 million in general funds).

Moderate: additions or reductions in cost and/ or energy usage would be between 5% and 15% of existing parkwide budget (currently $5.6 million in general funds).

Major: additions or reductions in cost and/ or energy usage would be more than 15% of existing parkwide budget (currently $5.6 million in general funds).

Regional Economy

This topic concerns impacts of proposed NPS actions on businesses and livelihoods in Marin County, California. One of the objectives of this document is: “to reduce impacts of non-native ungulates to agricultural permittees within pastoral areas. Such impacts might include direct consumption of forage, transmission of disease to livestock and damage to fencing” (Chapter 1, Purpose and Need). Livestock ranches within PRNS have sustained documented impacts from non-native deer management in the past and it is reasonable to evaluate impacts of future management to these ranches, as well as to ranches and farms outside Seashore boundaries. Also evaluated are impacts to local hotels, bed and breakfast inns, restaurants and retail businesses from any anticipated park closures resulting from non-native deer management activities.

Policies and Regulations

The legislation establishing both PRNS and GGNRA included provisions for continuing the historic ranching uses on some of the lands acquired for these parks. As agricultural lands were purchased, sellers were allowed to continue dairying or beef ranching activities under one of two arrangements. They could retain a Reservation of Possession (ROP), under which they would forego a portion of the purchase amount in exchange for the right to continue ranching activities for up to 25 years. Alternately, they could sell outright and enter into Special Use Permits (SUP) of up to five years with the park. Some

sellers retained an ROP on part of their land, and entered into SUP agreements for the rest, while others have entered into more than one SUP agreement with the Park.

The 24 ranchers currently operating within the project area hold 11 ROPs and 30 SUPs. Most of the ROPs will be expiring in the next decade. It has been the policy of PRNS in the past to allow ranchers whose ROP terms expire to continue ranching operations under SUPs. Together these permittees and ROP holders support approximately 6,350 cattle on a year-round basis.

Assessment Methodology

Alternatives were evaluated for their socioeconomic effects on local communities. Socioeconomic effects include potential direct effects of property loss and potential indirect effects in economic terms, resulting from deer depredation of livestock forage, damage to fences and reseeding pastures, and potential disease transmission to livestock. Also evaluated are direct effects of property loss and potential indirect effects of park closures. Alternatives were evaluated for their effects on minority and low-income populations and communities as well as their effects on the local community at large.

Estimates of economic impacts to ranchers within the Seashore were obtained from the ranchers themselves. A number of ranchers have no non-native deer on their ranches and others see a few fallow or axis deer seasonally. Four of the 13 ranching permitees see either or both species year-round, in varying numbers. One ranching operation leasing pasture on the Vedanta Society property in Olema also experiences large numbers of fallow deer year-round. Impacts to other agricultural operations outside NPS boundaries were determined through extrapolation of impacts within the Seashore and through conversations with ranchers and farmers.

Type of Impact

Adverse: degrades or continues to negatively affect the characteristics of the existing economic environment, as it relates to local communities including local ranchers and farmers, minority and low income populations, visitor population, regional economies.

Beneficial: improves characteristics of the existing social and economic environment, as it relates to local communities including local ranchers and farmers, minority and low-income populations, visitor population, regional economies.

Duration of Impact

Short-term: temporary and typically transitional; associated with implementation of an action.

Long-term: continues beyond the implementation of an action and may constitute permanent impacts on the social and economic environments.

Intensity of Impact

Negligible: undetectable and expected to have no discernible effect on the economic environment.

Minor: detectable for a few local businesses and not expected to have an overall effect on the character of the economic environment.

Moderate: detectable in a moderate to large number of local businesses or could have the potential to expand into an increasing influence on the economic environment.

Major: a substantial, highly noticeable influence on many local businesses, and could be expected to alter those environments permanently.

Environmental Consequences of Alternative A – No Action

No Action is the continuation of current management. As noted in the *Alternatives* chapter, current management of the non-native deer is restricted to monitoring activities, with no attempt to reduce numbers or control distribution.

Historical deer counts and population models indicate that current population levels of both non-native deer species are below carrying capacity and consequently, the No Action alternative would likely result in increased numbers of both axis and fallow deer in the Seashore. Alternative A would also likely result in increasing numbers of non-native deer outside of the Seashore. Expansion rates of non-native deer would depend on a number of factors beyond the control of PRNS, namely, range conditions and hunting pressure.

Impacts on Water Resources and Water Quality

Analysis

Grazing animals primarily affect water quality through practices that increase the potential for erosion or stream destabilization. They may also increase bacteria or nutrients in water through defecation in or near streams. Fallow deer, because they congregate in large groups and remain in certain areas for prolonged periods, cause impacts due to congregation. These impacts resemble those of confined animals, namely, domestic livestock.

Little is known about the extent of water quality effects resulting from ungulate populations, although some information is available in the literature. Both fallow and axis deer congregate in riparian areas, as do cattle, because vegetation in riparian areas tends to be more succulent year round. Cattle and non-native deer are known to occupy riparian areas even when their preferred foods have been eaten, particularly in the summer when they seek shade under willows and other vegetation. The fondness cattle have for streamside forests has led to impacts, some of them severe, researched and noted in other parts of the country. Although the extent of impacts from much smaller and lighter axis or fallow deer are not likely to be as severe, they do have similar grazing styles (e.g. both graze on grass year round, although deer supplement their diet with forbs to a greater extent) and so may have similar types of impacts. Because so little is known about the specific impacts of non-native deer at the Seashore on water resources, those known to result from grazing by cattle and other ungulates (mule deer and elk) are described in order to approximate impacts.

When large numbers of cattle periodically graze in riparian areas, or when smaller numbers repeatedly or continuously graze near rivers and streams, trampling and consumption of vegetation reduce the ability of these forests or shrublands to trap sediment from upland runoff. Also, because riparian soils are wetter, and because these areas are flat bottomlands, soils there tend to be more vulnerable to compaction (Hubert et al. 1992). This compaction interferes with the water storage function of riparian zones and increases the potential for runoff, which in turn can alter the normal hydrology of a stream or creek. In

one study, researchers found an increase of 210% in runoff volume in an area of pine and bunchgrass forest where moderate cattle grazing had occurred, and an increase of 325% in an area where heavy cattle grazing took place.

The amount of runoff is directly related not only to compaction of soil, but to the amount of unvegetated area. Fallow and axis deer are known to create trails and open areas (NSW Scientific Committee 2004), especially when they congregate. Similarly, one study of cattle grazing found 51% more runoff, related to the degree of bare patches, after 3 years of moderate grazing. Fallow deer trails in the Seashore are heavily frequented and easy to distinguish from native deer trails because they are wide, cross creeks and their soils are easily destabilized and subject to erosion. These areas have the potential to deliver soil directly to the stream channel without filtration by riparian vegetation and to increase runoff. Increases in runoff can translate to more frequent flooding, increased flows and downstream erosion, and changes in side channel or other aquatic habitat. The loss of riparian vegetation from trampling or consumption also means upslope flows and sediment run more freely into streams and rivers, increasing sedimentation and total suspended solids (TSS).

Both cattle and deer can have large-scale impacts on riparian areas by consuming vegetation. Cattle can eat virtually 100% of the vegetation in a riparian area if they remain in it long enough, or are numerous enough to do so. Under these conditions, they are known to eat lower branches of willows, and all palatable forbs or grasses. Although fallow deer are smaller than cattle, if they occupy a riparian area for a long period of time, it is likely that they would exert a noticeable impact on the vegetation in that area. In addition, fallow deer bucks tend to aggressively rub and thrash their antlers during the reproductive season or "rut", causing minor destruction of riparian vegetation. Impacts of fallow deer thrashing are most acute within the pastoral zone in Olema Valley, where many riparian areas have been deliberately excluded from livestock grazing to restore canopy and natural hydrologic processes. In these areas, revegetation efforts and natural regrowth have been severely retarded due to heavy grazing and antler rubbing by the non-native deer (B. Ketcham, NPS, personal communication). Seasonal thrashing by fallow deer prevent native riparian plants from growing beyond shrub height. Unlike cattle, non-native deer cannot be excluded from sensitive riparian areas by conventional fencing.

The removal of vegetation can indirectly affect water quality. Without the benefit of the root structures vegetation provides, soil is loosened and washed into nearby streams or rivers during the next rainy period. In addition, soils in the immediate vicinity are more likely to be washed into the water column, and as noted above, the ability of these riparian zones to trap upslope sediment and runoff is diminished.
This increase in runoff and sedimentation is sometimes aggravated by the destabilization of streambanks caused by congregating cattle. One study (Hubert et al. 1992) found 80% more stream channel instability in a grazed area in Montana than a similar one that had been ungrazed. Stream bank loss and increased erosion resulting from denuded areas, compaction of soils and increased runoff, can add enough silt to a stream to increase TSS levels and change stream morphology. For example, in one study in northeastern Utah, the depth of stream adjacent to an area where cattle grazed decreased from 33 cm to 8 cm; the width increased as banks destabilized; and the riffles and gravel used by fish to spawn were covered in silt (Hubert et al. 1992). Eventually, this caused a change in the fish populations along strips of stream where cattle were grazing. Another study of Rock Creek in Montana found a 317% greater fish biomass in sections along ungrazed areas. Sedimentation associated with grazing also affected fish species composition, with whitefish and suckers occupying sections where TSS was higher and trout occupying areas without grazing.

This difference has implications for watersheds and aquatic life at the Seashore. For example, in at least three of the park's watersheds, Olema, Lagunitas and Pine Gulch, three species of concern occupy streams and creeks. These species are coho salmon, steelhead and California freshwater shrimp. As noted in *Affected Environment*, these species are dependent on riparian vegetation for cover and shade, and

would require uncovered gravel for spawning and specific stream conditions for habitat and spawning success. The loss of this vegetation, streambank failure and increased runoff and erosion could alter habitat for any or all of these species in these watersheds, as fallow deer are known to occupy all three watersheds. For example, at one riparian restoration area in particular, John West Fork of Olema Creek, the park has erected fences to keep cattle out of riparian zones. Although livestock have been successfully excluded, fallow deer have found their way into the area (likely under the fences) and NPS staff has observed extensive damage to native willow in these areas (B. Ketcham, NPS, personal communication). As a result, it has taken five years since exclusion for willows to grow beyond waist height. Riparian restoration and planting projects conducted in wilderness and natural areas where densities of fallow deer are much lower (i.e., Muddy Hollow Culvert Restoration Site) have shown much more rapid vegetative recovery (NPS unpublished data).

Cattle are known to also contribute fecal coliform and fecal streptococcal bacteria as well as increases in nitrates and phosphate to streams. If cattle are grazing close enough to a stream, their waste is washed into the water column during heavy rains. This is particularly true when animal density or grazing pressure is high. PRNS monitoring has shown that high levels of sediment and pathogens, resulting from livestock, may enter streams from localized sources and yet persist for 1-2 km. downstream (NPS 2001c). This is possible for non-native deer as well, as increased levels of indicator bacteria have been attributed to wildlife in published studies (Hubert et al. 1992)

Because the impacts described above to hydrology, stream morphology, aquatic habitat and water quality are localized to date, they are only minor as defined in the Methodology section. However, because fallow and axis deer would continue to be unmanaged in Alternative A, impacts would persist indefinitely. Over the 15 year period of time covered by this plan, impacts would spread in the park as the population spreads, and would worsen as axis and fallow deer continue to return to riparian areas. Impacts inside the park would become moderate in intensity.

It is highly likely that axis and fallow deer would expand their range outside the park within the next 15 years under Alternative A. Expansion of non-native deer populations beyond park boundaries could significantly and adversely impact vegetation and water quality restoration activities occurring on private agricultural lands. Through various organizations, most notably the Marin-Sonoma Resource Conservation District, significant efforts to restore riparian corridors in the Walker and Chileno Creek watersheds have been made in conjunction with private agricultural operators. Long reaches of these streams have recently been excluded from cattle access with fencing and planted with willows and other riparian vegetation species. Expansion of deer populations outside Seashore boundaries could retard success or deter implementation of such riparian restoration projects due to reduced recovery rates and the perceived benefit associated with these projects.

In addition to affecting restoration efforts, the expansion of range for both axis and fallow deer could result in regional effects on water quality and hydrology. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, 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. Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin and Sonoma Counties, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, adverse long-term impacts to water resources such as those described above could be much wider spread and approach major in intensity.

Unlike livestock, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of human introduced, non-native grazing herbivores to the water resources and water quality.

Cumulative Impacts

Cumulative impacts are those that add to impacts on water quality or water resources already affected by Alternative A. As noted above, this Alternative could affect water quality and hydrology in many of the park watersheds. Additional activities inside Seashore boundaries or inside watershed boundaries that have also contributed to impact on water quality or hydrology include livestock grazing, dams and past practices of logging.

Within the Seashore, concentrated livestock agriculture, as instructed by Congress in its Point Reyes Seashore implementing legislation, continues in the form of dairy and beef operations. Historic levels of stocking maintained heavy concentrations of livestock that have impacts on the hydrology, aquatic habitat and water quality within the Seashore. Through the Special Use Permit system, natural resource managers have been working with the agricultural community to modify operations within the lease areas to reduce adverse impacts associated with livestock concentration. Ranching operations have been reduced from their historic extent on the entire Point Reyes Peninsula to about 25% of the overall land area. Nearly all of the remaining 75% of Seashore land is managed as natural or wilderness areas. In areas that are managed for agriculture, tools to exclude livestock from sensitive areas, riparian zones and creeks have been implemented with great success. While it is acknowledged that cattle have significant impacts to resources, there are tools for restricting their access to sensitive areas. Restricting non-native deer access and excluding them from anything other than small areas is not feasible (see Chapter 2, *Alternatives and Actions Considered but Rejected*).

Activities outside park boundaries that have an adverse effect on the same watersheds as those affected by non-native deer include four dams on Lagunitas and Nicasio creeks in the Lagunitas Creek watershed, and historic heavy logging on the Pine Gulch Creek watershed. Drake's Estero is also susceptible to nutrient inputs from grazed lands within the watershed and from increased sedimentation resulting from the Vision Fire. Beneficial cumulative effects on park watersheds have resulted from restoration planning for the Bolinas Lagoon (into which Pine Gulch Creek flows), riparian cattle exclusion fencing, and habitat restoration in the Olema watershed.

Conclusion

Based on current and past data on fallow and axis deer, non-native deer populations will continue to increase, resulting in expanded range and higher animal concentrations within the Seashore and Marin County. No impairment to water resources would occur from implementing Alternative A. All of the impacts associated with the presence and/or expansion of these populations are characterized as adverse. While current impacts to water quality and hydrology are minor, continued growth and expansion of the population will result in impact intensity increasing inside the park to moderate in the long term. As the range of each species expands, the potential for moderate to major impacts outside the park becomes greater.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Minor in the short term, moderate in the long-term; Major outside the park

Impacts on Soil

Analysis

Soils could be affected by non-native deer in several ways; through direct mechanical compaction, through erosion related to the loss of overlying vegetation, through the addition of nutrients in waste products, and by more subtle changes in soil characteristics related to physiological responses of vegetation to grazing.

The project area includes lands both east and west of the San Andreas Fault. Soils to the east of the fault are derived from the Franciscan complex, which are typically dominated by clay-sized particles (loam) with a lower capacity for water infiltration and storage. Franciscan-derived soils are highly sensitive to compaction, resulting in more rills and gullies related to increased runoff rates. To the west of the San Andreas Fault, soils are more organic and typically have a sandier quality. These soils are usually deeper and have higher rates of infiltration. While somewhat less susceptible to compaction, these soils are highly erosive when disturbed. The soils are less cohesive and more subject to erosion associated with rainfall and surface runoff.

Soil compaction may occur when large numbers of non-native deer or other large animals congregate in one area for long periods of time, or when vehicles are driven off road for non-native deer management activities. As noted in other sections of this document, fallow deer are known to congregate in large herds and occupy areas for prolonged periods of time. This increases both the likelihood and the intensity of soil compaction. When soils experience compaction, the bulk density of soil increases and the rate of infiltration decreases, which ultimately means an increase in runoff. One study of cattle grazing in Colorado found bulk densities averaged 21% higher in areas grazed (in this case by livestock) than in similar, ungrazed areas (Hubert et al. 1992).

Compaction may be more likely in the moist soils of flat bottomlands adjacent to riparian areas, but use of steeper areas by axis or fallow deer is also likely to increase the potential for erosion. Soils east of the San Andreas fault, which are more likely to experience compaction, would be particularly affected along bottomlands or riparian areas, while the organic soils west of the fault, along steeper slopes, would be subject to erosion. Axis deer on Lanai'i in the Hawaiian Islands are known to occupy both bottomlands or valleys and move up slope as browse disappears or the population expands (Dorman 1996). Axis deer were imported first to Moloka'i from India as a gift to King Kamehameha from the people of Hong Kong in 1868; in fewer than 100 years the population had expanded to 7,000 and have caused extensive loss of soils through grazing and breaking trails.

As described above in the *Water Resources* section, and below in the *Vegetation* section, non-native deer also affect soil indirectly by trampling and consuming vegetation. These deer can remove substantial quantities of vegetation, particularly when they congregate in large groups and remain in an area for a period of time. Studies have found that even moderate grazing by fallow deer can result in noticeable increases in open, unvegetated areas. For example, monitoring of a reintroduced herd of Persian fallow deer in northern Israel found that even low deer densities (less than 1 per acre) resulted in clear increases in the amounts of amount of open, unvegetated soil compared to a control area (Bar-David et al. 1999). This same population also created unvegetated open areas by breaking trails through chaparral. Fallow deer trails in the Seashore are heavily frequented and easy to distinguish from native deer trails because they are wide, cross creeks, are easily destabilized and subject to erosion. These areas have the potential to deliver soil directly to a stream channel without filtration by riparian vegetation. In primary rutting areas, fallow deer have been observed to denude, and then scrape and tear at the soil. The extent of damage in late fall is severe in some forest or shrubland areas.

When vegetation is removed through trampling, scraping and tearing, breaking trails, or consumption of vegetation, soils are no longer held in place by the subsurface root structure and are much more subject to erosion during precipitation events. Park biologists have observed more erosion along the trails and in the rutting areas of non-native deer than in similar undisturbed areas.

Once initiated, compaction and soil loss from erosion can last for a long period of time,. This is because vegetation is less likely to grow in soil that has been compacted, or where top organic layers have been removed through erosion. This long-term or permanent cycle of erosion and vegetation loss occurs particularly when compaction or erosion is severe.

Deer and all herbivores can change the characteristics of soil through their urine and feces, which return carbon and nutrients to the soil in labile forms, and enhance the nutrients in the soil around roots. This can increase plant growth and net primary productivity at a landscape scale, although the loss of vegetation caused directly by grazing decreases productivity.

Grazing cause physiological changes as well, which can translate into chemical changes in soil. For example, in some forests where nutrients are often not readily available (because they are locked up in the litter, which decomposes very slowly), deer will browse selectively on the most nutritious plants and then leave, taking the nutrients with them and making the system more nutrient poor. This also, in turn, reduces the activity of soil microbial organisms. On the other hand, in large grasslands, herbivory at low or moderate levels can stimulate a short-term increase in carbon in plant roots. This can lead to increased soil microbial biomass and net production of nitrogen by these microbes, which then becomes available for uptake into the plant shoots. One study, that mimicked grazing by clipping, found short-term increases in biomass and increased nitrogen in grass stems (Ayres et al. 2004). Heavy grazing in grasslands reduces the concentrations of carbon and nitrogen in both roots and litter (Mapfumo et al. 2002).

While these impacts of grazing, including denuding of sites, increased soil compaction, runoff and loss, changes in nutrients and changes in chemical properties may be quite noticeable, they would continue on a localized basis at the Seashore if Alternative A were implemented, and would probably not exceed minor in intensity. Without management, the impacts in the park would continue into the foreseeable future and so would be long-term.

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, 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. Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin and Sonoma Counties, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations expand outside NPS boundaries, adverse long-term impacts to soils could occur on more than 500 acres of ground and would therefore be characterized as moderate or major.

Unlike livestock, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of human introduced, non-native grazing herbivores to soil resources.

Cumulative Impacts

Within the Seashore, concentrated livestock agriculture continues in the form of dairy and beef operations. Soil compaction and denudation is a concern related to both historic and current livestock operations. The National Park Service conducts Residual Dry Matter (RDM) surveys on pastoral lands to ensure that livestock do not denude the land through overgrazing. Techniques to mitigate overgrazing, including stocking rate reduction and rotational grazing, have been implemented with success in the Seashore.

Soil compaction is a problem associated with all concentrated animal operations. Soil compaction outside of the pastoral zone is likely a direct result of non-native deer. Within the pastoral zone, it is not likely that deer would increase the level of compaction far beyond that caused by cattle.

Other activities in the park and region that have resulted in soil loss include the Vision Fire, development inside and outside of the park and historic logging.

Conclusion

Based on current and past data on fallow and axis deer, non-native deer populations will continue to increase, resulting in expanded range and higher animal concentrations within the Seashore and Marin and Sonoma Counties. No impairment to soils would occur from implementing Alternative A. All of the impacts associated with the presence and/or expansion of these populations are characterized as adverse. Although impacts to soils from non-native deer inside the park would likely remain no more than localized and minor, expansion of the populations outside the park could result in major adverse impacts to soils through compaction and loss.

Type of Impact:	Adverse.
Duration of Impact:	Long-term.
Intensity of Impact:	Minor inside the Seashore; Moderate to major outside the Seashore.

Impacts on Vegetation

The Seashore and northern district of GGNRA are known to support over 900 plant species. The project area can be divided into 10 broad vegetation classes, ranging from forests to grassland and dunes. Because non-native deer feed primarily on grasses and some forbs, they are found in highest numbers within 4 vegetation classes: riparian forests, coastal scrub, grasslands and pasture. To a lesser extent, they can be found in the other forested classes: Bishop pine, Douglas fir/coast redwood, hardwood, Monterey pine/Monterey cypress forests. Non-native deer are not found in the coastal dune or wetland/marsh vegetation classes. The following tables reflect the specific plant communities where each species of deer is currently found.

Table 7. Vegetation Communities Utilized by Fallow Deer at Point Reyes National Seashore (data based on PRNS vegetation map data and current PRNS fallow deer range data).

PLANT COMMUNITY	ACRES	% OF TOTAL RANGE
Grassland	6259	28%
Coastal Scrub	5,683	25%
Douglas-fir/Redwood	5,530	24%
Hardwood Forest	2,177	10%
Riparian Forest/Shrubland	1,011	5%
Pasture	684	3%
Bishop Pine	489	2%
Unvegetated	341	1%
Other	476	2%
Total Acres	22,655	

Table 8. Vegetation Communities Utilized by Axis Deer at Point Reyes National Seashore (data based on PRNS vegetation map data and current PRNS fallow deer range data).

PLANT COMMUNITY	ACRES	% OF TOTAL RANGE
Grassland	625	41%
Pasture	507	33%
Coastal Scrub	209	14%
Other Herbaceous	55	4%
Unvegetated	51	3%
Bishop Pine	41	3%
Hardwood Forest	22	1%
Riparian Forest/Shrubland	12	1%
Total Acres	1,523	100%

Analysis

Deer, and other ungulates, can cause a variety of impacts on vegetation. Obviously, they consume vegetation, which can result in changes to physical structure, structural diversity, species composition and productivity in plant communities, as well as weed and nutrient dispersal. Deer can trample vegetation, particularly when they congregated in large groups, as they do during the rutting season or other times of the year at the Seashore. Deer can alter patterns of nutrient cycling both within plant communities and by transferring nutrients from one community to another, and can change the distribution of nutrients between plant shoot and root structures. Depending on the soil fertility, intensity of grazing and the vegetation being grazed, deer and other ungulates can stimulate or suppress vegetative productivity across a landscape.

Studies of the diets of fallow and axis deer at the Seashore have found that both species tend to eat grasses and some forbs in the fall, winter and spring, and comparatively more forbs in the summer. The same studies found they ate more forbs and browse than cattle, and that native black-tailed deer ate mainly forbs throughout the year (Elliott and Barrett 1985, NPS unpublished data, 1983, Elliott 1983). The diet of black-tailed deer overlapped with axis and fallow deer to some degree, particularly during the summer or during times of drought, when both ate forbs. A review of Elliott's 1982 dietary overlap study by Gary Fellers, a U.S. Geological Survey scientist, suggested that exotic deer at levels of 350 for each species

could reduce the native black-tailed deer population size by up to 30% (Fellers 1983). If black-tailed deer numbers are strongly influenced by the energy content of their diet, the reduction in their population, when fallow deer number 350, could be as much as 40% below carrying capacity (Fellers 1983a, 1983b). Tule elk, another ungulate native to the Seashore area, were reintroduced to the park in 1978. The majority of tule elk are kept in a fenced area at Tomales Point, but a small group has been released into the remainder of the park. Studies of the diet of tule elk show that this species eats grasses year-round, particularly during the winter (Gogan and Barrett 1995). In the spring, they add considerably more forbs to their diet, and in summer, may add shrubs like willow.

A few species made up the bulk of fallow and axis deer diet. These are grasses *Danthonia californica* and of the genus *Agrostis* and *Bromus*, the forb *Plantago lanceolata*, and a legume *Lotus corniculatus* (Elliott and Barrett 1985). Black-tailed deer also consumed *Plantago* and *Bromus*. Other studies have characterized axis and fallow deer as primarily grazers, but opportunistic feeders that also eat shrubs, buds, shoots, and leaves of trees. They are classed as intermediate mixed grazers that can feed on a variety of shrub, understory, forb and grass species depending on availability (NSW Scientific Committee 2004).

The scientific literature is full of information about the effects grazing ungulates can have on vegetation, both in a particular forest or shrubland as well as across landscapes. In northern forests, where nutrients are often not readily available because they are tied up in slowly decomposing leaf and needle litter, selective grazing by deer can eliminate or retard the growth of young trees, shrubs and forbs, allowing grasses and unpalatable species to increase. Over time, and assuming browsing pressure is not high enough to eliminate all seedlings, deer will bring about a change in the species composition of surviving seedlings and saplings. For example, in mixed hardwood forests monitored in one study, birch, alder and beech were resistant because they are unpalatable *to what species?*, while oak, ash and willows were vulnerable (U.K. Forestry Commission 2000). A similar study that modeled the effects of heavy white-tailed deer (*Odocoileus virginianus*) grazing on forests in Virginia found sapling recruitment of white ash and *Rubus* spp. saplings was suppressed 80-95% over control sites. Deer densities in the study were 30-40 deer/ square km. (Cross 1998).

Grazing in woodlands can keep trees from reaching their full stature, or from becoming established at all. It can also reduce the height of shrubs, or nearly eliminate the shrub layer altogether (Putnam 1986). Axis and fallow deer eat some shrubs, but primarily eat grasses and forbs. In riparian areas where fallow deer congregate in large herds of up to 150 animals, long-term browsing of forbs and grasses has led to a lack of understory vegetation (N. Gates, NPS, personal communication). This and an absent middle layer of shrub vegetation is not unusual where heavy grazing occurs, and can eliminate an important component of wildlife habitat, particularly for birds. On Moloka'i in the Hawaiian Islands, axis deer have created "browse lines" on standing vegetation, an obvious clearing of vegetation from the ground to the highest point the deer can reach (Dorman 1996).

Lighter grazing does not have this effect. One study of the effects of deer on mixed hardwood and deciduous forests in the U.S. found that densities below about 3-7 deer/square kilometer allow regeneration of trees and shrubs (U.K. Forestry Commission 2000).

Heavy or sustained grazing in woodlands also reduces species diversity. Although lighter grazing might leave some saplings, browse, and forbs in forests and actually result in increased species diversity, sustained heavy grazing eliminates virtually all individuals of palatable species, and can leave near monocultures of unpalatable species behind. For example, in England where fallow deer were introduced a thousand years ago by the Romans, moderate levels of grazing have resulted in the expansion and spread of holly, to the exclusion of forbs and browse. Grasses and rosette-style plants, which are able to withstand heavier grazing pressure, have also proliferated (Putnam 1986). In the Royal National Park in

New South Wales, grazing by exotic Rusa deer (*Cervus timorensis)* have been shown to alter the structure, species abundance and composition of grassland communities. Areas with higher densities of deer *(densities were undefined)* show 30-70 % fewer plant species that those with lower densities. (New South Wales National Parks and Wildlife Service, 2002; New South Wales Scientific Committee 2004) In Pennsylvania forests, variable densities of white-tailed deer were found to be linked with forest changes. Species richness and the height of saplings declined once density of deer exceeded 7-8/square km., and seedlings of six species were missing altogether at these densities (deCalesta 1997).

Over time, heavy grazing of woodlands or shrublands can mean conversion to grassland dominated by unpalatable species. In grassland ecosystems, the natural progression to shrubland or forest is sometimes halted indefinitely by ungulate grazing (Putnam 1986, Deer Commission for Scotland 2004, Cross 1998). Fallow deer in England remove the tips of lateral and leading shoots of trees and shrubs, and will graze forbs and grasses to the point of creating a "lawn" only a few millimeters high and composed of a few grass species (Deer Commission for Scotland 2004). In some areas of the world, ungulate grazing has devastated species richness and altered physical structures to the point that the forest no longer exists. In Hawaii, on the island of Moloka'i, very heavy grazing pressure from introduced axis deer on the Kalaupapa peninsula has resulted in landscape-scale adverse impacts on vegetation (Dorman 1997) On Lana'i, axis deer and feral pigs have stripped vegetation and eaten emergent plants of trees and shrubs to the point that they have converted the Ohia-Hapuu rainforest to a grassy scrubland (Dorman 1997).

Concern over the selective grazing by exotic Rusa deer *on* rare species or vegetation in unique vegetative communities has also prompted the National Parks System of New South Wales to declare them a "key threatening process" and a target for eradication under Australia's Threatened Species Conservation Act (NSW Scientific Committee 2004). The scientific committee making this finding listed the loss of 30% of the understory species in sandstone heath, 40% loss in sandstone woodland, and 70% loss in littoral rainforest. All three are protected and rare plant communities.

In the Seashore, riparian areas account for 5-6% of the range occupied by fallow and axis deer. These are unique areas in the park, and offer habitat for a variety of wildlife species, some of them threatened or endangered. The Seashore is attempting to restore, with fencing, some of these riparian areas in the Olema Creek watershed that have been degraded by cattle. Park managers have been unsuccessful in keeping fallow deer out. In fact, fallow deer spend much of the rut season in these streamside forests and shrublands. Herds of up to 150 animals tend to remain faithful to certain pastures and woods and return to them frequently year-round (NPS unpublished database). Densities can be as high as 80 deer/ square km., several times the densities at which the effects of heavy grazing have been documented for white tailed deer and other ungulates.

The effects of so many deer in a sensitive streamside habitat can be locally severe. Most small to mid-sized deer species are thought to consume 3% to 4% of their body weight in vegetation daily (Halls 1970). This means that, at a minimum, current non-native deer populations remove 1-2 tons of forage from the Seashore per day. Riparian vegetation is not extensive in the Seashore, and concentrating some portion of this consumption in it even for a short time could have highly noticeable effects. Because fallow deer return annually to these rutting ("lekking") areas, the effects could be wider in scope or be cumulative over time than if it were a single event. In addition to consuming vegetation, fallow deer damage and remove it through trampling, through breaking trails, and bucks through antler polishing or mating displays.

The impacts of such high densities have been increased denudation of areas, soil erosion, compaction of soils and a reduced ability for vegetation to regrow. Where the park has fenced riparian areas to protect them from cattle grazing, revegetation efforts and natural regrowth have been severely retarded due to heavy grazing and antler rubbing by fallow deer (B. Ketcham, NPS, personal communication). Continual

grazing of new shoots and seasonal thrashing by fallow deer can prevent native riparian plants from growing beyond shrub height. At one riparian restoration area in particular, John West Fork of Olema Creek, NPS staff has observed extensive damage to native willows (*Salix spp.)* in areas excluded from livestock access (B. Ketcham, NPS, personal communication). It has taken five years, since cattle exclusion, for the willows to grow beyond waist height. Riparian restoration and planting projects conducted in wilderness and natural areas where densities of fallow deer are much lower (i.e., Muddy Hollow Culvert Restoration Site) have shown much more rapid vegetative recovery (NPS, unpublished data).

In addition to the effects deer have on the physical structure, species diversity and composition of vegetative communities, they can act as forces in the distribution of seeds and nutrients. For example, consumption of non-native seeds in one area and migration and dispersal into an unaffected area can add to the spread of invasive plants. This is true for native plants as well. Grazers can also exert a large-scale effect on the nutrient levels in soils through their waste products. While the high nitrogen content of urine may damage some species, others grow more quickly in nitrogen enriched soil. Feces and urine can stimulate soil microbial activity as well, which means the production of nitrogen is increased and available to plant roots. This is taken up by plant shoots and becomes available to herbivores as more nutrient rich forage (van derWal et al. 2004). The cycle of adding nutrients in the form of waste products and returning it in the form of more nutritious forage is one of the key mechanisms grazers manipulate their own food supply, particularly in grasslands, although the effect has been proven in tundra ecosystems as well (van derWal et al. 2004). Grazing or browsing can also stimulate carbon allocation to root systems. This increases microbial activity and stimulates the production of nitrogen, which in turn can increase productivity above ground. This cycle occurs readily in grassland ecosystems where grazing pressure is light, and can lead to a proliferation of grasses preferred by some ungulates (Wardle and Bardgett 2004).

Finally, non-native deer can have a cumulative effect on vegetation with other native ungulates at the park, or conversely can create landscape conditions that reduce habitat for these species. Tule elk feed on grasses and forbs similar to axis and fallow deer, although they rely on forbs in the spring to a much greater extent. Black-tailed deer eat a high percentage of forbs year round (Elliott and Barrett 1985). To the degree that they eat the same types of forage during the same season as tule elk or black-tailed deer, axis and fallow deer compete with these native deer and may displace them. Non-native deer may also promote conversion of habitat to grasslands, consisting of plant species the deer favor, all through the mechanisms described above. If the resultant plant species are not those preferred by tule elk or black-tailed deer, habitat for these native deer may be reduced. Also, grazing by non-native deer at the Seashore adds to any impact that vegetation may be experiencing from native ungulates (or cattle) resulting in a cumulative impact through consumption, trampling and the other factors identified above. *To the extent that non-native deer displace native species, this impact is lessened.*

Unmanaged and expanding populations of non-native deer would continue to impact vegetation communities throughout the Seashore. Non-native deer grazing and thrashing impacts would also reduce the success and effectiveness of plant conservation and restoration projects by affecting individual rare species as well as recovering native vegetation. Currently, the impacts of non-native deer to vegetation in the park remains localized and is minor. However, if Alternative A were implemented, herds would increase in size and the damage to vegetation would be more widespread inside the park. Over the 15-year lifetime of the plan, impacts inside the park would become moderate and would persist indefinitely or continue to worsen.

Alternative A would likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, 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. Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin and Sonoma Counties, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, adverse long-term impacts to the plant species described above could be substantial, highly noticeable, and could irreversibly change plant community size, continuity, or species richness and would therefore be characterized as major.

Unlike livestock, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of human introduced, non-native grazing herbivores to vegetation communities.

Cumulative Impacts

Cumulative impacts to vegetation in the park that is also affected by non-native deer include the impacts of cattle grazing, logging and development. Logging precedes the establishment of the Seashore, but has removed forest vegetation and increased erosion of soils.

Within the Seashore, concentrated livestock agriculture continues in the form of dairy and beef operations. Historic levels of stocking and operational trends maintained heavy concentrations of livestock that had impacts on vegetative communities within the Seashore. Through the Special Use Permit system, natural resource managers have been working with the agricultural community to modify operations within the lease areas to reduce adverse impacts associated with livestock concentration. Ranching operations have been reduced from their historic extent (the entire Point Reyes Peninsula) to only about 25% of the overall land area. Nearly all of the remaining 75% of Seashore lands are managed as natural or wilderness areas. Some of these areas are returning to shrub and forest communities without the "clearing" effects of livestock grazing. Increased numbers of non-native deer, because they are primarily grazers, will reverse this shift and could return natural and wilderness landscapes back to open grassland communities.

In areas that are managed for agriculture, tools to exclude livestock from sensitive areas, such as riparian zones and creeks, have been implemented with great success. While it is acknowledged that cattle have significant impacts to resources, there are tools for restricting their access to sensitive areas. Restricting access for non-native deer populations with fencing is impractical for anything other than small areas. Persistence of non-native deer will maintain concentration-associated adverse impacts to vegetation in areas no longer managed for agriculture. This scenario may also reduce the success and effectiveness of riparian restoration projects due to grazing and thrashing pressure by non-native deer.

Conclusion

Based on data on current and past population growth of fallow and axis deer at PRNS, this alternative would result in an increase in non-native deer numbers within the Seashore and throughout Marin County. No impairment to vegetation would occur from implementing Alternative A. Based on current reports of damage to riparian and understory vegetation within the Seashore, the magnitude of these impacts to vegetation within NPS boundaries are currently considered minor in intensity (as defined in Methodology Section, Impacts on Vegetation). However, under this alternative, the impact intensity to park vegetation is expected to increase over time to a moderate level because of increasing deer densities and increasing geographical scope. Impacts outside the park could be major in intensity. Impacts from this alternative to vegetation are adverse and long-term.

Type of Impact: Adverse
Duration of Impact: Long-term
Intensity of Impact: Moderate

Impacts on Wildlife

The project area supports a wide diversity of wildlife species, including 28 species of reptiles and amphibians, 65 species of mammals, and uncounted invertebrates. Over 480 bird species (representing 45% of the avian fauna documented in the United States) have been sighted and approximately 100 species breed within the park. Wildlife can be impacted in a number of ways by non-native deer management. Directly, wild animals can be injured or killed during deer capture, monitoring or management operations. Indirectly, through destruction of habitat and competition for required resources, animals can be impacted by changes in the abundance and range of non-native deer.

Wild animals are dependent on a multitude of ecosystem elements, ranging from specific habitats for reproduction to specific trace dietary minerals for growth and maintenance. Some of the elements, which constitute an animal's "niche," are known to scientists, some have yet to be discovered. If two species utilize the same resource, scientists describe the finding as "niche overlap." Such a finding implies, but does not definitively prove, that increasing numbers of one of the overlapping species would negatively impact the other. An example of such an overlap is Elliott's finding that in times of low forage availability, such as during droughts or at the end of summer, both non-native deer species feed on many of the same browse plants as native black-tailed deer (Elliott 1982). At this time of year, when the energy and protein content of available forage is at its lowest, axis and fallow deer switch from eating primarily grass to eating forbs, non-grass like herbs that constitute the bulk of the black-tailed deer diet year-round. Evidence of niche overlap, as demonstrated in dietary overlap studies, cannot automatically be interpreted as competition between two species (Gogan and Barrett 1995, Feldhammer and Armstrong 1993, Litvaitis et al. 1994). Conversely, lack of niche overlap does not necessarily rule out competition since competition for shared resources can force species to adopt different food or habitat preferences to avoid competitive conflict (Putman 1986). Scientists would require evidence that the overlapping resource, in this case forbs, was limited and not available in sufficient quantity to supply both species. Evidence of detrimental effects, such as decreased fawn recruitment in black-tailed deer, would demonstrate that the overlap might be impacting one of the competing species. Intraspecific competition is notoriously difficult to demonstrate scientifically. In the absence of scientific evidence of competition between species in the context of evaluating impacts of non-native deer to wildlife, data collected from research elsewhere in the U.S. and abroad will be evaluated. In addition, degree of suspected niche overlap along with anecdotal and historical evidence and expert opinion will provide insights and guidance for the analysis.

Impacts to individual animals within a species will be considered in the context of pain and suffering caused by proposed actions to wildlife, specifically, non-native deer. All proposed alternatives include provisions to prevent unnecessary animal suffering (see Actions Common to All Alternatives). Recommendations for humane animal treatment developed by the American Veterinary Medical Association (AVMA) will be used for all alternatives. The AVMA considers, in some circumstances, gunshot to be the only practical and acceptable method of euthanasia in wildlife, when delivered by personnel sufficiently skilled to be accurate and experienced in the proper and safe use of firearms (AVMA 2001). Because pain and suffering is not scientifically measurable in animals, it will be assessed for each alternative using best professional judgment of wildlife biologists, managers and veterinarians. Humaneness is a person's perception of harm or pain inflicted on an animal. The concept, a uniquely human construct, is complex and can be interpreted in a variety of ways (USDA 1997). Consequently,

impacts to visitors of animal pain and suffering caused by project actions will be discussed in Impacts on Visitor Experience.

Analysis

For this analysis, the best professional judgment of wildlife biologists, as well as research completed at the Seashore and elsewhere, have been used to determine impacts of increasing fallow and axis deer populations and range on other wildlife species. In general, more non-native deer would constitute an increase in magnitude and scope, both within and outside the Seashore, of current impacts to other species that share limited resources.

Non-Native Cervids

The larger population sizes and ranges, which would result from this alternative would clearly benefit both axis and fallow deer. Their ranges would increase both within and outside of NPS boundaries, into other parts of Marin County. Axis deer have occasionally been sighted as far east as Nicasio Reservoir (PRNS, unpublished data). Current fallow deer range maps suggest that fallow deer have spread recently towards the south and eastward borders of the Seashore. Fallow deer in New Zealand have spread at rates of up to 4.5 miles per year (Mungall and Sheffield 1994). Favorable non-native deer habitat (interspersed grasslands and oak woodlands) exists in close proximity to PRNS, GGNRA and throughout Marin County. Fallow deer were successfully introduced to an area of grassland/oak woodlands in central Mendocino County in 1949 and have persisted there. Their numbers and range are apparently restricted by surrounding coniferous forests, chaparral, and hunting (Jurek 1977). Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin County, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of the county is likely. Low levels of hunting in Marin suggest that population expansion might remain uncontrolled and irreversible[5]. Expansion rates of non-native deer would depend on a number of factors beyond the control of NPS, namely, range conditions, and hunting pressure.

Impacts to non-native deer from Alternative A would be beneficial and long-term. Because the impacts have the potential to affect areas beyond Seashore boundaries and could be irreversible, impact intensity is considered major.

Native Cervids

In their study of axis and fallow deer introductions nationwide, Feldhammer et al. (1993) stated:

> "We may expect competition between exotic and native artiodactyls both intuitively, and on the basis of previous field experiments with a variety of animal groups from various trophic levels and habitats…"

Native black-tailed deer are primarily browsers while both axis and fallow deer have been shown to be grazers. However, studies at PRNS have demonstrated that, during times of low forage availability, non-native deer adapt their feeding habits and consume larger amounts of forbs and browse (Elliott 1983, Elliott and Barrett 1985). Higher numbers of non-native deer would result in increased competition with native black-tailed deer for forbs and browse during droughts, at the end of summer, and year-round on poor quality ranges (Connolly 1981, Elliott 1983, Fellers 1983). Fiercer competition for limited forage

[5] Fewer than 1% of all hunting licenses (type 110) sold in California in 1999 were purchased by Marin County residents (CDFG database, http://www.dfg.ca.gov/licensing/pdffiles/Reg_HuntingItems90s.pdf).

would result in diminished condition in black-tailed deer (Brunetti 1976, Fellers 1983). It has been repeatedly shown in the scientific literature that poor condition in adult female cervids results in decreased reproductive capacity (Verme 1962 and 1967, Thorne et al. 1976, Keech et al. 2000). Increased competition for forage would likely result in lowered black-tailed doe fertility, decreased fawn production and lower fawn survival over current levels. The magnitude of the impacts to black-tailed deer populations would depend on range conditions, precipitation patterns and non-native deer numbers but would likely range from minor to moderate and could be expected to last longer than two breeding cycles. It is important to note that impacts would occur throughout larger and larger areas of Marin as non-native deer range expanded in the future as a result of this alternative.

Black-tailed deer prefer a mosaic of various-aged vegetation that provides woody cover, meadow and shrubby openings while non-native deer favor habitats containing >50% grassland (CDFG 1996, Elliott 1982). However, there is some interspecies habitat overlap during certain times of the day and seasonally. Black-tailed deer are thought to avoid large herds (consisting of more than 50 animals) of fallow and axis deer (N.Gates, PRNS, personal communication). Alternative A would result in higher densities of non-native deer both within and outside of the Seashore. Consequently, native black-tailed deer would likely avoid high-density areas when non-native deer were present.

Biologists in New Zealand documented that established, high-density populations of fallow deer competitively excluded red deer (*Cervus elaphus scotticus*), an elk species native to Europe (Challies 1985). Red deer are considered the most widespread and successful of all deer species introduced to New Zealand except where their range overlaps with previously established fallow deer populations (Challies 1985). Increased densities of fallow deer in areas of the Seashore where free-ranging tule elk inhabit will likely inhibit expansion of the elk herd and may suppress elk numbers where the new free-ranging subpopulations are not well established. These areas include the southwestern wilderness areas of the park south of Drake's Estero and west of Inverness ridge.

Tule elk, like fallow and axis deer, are primarily grazers. Grasses constitute a large proportion of the diets of all three species year-round (Elliott and Barrett 1985, Gogan and Barrett 1985, Fallon-McKnight unpublished data). In addition to inhibiting further expansion of tule elk herds, higher numbers of non-native deer could adversely impact current elk populations in the Seashore through increased competition for forage (Brunetti 1976). Deer are thought to consume 3% to 4% of their body weight in vegetation daily (Halls 1970). At a minimum, current non-native deer populations consume 1-2 tons of forage per day. As a result of Alternative A, this total forage intake would increase and a significant amount of vegetation would become unavailable for native grazers. Such impacts would be reflected in lower elk calving rates, delayed onset of reproduction in tule elk cows and reduced elk calf survival.

Direct behavioral competition between fallow deer and tule elk currently exists at PRNS and would likely increase with Alternative A. Researchers in the Zehusice Deer Park in the Czech Republic have documented behavioral exclusion of red deer by fallow deer at high-density feeding sites (Bartos et al. 1996). Fallow deer at Zehusice were observed to: 1) be consistently more aggressive than red deer; 2) preferentially seek out feeding sites where red deer congregated; and 3) attack red deer from the rear as a strategy to overcome their larger opponents (Bartos 1996). In the Tomales Point Elk Reserve at PRNS, fallow bucks have been observed sparring with tule elk bulls (PRNS, unpublished data). In all observed instances, fallow bucks were successful in chasing away elk bulls in spite of a significant size disadvantage. The consequences of increased behavioral competition are difficult to predict with certainty but could include exclusion of elk from higher quality forage or habitat, decreased condition of reproducing adults and ultimately, decreased population growth or population decline.

Paratuberculosis, or Johne's disease, is an infectious and incurable diarrheal wasting disease of wild and domestic ungulates. In a study conducted at PRNS in 1979, paratuberculosis was documented in 9.6%

and 8.1% of axis and fallow deer, respectively (Riemann et al. 1979). The disease has been documented in tule elk at Tomales Point Elk Reserve since 1980 (Jessup et al. 1981). In spite of their known susceptibility to the disease, black-tailed deer have not been documented to carry paratuberculosis in PRNS (Williams et al. 1983, Sansome 1999, unpublished report). In 1998, relocation of 45 adult tule elk from Tomales Point to the Limantour wilderness area included a 6-month quarantine and extensive testing for Johne's disease (Manning et al. 2003). Only those animals that consistently tested negative on all blood tests and fecal cultures were released in July 1999 to form a new free-ranging herd. This elk herd is currently made up of 38 animals. The goal of the relocation is to restore the dominant native herbivore to the Seashore's wilderness ecosystems.

Transmission of the organism that causes paratuberculosis (*Mycobacterium avium ss. paratuberculosis*) occurs primarily from infected adults to young animals. The period of greatest susceptibility for this infection appears to be the first 6 months of life. The organism is shed by infected animals into feces that may contaminate feed, water, and pastures. The prevalence of the infection and the incidence of clinical disease may climb when an affected population approaches carrying capacity. At these high densities, affected herds experience the stressors of reduced forage nutritional quality and reduced ability to fight disease. This immunosuppression can result in increased transmission of infections, heavier parasite loads and progression to clinical illness. (Manning et al. 2003). Animals in the clinical phase of Johne's disease shed the organism more often and in greater numbers. Premise contamination with this hardy and long-lived organism may thus increase, a factor relevant to the health of numerous species. All cervids are believed to be susceptible to this infection (Manning and Collins 2001).

Alternative A would result in higher densities of non-native deer in PRNS and outside of NPS boundaries, with populations of axis and fallow deer eventually reaching carrying capacity. Because non-native deer congregate in large herds, the prevalence of paratuberculosis would rise in these herds and the potential for transmission to the tule elk and black-tailed deer that share their habitat would increase. Exposed elk or deer, infected as juveniles, would spread the disease to their offspring. As has been observed at Tomales Point, infection would result in diarrhea, weight loss, lowered reproductive capacity and eventual death of individual deer. On a population level, introduction of paratuberculosis into the free-ranging tule elk herd could result in slower growth of the population. Black-tailed deer may be more susceptible than other species to natural infection and rapid onset of the disease (Williams et al. 1983). Transmission, should it occur, would adversely impact juvenile survivability and, in cases where large numbers of black-tailed deer were exposed, would cause eventual decline of native deer numbers.

Genetic variability assists populations in adapting to environmental changes and reduces vulnerability to catastrophic events such as disease, abnormal weather cycles, pollution etc. Fewer than 4,000 of the 500,000 tule elk historically present in California, currently remain. Tule elk at PRNS have passed through at least four severe population reductions or "bottlenecks". With each bottleneck, the amount of genetic variability in the population has been reduced. It has been estimated that PRNS elk are among the most inbred in California, with a degree of relatedness equivalent to that resulting from three consecutive brother-sister matings (McCullough et al. 1996). Physical signs of inbreeding, such as cleft palate, have been observed in the Tomales Point herd (Gogan and Jessup 1985).

Management techniques to increase genetic diversity within and among wildlife populations include: 1) translocating animals between subpopulations, and 2) increasing the number of reproducing animals within each subpopulation (McCullough et al. 1996). For the past 5 years, NPS has cooperated with California Department of Fish and Game to transfer adult elk cows to Tomales Point, in order to increase genetic variability. One of the primary goals of the PRNS General Management Plan is to maintain viable populations of tule elk in the Seashore and to restore free-ranging elk to wilderness ecosystems. Alternative A would likely slow the growth of tule elk numbers required to increase genetic variability in the Limantour elk herd. Increased competition for resources with fallow deer and potential transmission

of paratuberculosis could hobble herd growth. Smaller numbers of breeding animals would result in lower genetic variability and increased risk of catastrophic population downswings.

Alternative A would result in:

- decreased tule elk and black-tailed deer food availability;
- slowed growth or reduction of tule elk and black-tailed deer numbers;
- decreased tule elk range; and
- reduced potential for increased genetic variability within a the PRNS tule elk population.

Impacts to native cervids from Alternative A inside and outside of NPS boundaries would be adverse, moderate and long-term.

Small Mammals

The impacts of increased non-native deer populations on small mammals would occur in two ways: 1) by beneficial or adverse habitat alteration, influencing food supply, and cover; and 2) by direct, adverse competition for resources, mainly, food (Flowerdew and Ellwood, 2001). In order to definitively demonstrate impacts of growing deer populations on small mammals at PRNS, large-scale deer exclosure experiments would have to be used to investigate responses at varied deer densities. Impacts to small mammals are extrapolated from research completed in the U.S. and in the U.K. on fallow deer and white-tailed deer in lowland woodlands (Putman 1986, McShea 2000, Flowerdew and Ellwood 2001, Fuller 2001). Inventories of small terrestrial vertebrates, conducted at PRNS from 1998-2001 in agricultural and ungrazed areas of the Seashore, were also considered in this analysis (Fellers and Pratt 2001).

In the Britain, heavy grazing pressure (100 deer/km^2) by fallow deer in lowland forests caused reductions and even local extirpations of wood mice, bank voles and common shrews (Putman et al. 1989). The loss of palatable ground-level vegetation removes food sources for small herbivores and at the same time, changes microclimates and reduces protection from predators (Flowerdew and Ellwood 2001). Increased browsing of shrubs in forested habitat or on forest-grassland interfaces, as has been demonstrated in both axis and fallow deer at the end of summer and during droughts (Elliott 1982), could alter suitability of those areas for some species. High densities of fallow deer have been observed to alter riparian cover and vegetation at PRNS through browsing and antler thrashing (B. Ketcham, NPS, personal communication). Such high-density impacts could decrease cover and habitat dusky-footed woodrat (*Neotoma fuscipes*).

Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). Densities of fallow deer in the Olema Valley areas of PRNS currently approach 80 deer/ km^2 (NPS 2002a) and could be expected to increase in Alternative A. Grazing pressure from deer in many Olema Valley sites is currently considered heavy. Should this grazing pressure continue or increase with Alternative A, species that could be adversely affected are the: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*). Increased fallow deer densities and range resulting from Alternative A would likely reduce habitat for these species in limited areas of the Seashore and throughout Marin County, for longer than 2 breeding cycles. The adverse impacts could therefore be considered moderate and long-term.

Not all species decline with increasing deer grazing pressure. Grazing at intermediate and low deer densities has been shown to increase or have no effect on some plant and animal species in Britain (Fuller

and Gill 2001). At PRNS, deer mice (*Peromyscus maniculatus*) were found more often in pastures grazed by cattle than in pastures where cattle were excluded (Fellers and Pratt 2002). It is possible that with increased deer grazing pressure in PRNS, deer mouse abundance would increase. The Valley pocket gopher (*Thomomys bottae*), another small mammal species that thrives in open grassland environments, could also remain unaffected or increase.

Direct competition for food between non-native deer and small mammals is a potential adverse impact resulting from Alternative A. As stated before, definitive documentation of competition would require exclosure experiments. In the absence of such experimentation, evidence of dietary overlap between species has been evaluated. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). In addition, analyses of fallow and axis rumen and fecal samples have shown heavy use of many of the same species used by small mammals (Elliott 1982, Fallon-McKnight, unpublished data). Small mammals likely to be adversely affected by increasing competition for food are the: Pacific jumping mouse (*Zapus trinotatus*), California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus)*, western harvest mouse (*Reithrodontomys megalotis*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*).

Depending on local deer densities, weather patterns and the yearly mast crop, adverse impacts to small mammals from Alternative A range from mild to moderate throughout the Seashore and Marin County. Because they persist for longer than 2 breeding cycles, impacts are considered long-term.

Mammalian and Avian Predators

This category includes wildlife species, such as mountain lions (*Felis concolor*), coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), badgers (*Taxidea taxus*), weasels (*Mustela spp.*), and the raptors that prey on small mammals.

Although no research at PRNS has been conducted to document the extent to which non-native deer are preyed upon by carnivores, anecdotal and historical evidence suggest low-level predation, especially on fawns. Since their introduction in the 1940s, there has been a decrease in the proportion of observed white fallow deer, from 75% to 21%, suggesting that white individuals may be preferentially selected by predators (Wehausen 1973, NPS 2002a). An anecdotal report exists of an axis doe defending her fawn from a bobcat (NPS, unpublished data). Ranchers have reported coyotes preying on axis fawns in the pastoral zone (N. Gates, NPS, personal communication). However, because non-native deer congregate in large groups and prefer open habitat, it seems unlikely that they serve as a primary prey base for native mega- and meso-carnivores, who specialize on stalking black-tailed deer and small mammals. Alternative A would increase the prey base for mountain lions, coyotes and bobcats. This beneficial impact would likely be offset by a decrease in both the black-tailed deer and small mammal prey base for these carnivores, foxes, weasels and badgers.

In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls (*Strix aluco*) and kestrels (*Falco tinnunculus*), especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely adverse impact on their rodent prey base, Alternative A would have an adverse impact on birds of prey such as great-horned owls (*Bubo virginianus*), short-eared owls (*Asio otus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), red-shouldered hawks (*Buteo lineatus*), red-tailed hawks (*Buteo jamaicensis*), Northern harriers (*Circus cyaneus*), black-shouldered kites (*Elanus caeruleus*), sharp-shinned hawks (*Accipiter striatus*) and Cooper's hawks (*Accipiter cooperii*).

Overall, the adverse impacts of Alternative to predators in the Seashore and in Marin County would be moderate and long-term.

Other Birds

Little is known about the impacts of grazing wildlife on birds in the Seashore. In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle to ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Only one species, the savannah sparrow (*Passerculus sandwichensis*), was found in higher numbers in grazed grasslands.
Deer exclosure studies in Pennsylvania hardwood forests indicate that high densities of white-tailed deer (*Odocoileus virginianus*) cause declines in intermediate canopy-nesting songbirds. This study showed complete absence of certain songbird species, including American robins (*Turdus migratorius*), at deer densities over 25 deer/km² (deCalesta 1994). These declines are thought to occur because high deer numbers alter the structure of woody and herbaceous vegetation 0.5 - 7.5 meters above the ground (deCalesta 1994). Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests suggested that some bird species, namely understory nesters, declined with high deer grazing pressure while other species, namely bark foragers, benefited from reductions in understory vegetation. Researchers in British lowland forests determined that "losers" substantially outnumbered "winners" and that breeding populations of migrant birds were especially vulnerable to adverse impacts from heavy deer grazing pressure (Fuller 2001).

Table 9 lists the ground or low nesting bird species (nesting at approximately 0.3-3 meters) found in the Seashore. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). Impacts to the species listed would likely occur in a manner similar to the Pennsylvania study (deCalesta 1994). That is, there may be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. Impacts on reproductive success and survival are unknown. It should be noted that Table 9 primarily contains species breeding at PRNS and GGNRA and is not exhaustive. Three species that would likely be impacted, the San Francisco common yellowthroat (*Geothlypis trichas sinuosa*), the northern harrier (*Circus cyaneus*) and the California Swainson's thrush (*Catharus ustulatus oedicus*) are not listed in this table because they are either California Bird Species of Special Concern (CDFG) or Birds of Conservation Concern (USFWS) and are discussed in the section on Impacts on Special Status Species.

Table 9. Bird species likely to be adversely impacted by Alternative A.

Common Name	Scientific Name
Allen's hummingbird	*Selasphorus sasin*
American goldfinch	*Carduelis tristis*
Bewick's wren	*Thryomanes bewickii*
Brewer's blackbird	*Euphagus cyanocephalus*
California towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Marsh wren	*Cistothorus palustris*
MacGillivray's warbler	*Oporornis tolmiei*
Orange-crowned warbler	*Vermivora celata*
Oregon junco	*Junco hyemalis thurberi*
Red-winged blackbird	*Agelaius phoeniceus*
Spotted towhee	*Pipilo maculatus*
Western meadowlark	*Sturnella neglecta*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*

In increasing areas of PRNS, GGNRA and Marin County, it is expected that overall avian species richness, abundance and diversity would decrease measurably with the heavy grazing pressure resulting from Alternative A. Beneficial impacts to a few grassland species would be offset by larger adverse impacts to relatively more species that depend on understory shrub layers for nesting, especially in impacted riparian and woody-grassland interfaces. The adverse impacts to various species would be moderate and long-term within and outside NPS boundaries.

Reptiles and Amphibians

Little is known about the impacts of large herds of grazing herbivores on reptiles and amphibians in the Seashore. During inventories of small vertebrates conducted at PRNS in 2001, northern alligator lizards (*Gerrhonotus coeruleus*) were not found in pastures grazed by cattle but were found in similar ungrazed sites (Fellers and Pratt 2002). Changes to woodland understory vegetation, especially in riparian areas, and grassland cover, as has been documented with high densities of fallow deer at PRNS, would alter microclimates and habitats for frogs, lizards and salamanders. Adverse impacts could be expected for: alligator lizards, California slender salamanders (*Batrachoseps attenuatus*), rubber boas (*Charina bottae*), western skinks (*Eumeces skiltonianus*), racers (*Coluber constrictor*), garter snakes (*Thamnophis elegans)*, and Ensatina salamanders (*Ensatina eschscholtzii*).

Because of expected mild to moderate adverse impacts of Alternative A on small mammal abundance (see above), concomitant decreases can be expected in reptiles that prey on shrews and rodents. Species in this category are the: western terrestrial garter snake, rubber boa, and gopher snake (*Pituophis melanoleucus*).

Studies of British lowland forests heavily grazed by fallow deer have shown that as a result of decreasing rodent numbers, kestrels relied preyed more heavily on lizards (Putman 1986). Inside and outside the Seashore, similar increases in predation by raptors and owls on lizards, frogs and snakes is likely to occur in areas of high non-native deer density.

Impacts to amphibians and reptiles in PRNS and throughout Marin County with Alternative A are expected to be adverse to a number of species. The impacts are moderate and long-term.

Alternative A will likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, 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. Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin and Sonoma Counties, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, adverse long-term impacts to the wildlife species described above could be substantial, highly noticeable, measurable, and potentially irreversible. The intensity of such impacts could therefore be characterized as major.

Cumulative Impacts

Statewide deer estimates, which include all native subspecies of black-tailed deer, compiled by the California Department of Fish and Game (CDFG), suggest that deer numbers have decreased from record highs in the 1950s and 1960s. This decline is thought to have occurred because of declining deer habitat quality as a result of urbanization, fire suppression and changes in logging (CDFG 1996). Along with these statewide declines in black-tailed deer numbers, Alternative A would constitute a cumulative adverse impact to black-tailed deer populations.

Sudden Oak Death (SOD), a fungal-type disease that kills tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and black oaks (*Quercus kelloggii*), was first discovered in 1995. Since then it has been documented in 12 California counties including Marin. The disease causes oak death and the loss of acorn crops. In California and elsewhere, fallow deer are known to feed on acorns, an important

food source for many small mammals (Poli 1996, Jurek 1977). Along with increasing countywide mast losses due to SOD, Alternative A would constitute a cumulative adverse impact to wildlife species dependent on acorns.

Non-native wild turkeys (*Maleagris gallopavo*) have existed in Marin County since their release by CDFG in the 1970s. Since 1995, increasing numbers have been observed in western Marin and within PRNS boundaries (PRNS unpublished data). Wild turkeys are generalists and acorns can make up a significant portion of their diets. As a result, turkeys compete directly with a number of wildlife species dependent on mast. Along with a countywide increase in wild turkey numbers, Alternative A would constitute a cumulative adverse impact to wildlife species dependent on acorns.

Conclusion

Data on current and past population growth of fallow and axis deer at PRNS indicate that this alternative will result in an increase in non-native deer numbers within the Seashore and throughout Marin County. No impairment to native wildlife would occur from implementing Alternative A. Based on research on impacts of non-native deer to wildlife in other countries as well as known impacts of grazing by cattle and white-tailed deer in the U.S., the impacts of Alternative A are expected to be beneficial to a few native species and adverse to a larger number of native species. Pockets of extremely high non-native deer density, such as those currently seen in Olema Valley, are likely to be found increasingly throughout Marin County. Native species richness and diversity would likely decrease in those high-density areas. Overall, the magnitude of impacts to native wildlife within NPS boundaries are considered moderate in intensity, adverse and long-term, and those outside the boundary have the potential to become major in intensity.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate inside Seashore; major outside

Impacts on Special Status Species

This category includes federally listed wildlife species identified, other species of concern recognized by the state of California or Birds of Conservation Concern (U.S. Fish and Wildlife Service) include several species of nesting land birds and raptors. The project area supports 47 listed animal species; 14 of these have federal status as endangered, 8 as threatened and 24 as species of concern. Nineteen federally listed plant species (seven of which are also state listed) and an additional 25 listed or proposed for listing by the California Native Plant Society (CNPS) have been documented in the project area.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect federally and state listed species, anecdotal and historical evidence and expert opinion can provide insights and guidance. The federally listed species that are likely to be affected by non-native deer include northern spotted owls (*Strix occidentalis caurina*), western snowy plover (*Charadrius alexandrinus nivosus*), California red-legged frog (*Rana aurora draytonii*), Coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorynchus mykiss*), California freshwater shrimp (*Syncaris pacifica*), and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

Analysis

Northern spotted owl

The northern spotted owl is a federally threatened species that reaches the southern limit of its range within GGNRA, PRNS and Muir Woods National Monument (MWNM) in Marin County, California. Data collected by the NPS indicates that these parks may support the highest density of spotted owls known. However, the population is geographically isolated and subject to unique threats including urban development, intense recreational pressure, habituation of owls to humans, potential for catastrophic wildfires, and changes in hazardous fuel management practices. Owls occur throughout the forested lands in the Seashore and the population is likely stable; however, owls have been monitored for only 7 years in the Seashore (NPS and PRBO, unpublished data). Owls prey almost exclusively on small mammals, particularly dusky-footed wood rats (*Neotoma fuscipes*) in the Seashore (Chow and Allen, unpublished data). Woodrats, in turn, are dependent on roots, stems, leaves, seeds and mast (Linsdale and Tevis 1951, Willy 1992).

Fallow deer have been recorded in areas where spotted owls nest and roost. To date, no direct effects have been noted on the productivity or survival of owls. However, deer compete with the prey species of owls, and therefore, likely have an indirect negative impact on food resources. By biting off buds and flowers they reduce the amount of seed and fruit available in autumn and winter. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls and kestrels, especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely minor adverse impact on rodent prey base due to competition for forage, Alternative A would have an indirect, minor, adverse impact on northern spotted owls. Overall, the adverse impacts of Alternative A to owls in the Seashore and in Marin County would be minor and long-term.

Western snowy plover

Western snowy plovers, federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS), nest along the sandy beaches of the Seashore, primarily on Point Reyes Beach between North Beach and Kehoe Beach. Historically, plovers also nested at South Beach, Drakes Beach and Limantour. Plover nesting success has increased slightly over the past few years due to intensive management by the Seashore; however, the species is vulnerable to numerous activities in the park including predation by ravens and disturbance by recreationists. Fewer than 20 chicks fledged in 2004 (Peterlein 2004). Cattle roaming on the beaches in the past were a potential source for disturbance; however, the Seashore now intensively restricts cattle from beaches. A large herd of 60 axis deer has been seen on South Beach within the last five years, and where the herd occurred, the ground was heavily impacted (S. Allen, NPS personal communication). The frequency of this activity by axis deer is unknown but likely does not occur with regularity. Consequently, the overall impact of Alternative A to plovers in the Seashore is likely minor, depending upon whether plovers nest again at South Beach or whether axis deer expand onto the North Beach to Kehoe Beach area.

California Red-legged frog

The California red-legged frog is Federally listed as a Threatened species. Red-legged frogs breed in ponds or pools during the wet season (December through March), and use ponds and/or riparian habitats during the rest of the year. Fallow deer regularly frequent riparian areas and will vigorously rub and

thrash their antlers during the rut, resulting in maiming and destruction of riparian vegetation. While engaged in this activity, fallow deer may trample frogs. Damage to the vegetation could lead to degradation of non-breeding habitat. Overall, the adverse impacts of Alternative A to frogs in the Seashore and in Marin County would be minor and long-term.

Coho salmon and steelhead trout

Anadromous fish, listed as threatened by USFWS, occur in many of the streams of the Seashore, particularly in Olema Creek and Lagunitas Creek. The Seashore contains 10% of the last remaining wild population of Coho salmon for this Ecologically Significant Unit (ESU), and consequently, any loss of this population would have an impact on the ESU. The NPS, along with the National Marine Fisheries Service and the California Department of Fish and Game, have conducted intensive fish surveys and have funded and implemented numerous restoration projects along the streams that flow through the park and adjacent lands. Numerous culverts have been removed along with other blockages to fish passage. In addition, the agencies have installed fencing to restrict cattle from riparian areas. These fences, though, do not impede the movement of fallow deer.

Fallow deer regularly frequent riparian areas and damage the riparian vegetation, particularly during the rut when bucks thrash branches and leaves with their antlers. While engaged in this activity, fallow deer may indirectly affect the fish by damaging riparian plants, resulting in: reduced cover, warmer water in streams and drying up of streams due to exposure to sunlight. Increased numbers of fallow deer would increase the scope and intensity of this impact to riparian vegetation. In addition, an unmanaged and expanding population of non-native deer would reduce the success and effectiveness of riparian restoration projects for salmon due to grazing and thrashing pressure on recovering native riparian vegetation. In restoration areas, revegetation efforts and natural regrowth would be severely retarded due to heavy grazing and antler rubbing. Different from browsing where leaves are plucked from a stem, this constant grazing and thrashing would prevent native riparian plants from growing beyond shrub height. In riparian areas where large numbers of fallow deer congregate or travel, fish redds could be trampled, adversely impacting reproduction in both species. Overall, the adverse impacts of Alternative A to anadromous fish in the Seashore and in Marin County would be minor and long-term.

California Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is listed by the USFWS as Endangered. The shrimp inhabits lower Lagunitas Creek and lower Olema Creek, within the current fallow deer range at PRNS. Shrimp are highly dependent on overhanging riparian vegetation, under which they live year-round. Fallow deer have not been observed within known shrimp habitat. However, in other areas of both Lagunitas and Olema Creeks, high densities of fallow deer have been observed to browse and trample riparian vegetation (Brannon Ketcham, NPS, personal communication). An increase in fallow deer range, resulting from Alternative A would likely cause loss of shrimp habitat thus adversely impacting shrimp survival at all stages of the life cycle.

Myrtle's silverspot butterfly

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) (MSB) is one of three coastal subspecies of *S. zerene* in the Western United States. The USFWS listed the subspecies as Endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992).

As of 1998, three populations are known to remain. The USFWS Myrtle's Silverspot Butterfly Recovery Plan (1998) estimated the three populations combined comprise 10,000 individuals. Two populations of

MSB occur within the Seashore and the third is on private land in northern Marin County. The Center for Conservation Biology at Stanford monitored distribution and abundance of the MSB at Point Reyes National Seashore almost yearly from 1992 to 1998. The Stanford survey work shows a decline in MSB population levels during the six-year period and the central population to be "barely existing" (Launer et al.1998). Grazing is believed to deplete the MSB larval host plants. The Seashore is currently supporting an intensive survey of the habitat of the MSB and research on the current abundance and distribution of the larval host plant and adult nectar sources.

The PRNS coastal dune system and coastal prairie provide critical habitat for the federally endangered Myrtle's silverspot butterfly. Many different plants are used by the MSB as nectar sources; native plants (*Grindelia rubicaulis, Abronia latifolia, Monardella undulata, Erigeron glaucus,* and *Wyethia sp*.), as well as non-native bull thistle (*Cirsium vulgare*) and Italian thistle (*Carduus pycnocephalus*). The only known larval host plant is the western dog violet (*Viola adunca*).

Axis and fallow deer frequent coastal prairie habitat. To date, it is not known whether they browse on the preferred nectar or larval host plants of the MSB. Research in which deer-proof exclosures were monitored in the New Forest in England showed that fallow deer preferentially consumed a *Viola* species in a 1969 but not in a repeat survey in 1978 (Putman 1986). In Hawaii, the introduction of axis deer and mouflon sheep to Lana`i have likely played a major role in the disappearance of *Viola lanaiensis* (USFWS 1995a). Another Hawaiian species, *Viola kauaensis* var. *wahiawahensis,* is also listed as endangered by USFWS because of perceived threats of habitat degradation by feral animals and axis deer (USFWS 1995b). It therefore seems likely that non-native deer, given the opportunity, would graze on the MSB's larval host plant.

Intensive grazing would further threaten the availability of these plants for the butterfly. If the fallow and axis deer populations continue to increase, the impact to the vegetation used by this butterfly would likely increase. Overall, the adverse impacts of Alternative A to Myrtle's silverspot butterfly in the Seashore and in Marin County would be moderate to major and long-term.

Bird species of concern

The Seashore has collaborated with the Point Reyes Bird Observatory (PRBO) over the past two decades to protect and restore habitat of nesting land birds within the boundaries of the Seashore. Many species of land birds are species of concern both under the California Bird Species of Special Concern (CDFG) and the Birds of Conservation Concern (FWS). Examples of species include common yellowthroat *(Geothlypis trichas sinuosa*), California Swainson's thrush *(Catharus ustulatus oedicus),* and tricolored blackbird *(Agelaius tricolor).*

Numerous restoration projects and fire management actions have strived to improve nesting success in land birds, particularly in riparian areas. In addition, the park is an active member of the Partner-in-Flight program, collaborating with other agencies and organizations to protect and restore populations of neotropical migratory songbirds. PRBO has monitored the reproductive success and species composition of birds for more than 30 years. Monitoring has taken place in areas of the park (Palomarin) where fallow deer occur only rarely.

In areas where fallow deer are abundant, there often is a well-defined browse line on trees and shrubs between 1.5 and 2 meters above the ground. Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests have suggested that some bird species, namely understory nesters, declined with high deer grazing pressure (Fuller 2001). Similarly, ground or low nesting (approximately 0.0 – 3 meters) bird species found in the Seashore are vulnerable to heavy grazing by non-native deer. These species are found in habitats where the greatest impacts from large

herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). There may be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. The potential impacts on reproductive success and survival are unknown. Overall, the adverse impacts of Alternative A to understory nesting songbirds of concern in the Seashore and in Marin County would be moderate to major and long-term.

Plant Species of Special Concern

This category includes federal, state, and California Native Plant Society (CNPS) listed plant species identified below. Grazing by wild ungulates plays a role in the life history of many special-status plant species by removing understory and maintaining open habitat, encouraging reproduction in some species, and affecting competing species. Grazing can be detrimental to native plant species, especially when timing, frequency, and intensity are outside of the natural cycle to which the species is adapted (Archer and Smeins 1991). Grazing in California grasslands has been found to differentially affect various native life-history guilds such as annual or perennial forbs and grasses (Hayes and Holl 2003).

Analysis

Although no research at PRNS has been conducted to document the extent to which non-native deer affect plant species of special concern, anecdotal and historical evidence and expert opinion can provide insight and guidance. Rare plants have been inventoried at Point Reyes National Seashore over the past twenty years. The preponderance of this information is presence/absence data for species of concern, with some additional data describing distribution of select species. Given the substantial amount of plant distribution data, it is important to note that this information only describes known rare plant occurrences. Obviously there are many acres within the Seashore that have not yet been surveyed for rare plants. Impacts related to rare plants, therefore, can only be estimated in terms of limited best available information.

Rare plants known to occur within current axis deer range include:

- *Arabis blepharophylla*, coast rock cress
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Cordylanthus maritimus* ssp. *palustris*, Point Reyes bird's beak *
- *Fritillaria liliaceae*, fragrant fritillary
- *Grindelia hirsutula* var. *maritima* San Francisco Bay gumplant
- *Limnanthes douglasii* var. *sulphurea*, Point Reyes meadow foam*
- *Linanthus grandiflorus*, large-flowered linanthus
  Triphysaria floribundus, San Francisco owl's clover

Rare plants known to occur within current fallow deer range include:

- *Abronia umbellata ssp. breviflora*, pink sand-verbena
- *Agrostis blasdalei*, Blasdale's bent grass
- *Arabis blepharophylla*, coast rock cress
- *Arctostaphylos virgata*, Marin manzanita
- *Astragalus pycnostachyus* var. *pycnostachyus*, coastal marsh milk-vetch*
- *Calystegia purpurata* ssp. *saxicola*, coastal bluff morning-glory
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *gloriosus*, Point Reyes ceanothus
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Chorizanthe cuspidata* var. *cuspidata*, San Francisco bay spineflower

- *Cordylanthus maritimus* ssp. *palustris*, Point Reyes bird's beak *
- *Elymus californicus*, California bottlebrush grass
- *Fritillaria affinis* var. *tristulis*, Marin checkerlily
- *Fritillaria liliaceae*, fragrant fritillary
- *Gilia capitata* ssp. *chamissonis*, dune gilia
- *Grindelia hirsutula* var. *maritima* San Francisco Bay gumplant
- *Linanthus grandiflorus* large-flowered linanthus
- *Microseris paludosa*, marsh microseris*
- *Perideridia gairdneri* ssp. *gairdneri*, Gairdner's yampah
- *Polygonum marinense*, Marin knotweed
- *Ranunculus lobbii*, Lobb's aquatic buttercup*
- *Sidalcea calycosa* ssp. *rhizomata*, Point Reyes checkerbloom*
- *Triphysaria floribundus*, San Francisco owl's clover

Non-native deer can impact rare plant species directly by consuming and trampling them. PRNS staff observed fallow deer digging up and eating *Fritillaria sp.* bulbs within the burned area after the 1995 Vision Fire (Sarah Allen, NPS, personal communication). It should be noted that damage to *Fritillaria sp.* and other lily species has been observed outside exotic deer range, presumably caused by black-tailed deer or other herbivores (Michelle Coppoletta, NPS, personal communication). Based on analyses of deer diets conducted in Point Reyes, it can be inferred that after a major vegetation-changing event such as a wildfire, both axis and fallow deer will seek other food sources to supplement a depleted diet (Elliott 1983). This might include heavier foraging on bulb species.

Other species that may be impacted would be those occurring in areas of high-density herd congregations, where damage to plants through trampling would occur. Fallow deer herds have been observed often in grassland, evergreen scrub, and Douglas fir/redwood plant communities (NPS 2001b). These communities provide habitat for each of the plant species listed above. Adverse impacts to rare plants in the Seashore are currently considered to be minor and short-term. Alternative A would result in increased ranges and densities for both species and would likely lead to adverse impacts which were moderate and long-term.

Of the above listed species, several occur in wetlands or saltmarsh habitats. It is highly unlikely that these species are affected by non-native deer activities. These species are so noted with a "*".

There are no means of mitigating for impacts of non-native grazing herbivores to the species of special concern of the Seashore.

Alternative A will likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, 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. Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin and Sonoma Counties, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, impacts to the species described above could become substantial, highly noticeable, or with the potential for landscape-scale effects. Therefore the intensity of such adverse, long-term cumulative impacts could be characterized as major.

Cumulative Impacts

NPS has developed a Fire Management Plan (FMP) to outline future management of the fire program at PRNS and the North District of Golden Gate National Recreation Area. This plan includes a number of action alternatives that call for increased use of prescribed fire as a management tool to enhance natural resources and guard against catastrophic fire. Up to 2000 acres of additional park natural and wilderness areas could be burned or mechanically treated over the next decade as a result of the FMP. In light of observed consumption by non-native deer of rare bulb species after the 1995 Mount Vision fire, grazing pressure on *Fritillaria sp.* and other rare species in burned areas could increase after prescribed burns. Along with any increased burning of parklands, Alternative A would constitute an adverse cumulative impact to rare plant species within the Seashore.

Species specific cumulative impacts from both large-scale fire and other relevant sources are described below:

Northern Spotted Owl. Cumulative impacts to spotted owls come from development, visitor use, habitat changes, and can come from large-scale fire.

Visitor use in the park is expected to increase along with the projected human population increase in the San Francisco Bay Area. With increased visitor use of the park, the potential for human disturbance of owls along trails may increase. To reduce visitor impacts to owls, the park does not publish the location of owl activity centers and distributes a flyer on how to behave around owls.

Oaks in Marin and Sonoma counties have been dying suddenly over the past few years as a result of a fungus. The die-off, called Sudden Oak Death (SOD), has spread throughout Marin County and is currently in some owl habitat in the park. The death of the oaks results in local changes in percent cover and in food availability of the dusky footed woodrat, the primary prey of owls, at PRNS (Chow and Allen, 1996). Widespread habitat conversion is not expected from SOD in the study area; however, park biologists are monitoring the distribution of the die-off.

An ongoing threat to spotted owls is development, which removes habitat and creates smaller blocks of forest, or forest that is discontinuous. Smaller isolated tracts of forest that would otherwise be suitable do not meet the needs of spotted owls, which require large contiguous blocks. Private land without conservation easements or other protection is most vulnerable to development. Several purchases of conservation easements, state parks and A-60 zoning (one house per 60 acres) has contributed positive cumulative impacts for owls.

The impact of a large wildfire on spotted owls would be habitat destruction. This species requires greater than 60% total canopy cover for nesting/roosting with large overstory trees, large amounts of down woody debris and the presence of trees with defects or signs of decadence in the stand. This old growth type forest in the park may have the high fuel loading and ladder fuels to feed a hot stand-replacing fire, which would eliminate the habitat for many years. In a large wildfire, such as the Vision Fire, the chances of directly destroying nests or habitat could be quite high. Suppression activities such as water and retardant drops would have an adverse effect on spotted owls if they occurred over nesting habitat and, especially, nests. Such events are less likely than direct destruction of nests or habitat to occur, and impacts would be mitigated if nest sites and probable nesting habitat could be avoided.

Red-legged Frogs. As noted above, lands outside of PRNS and GGNRA offer substantial protection for wildlife through conservation easements, zoning, and low-impact land use practices. Extensive areas adjoining the study area preserve nearly 25,000 acres of public land, thousand of acres of conservation land privately held by non-profit groups, and over 30,000 acres of private land with conservation

easements preventing development. In addition, much of western Marin is zoned at a very low density, particularly where it adjoins watersheds where red-legged frog habitat exists.

Additional impacts to frogs may come from restoration projects such as of the Giacomini wetlands or of fisheries in streams where frogs are known to occur. Impacts would be avoided, minimized, or mitigated however, and all project sites would be reviewed prior to implementation with the park GIS database. If there were potential for a take, the park would have staff specialists survey the site and provide recommendations for avoidance or mitigation. In the long-term, these fisheries restoration projects would benefit frogs by enhancing natural processes, including reduction of erosion and stream temperature and enhanced water quality.

Human activities may have had both direct and indirect effects on red-legged frogs. Development has removed habitat, and logging or other activities may have adversely affected geomorphological stability, erosion rates or river channels. For example, historic logging of parts of Inverness Ridge, channel alterations in the lower 2.8 km of Olema Creek, and the effects of highway culverting have removed suitable habitat along Olema Creek and its tributaries may have been. Areas of downcutting, bank cutting, and sedimentation are present along the mainstem and its tributaries, resulting in a probable reduction in numbers of backwaters and pools.

Ranching may also have adversely affected frog habitat, although since coming under NPS ownership and oversight, ranching practices on PRNS ranchland have been modified in ways that have likely benefited California red-legged frogs. Especially effective have been the reductions of cattle numbers on excessively grazed ranchlands and exclusion of cattle from a number of wetland sites. The species appears to be thriving under the current PRNS management of grazing lands, although cattle may be having adverse impacts in some locations. Fire can adversely affect frogs by removing riparian vegetation, and through the increase in sedimentation accompanying vegetation removal.

Coho and steelhead. Dating back to the late 1800s, West Marin County was a popular destination for salmon fishing. Records of salmon hatchery releases to Lagunitas Creek and even Bear Valley Creek occurred even in the 1890s. Interviews with long time residents and fisheries managers suggest that coho and steelhead in the project area have been declining since the turn of the century, with significant declines occurring as late as the mid-1950s. Anecdotal information suggests that salmonids were abundant in the Lagunitas/Olema Creek drainage before extensive alteration by dam-construction, logging, and channelization. On its 1996 federal listing, the Lagunitas watershed, including Olema Creek, was documented to support 10% of the Central California Coast coho population (Brown et al. 1994, NOAA Fisheries 1996).

The mouth of Lagunitas Creek and adjacent floodplain supports activities associated with the Waldo Giacomini dairy. This 563-acre property, once tidal wetlands, was diked and drained in the early 1940s to create pastures. For many years, a gravel dam was constructed annually just below the confluence of Lagunitas and Olema creeks for irrigation and stock watering. The dam created an abrupt transition from fresh to saline water for smolts and spawning adults, eliminating the transition zone found in an unimpaired estuarine system. The transition zone allows smolting fish time to adjust to saline conditions and provides productive feeding zones where both freshwater and saltwater invertebrates are available (SWRCB 1995).

The dam and the levees concentrated the area where spawning fish could hold and smolts could feed, and increased the potential for predation. While the annual construction of the dam has been discontinued, the levees are still in place. PRNS as acquired these lands and is developing a restoration plan. A phased restoration project requiring from five to ten years is planned to begin after final acquisition in 2007.

Such restoration is expected to improve estuarine smolt and adult emigration habitat for both coho and steelhead.

The Coastal Watershed Restoration Project, proposed for nine sites within the Drakes Estero Watershed is planned for construction in 2006. The activities proposed through this project will remove or replace facilities such as road culverts and impoundments that impede natural freshwater and estuarine process. All treatment sites will meet fish passage design guidelines established by the NOAA Fisheries and CDFG (NOAA Fisheries 2001, CDFG 2003).

A large-scale wildfire could have moderate impacts on either fish species by removing riparian vegetation, increasing water temperature and removing upslope vegetation, with resultant increases in erosion and sedimentation.

Western Snowy Plover. Along the California coast, western snowy plovers have been extirpated from 33 of 53 nesting sites since 1970, and now number approximately 1,400 birds (USFWS 1993). Although it is not one of the eight areas that support 78 percent of the California coastal breeding population, PRNS is 1 of only 20 remaining plover breeding areas in coastal California (USFWS 1993). The Point Reyes peninsula is one of the largest relatively undisturbed beach habitats on the California coast, providing a large area of potential snowy plover habitat free of threats that have impaired habitat elsewhere, such as development, ORV use, and heavy visitor use.

Fledging rates for snowy plovers before nest protection began were insufficient to maintain the species at PRNS, as indicated by declining numbers of nests and nesting adults in the period 1986-1995. Continuation of such low nest success rates could have resulted in loss of the PRNS breeding population of snowy plover. The current nest protection program has raised nest success rates to levels similar to those at other coastal California locations (USFWS 1999a), but would be costly to maintain indefinitely.
Myrtle's Silverspot Butterfly. The largest numbers of Myrtle's silverspot butterflies documented in the early 1990s occurred on private land in the vicinity of Estero de San Antonio in Marin County northeast of PRNS. A golf course development proposed at that time was withdrawn, and the area is currently ranchland grazed by cattle and sheep. It is given a measure of protection from development by Marin County's agricultural zoning and policies to maintain the integrity of ranchlands in the western half of the county. Several of the ranches in the habitat area have sold development rights to the MALT, an organization seeking to preserve agricultural land in western Marin County. Any proposed development would have to comply with requirements of the ESA to protect the Myrtle's silverspot.

While it is difficult to determine the status of Myrtle's silverspot population at PRNS given current information, the species does not appear to be at risk of extinction in the near future. Cattle grazing has been identified as only one of a number of possible reasons for the species decline, but is also considered valuable in maintaining Myrtle's silverspot habitat.

While several areas have been identified where grazing may be adversely affecting the species' habitat at PRNS, overall grazing management has helped maintain a variety of plant cover conditions in Myrtle's silverspot habitats.

Non-native wild turkeys (*Maleagris gallopavo*) have existed in Marin and Sonoma Counties since their release by CDFG in the 1970s. Since 1995, increasing numbers have been observed in western Marin and within PRNS boundaries (PRNS unpublished data). Wild turkeys are generalists and mast, berries and seeds can make up a significant portion of their diets. As a result, turkeys compete directly with a number of wildlife species dependent on mast.

Conclusion

Based on current and past data on fallow and axis deer, the populations will continue to increase, resulting in expanded range and higher animal concentrations within the Seashore and Marin County. Ongoing impacts to species of special concern range from minor to major, although beneficial cumulative impacts to riparian species through habitat conservation are also ongoing. No impairment to special status species would occur from implementing Alternative A. All of the impacts associated with the presence and/or expansion of these populations are characterized as adverse. While short-term levels of adverse impact intensity are considered minor, continued growth and expansion of the population will result in increased impact intensity to moderate.

Type of Impact:	Adverse
Duration of Impact:	Mixed - both short-term and long-term
Intensity of Impact:	Minor in the short term, moderate in the long-term

Impacts on Human Health and Safety

Analysis

One of the actions common to all alternatives includes monitoring non-native deer numbers through ground or aerial surveys. Use of aircraft to monitor deer numbers or range expansion may result in minor, short-term adverse safety impacts to staff and visitors because of the risk of aircraft accidents. This risk is mitigated by strict adherence to Office of Aircraft Safety (OAS) and FAA regulations and policies for all NPS aerial operations (Director's Order #60).

In Alternative A, the numbers and range of both species of non-native deer are expected to increase, likely spreading beyond Seashore boundaries on to private and other public lands. A concomitant increase in deer-vehicle collisions over current levels, and throughout Marin County, is expected as a result. Such potential collisions constitute a minor, long-term adverse impact to human safety, both inside and outside Seashore boundaries.

Cumulative Impacts

There are no known cumulative impacts associated with Alternative A.

Conclusion

Because of increased risk of deer-vehicle collisions, the No Action alternative would result in minor adverse impacts to human safety for staff, Seashore visitors and Marin County inhabitants. Because such impacts can be expected to recur indefinitely, they are characterized as long-term. When compared to all other alternatives, the No Action alternative would result in the greatest level of risk to human safety in this regard, although the use of firearms and possibly of aircraft to manage deer in each action alternative would present a higher safety risk overall.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Minor

Impacts on Visitor Experience

Analysis

As a result of Alternative A, fallow and axis deer will increase in number in areas throughout the Seashore and opportunities for viewing non-native deer would increase slightly, a negligible to minor, long-term benefit to the visitor experience for the majority of park visitors who hold aesthetic views as described in Affected Environment. Conversely, for those visitors seeking to view native black-tailed deer or who have more ecologistic views, a minor, long-term adverse impact is expected. Native deer viewing opportunities would be fewer and might require more time and effort on the part of the visitor because of adverse effects of non-native deer on native ungulates (see above Impacts on Wildlife – Alternative A). Under all action alternatives, the opportunities to view native deer species would improve as a result of the reduction of non-native deer numbers.

Increased numbers and density of non-native deer grazing in pastoral, wooded and riparian areas could change scenic viewsheds by suppressing undergrowth vegetation, shrubs and brush. The areas where such changes are most likely to be apparent to visitors are in Olema Valley (from fallow deer) and in the western pastoral areas of the Seashore (from axis deer). In these areas, agricultural grazing is the primary determinant of scenic viewsheds. The contribution which non-native deer would make to altering viewsheds is likely to increase over time with increasing deer densities, a negligible to minor adverse, long-term impact to the visitor experience related to viewshed enjoyment.

Monitoring of non-native deer occurs via helicopter counts, which take place annually. The noise associated with these overflights would have a negligible long-term impact to visitors under this alternative.

Cumulative Impacts

Overflights to count other ungulates or for management purposes would have a cumulative, negligible adverse impact to visitor experience.

Conclusion

Based on data on current and past population growth of fallow and axis deer at PRNS, this alternative would result in an increase in fallow and axis deer numbers within the Seashore and throughout Marin County. When compared to action alternatives, the opportunities to view native deer would be notably decreased under alternative A, while the likelihood of viewing non-native deer increases. Therefore, impacts would be mixed depending on the social value of the visitor, but would be negligible or minor in either case. In addition, implementation of alternative A would likely increase adverse impacts to viewshed enjoyment over time as vegetation is removed.

Type of Impact:	Mixed, Both Adverse and Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Negligible to Minor

Impacts on Park Operations

Under alternative A, potential effects associated with a growing population of non-native deer would result in increased allocation of funds and staffing to monitor and mitigate impacts to a broad spectrum of

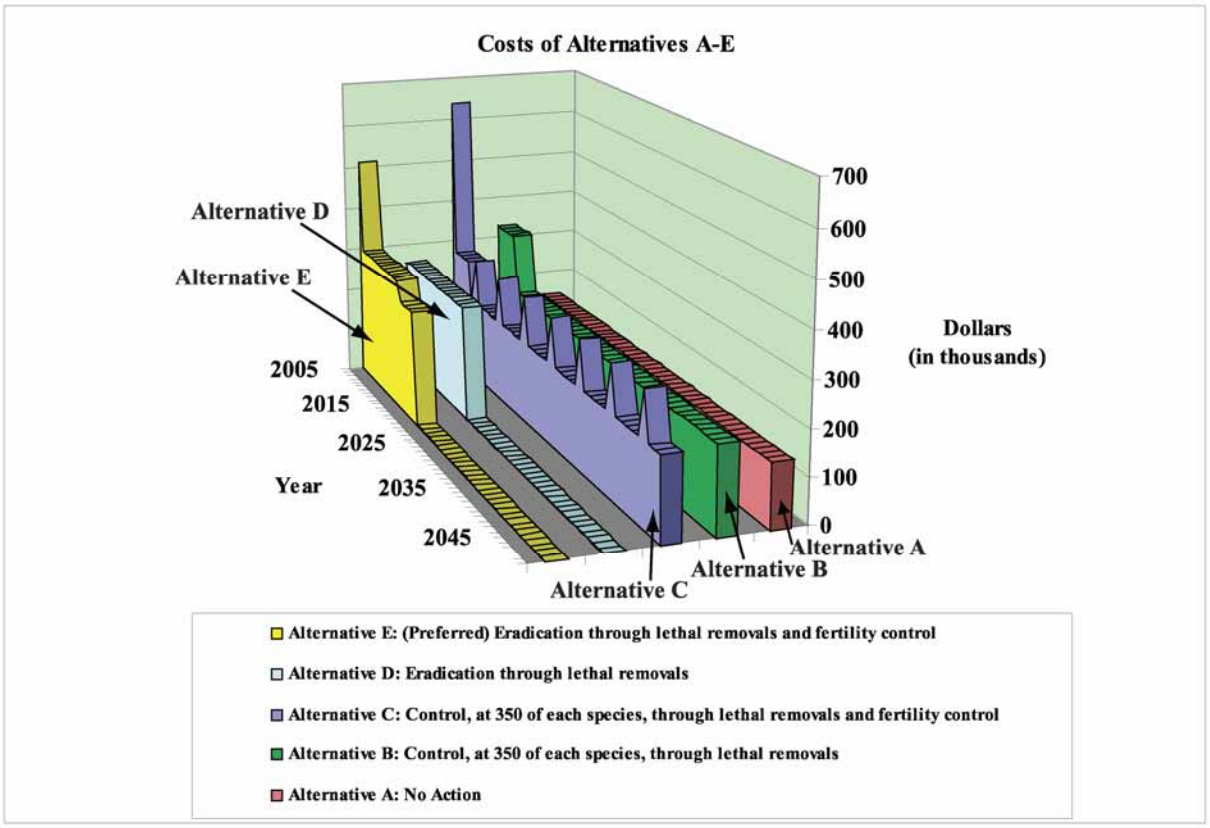
environmental, health and safety, and economic consequences analyzed elsewhere in this document.. Operational costs and commitments would be expected to increase from both internal considerations and from increased coordination and cooperation outside the park. In addition, because this alternative results in presence of non-native deer in the Seashore in perpetuity, the costs will be incurred indefinitely.

Analysis

A growing population of non-native deer would result in increased allocation of funds and staffing to deal with and mitigate impacts to a broad spectrum of environmental, health and safety, and economic consequences analyzed elsewhere in this document. All impacts to park operations associated with continued monitoring of non-native deer and alleviation of impacts to natural resources and agriculture would be adverse.

Costs related to monitoring of large populations of non-native deer in the park are associated with impact to natural and cultural resources. In FY 2003, personnel costs for 1.5 FTE (full time employees) and the costs of equipment, vehicles, supplies and staff for non-native deer monitoring (including one census yearly) are projected to total $126,000. Administrative and interpretive costs, excluding the costs of completing this document, likely comprise another $15,000. These costs, currently 2.9 % of the total PRNS annual budget, can be expected to double in the future with increasing non-native deer numbers and range. See Figure 12 for a comparison of the costs of the alternatives considered.

Figure 12: Comparison of Costs, Alternatives A-E.



Note: Totals illustrated above, for comparison purposes, are minimum estimates of projected dollars spent by PRNS on monitoring or control programs. Costs of mitigating impacts to natural resources (as described in Chapter 4) could not be estimated and were not included.

Continuing costs to the park of mitigating impacts of non-native deer are unknown and will increase as their numbers increase under the No Action alternative. Such continuing adverse impacts include:
Costs of disease monitoring and testing in areas of high deer density and where non-native deer are in close contact with livestock. Increased deer ranges and expansion into other areas in Marin County will require coordination and cooperation with state and federal regulatory agencies.

Costs of erecting exclosures or deer-proof fencing in areas where high deer densities are adversely impacting sensitive resources, i.e., riparian areas or populations of rare plants.

Costs of monitoring native species, such as native cervids, songbirds and special status species, adversely impacted by growing non-native deer numbers and range.

With increased densities and expansion of non-native deer beyond NPS boundaries likely under this alternative, the risk of costly litigation against the Seashore increases. Adverse impacts to agricultural lands outside the Seashore could engender suits against NPS from Marin County property owners. Increased numbers of deer-vehicle collisions, costly both in terms of human safety and material damages, as well as perceived risks to human health of aggressive non-native bucks during reproductive season, could engender suits against NPS from visitors and local inhabitants. All such litigation would result in substantial costs to the Seashore, in personnel time and potential monetary awards. Litigation costs are estimated at approximately $50,000.

Estimates for minimum cost for the implementation of the No Action alternative total approximately $2.1 million dollars by the year 2020. Thereafter, minimum annual costs could vary between $140,000 and $280,000 for an indefinite period of time. The cost of implementing alternative A, a 5-15% increase in the total PRNS annual budget, can be expected to continue indefinitely.

Under the No Action alternative, non-native deer monitoring, mitigation of damage to natural resources associated with non-native deer, and potential litigation expenses could result in moderate, long-term, adverse impacts to park operations a result of increased budgetary commitments.

Cumulative Impacts

Increased energy, inflationary, and health care costs, cost-of-living increases, along with static Seashore base funding, all result in recent yearly budgets in which personnel costs take an increasing share. Consequently, base funding for resource management projects is expected to continue to shrink as a proportion of the Seashore's yearly budget. Competition for funds will intensify in coming years between resource priorities, ranging from endangered species protection and restoration of degraded natural areas, to non-native deer management. Along with intensified competition for natural resource funding, Alternative A would adversely impact other important resource management projects in the Seashore and would represent an adverse, cumulative impact to park operations.

Invasive non-native species are playing an ever-increasing role in threatening native biodiversity worldwide and in national parks. Species such as ice plant (*Carpobrotus edulis*), European beach grass (*Ammophila arenaria*), the bullfrog (*Rana catesbeiana*), and the green crab (*Carcinus maenas)* all threaten rare native species in the Seashore and constitute a growing problem for resource managers charged with mitigating their impacts. Because the cost of mitigating impacts of increasing deer populations competes directly for funding and staff time with these projects, Alternative A would result in adverse, cumulative impacts to park operations related to the protection of sensitive natural resources.

Cumulative impacts of Alternative A are characterized as adverse, long-term and moderate.

Conclusions

In addition to cumulative impacts, park operations would be affected under this alternative as a result of greater demand on park staff to deal with increasing monitoring, impacts/mitigation for natural resources, associated management costs and possible litigation costs. All of the impacts associated with the presence and/or expansion of non-native deer are characterized as adverse and long-term (in perpetuity). Because additions in cost and/ or energy usage under the No Action alternative would constitute 5-15% of the total PRNS budget, the impacts are considered to be moderate. The No Action alternative, out of all the considered alternatives, represents the greatest level of potential adverse impacts to park operations as a result of the expected increase in financial commitments that would be required indefinitely.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate

Impacts on the Regional Economy

The impacts of growing population size and range would constitute an aggravation and an increase in scope of current impacts to ranchers and other farmers, both within and outside of the Seashore. Because non-native deer could be expected to spread into other parts of Marin County for the foreseeable future under the No Action alternative, growing impacts to agriculture would be long-term.

Analysis

No Seashore ranchers have reported any beneficial economic impacts of non-native deer. Conversations and letters from permittees indicate that current impacts to those ranchers who see non-native deer year-round include (refer to Chapter 3, Regional Economy, for greater detail on existing conditions):

- Fence repair costs ($500-$1000/yr/per ranch [4 reports])—damage by deer crossing.
- Costs of lost pasture forage (unknown costs [4 reports])—pasture forage consumption by non-native deer.
- Costs of lost supplemental feed (unknown costs [1 report])—supplemental food put out for livestock eaten by non-native deer.
- Costs of reseeding pastures ($9000/yr/per ranch [1 report])—overgrazing of fallow fields by non-native deer.
- Veterinary costs ($1200 in 2001 [1 report])—leptospirosis

.

Several cattle ranchers operating outside the Seashore boundaries described similar types of impacts and related costs of $3500-$4000/yr. One organic farmer located outside the park has experienced noticeable depredation of planted vegetables during the fall from fallow deer migrating out of the Seashore. Because the population of non-native deer would increase, and deer would very likely range to areas outside the park under the No Action alternative (no population management), long-term, moderate, adverse impacts to the regional economy are possible and could increasingly influence the economic viability of agricultural operations inside the park boundaries.

The No Action alternative could have a disproportionate socioeconomic effects on minority and low-income populations countywide if agricultural operations that hire low income farm workers were forced to downsize in the future because of losses due to expanding non-native deer populations. Such downsizing on low-income farm workers would have negligible to minor, long-term adverse effects on the regional economy.

Because the No Action alternative requires no park closures, there would be no anticipated effects to local tourist businesses.

Alternative A will likely result in increased range for both axis and fallow deer. Alterations in fallow deer range in the past 10 years suggest that fallow deer would continue to expand southwards and eastwards, 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, including pasturelands) exists in close proximity to PRNS, GGNRA and throughout Marin and Sonoma Counties. Although it is impossible to predict whether or not either species would successfully colonize other areas of Marin and Sonoma Counties, the successful colonization and spread of axis and fallow deer within the Seashore suggest that range expansion throughout at least some of those counties is likely. Should non-native deer populations outside NPS boundaries reach or exceed densities currently seen in PRNS, impacts to agricultural operations in Sonoma and Marin Counties are likely. Because the impact could be quite widespread, it could be moderate or major in intensity and would persist indefinitely.

Cumulative Impacts

A Biological Assessment was prepared in 2002 to review the proposed renewal of livestock grazing permits for areas managed by Point Reyes National Seashore (PRNS) and to determine to what extent renewing the permits might affect any of the federally listed threatened or endangered species (National Park Service 2002c). As mitigation for impacts of ranching operations on California red-legged frogs (*Rana aurora draytonii*), western snowy plovers (*Charadrius alexandrinus nivosus*), coho salmon (Oncorhynchus kisutch), and a number of listed plant species, the Seashore is requiring permitees to alter some ranching practices. Examples of such changes include increasing setbacks for livestock from riparian areas, delaying silage mowing, and improving drainage of livestock waste. Along with new requirements for agricultural permittees, increased numbers of non-native deer over a larger area of the Seashore resulting from this alternative could constitute minor, adverse, cumulative impacts to the regional economy.

Conclusion

Alternative A would continue existing minor adverse impacts to the regional economy indefinitely as non-native deer interfere with park ranching and grazing operations. Impacts to agricultural concerns could increase over time to a moderate, adverse level as the density of deer and the damage they cause increases. Negligible to minor, adverse socioeconomic impacts are also possible to low-income/minority farm workers should the viability of agricultural operations be threatened under this alternative. As the population of non-native deer expands outside the park, impacts to agricultural operations would become more widespread and could become major in intensity. When compared to all other alternatives, the No Action alternative would likely result in the highest degree of adverse effects to the regional economy.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate inside the park; major outside

Environmental Consequences of Alternative B – Control of Non-Native Deer at Pre-Determined Levels by Agency Removal

This alternative would control levels of fallow and axis deer to below estimated carrying capacity, at numbers that would be both logistically sustainable with NPS staff and funding, and would not likely lead to extinction of either species. In the 1970s and 1980s park staff controlled deer to 350 of each species. For purposes of analyzing impacts of this action alternative, the same levels (700 total non-native deer) will be assumed. Total numbers of non-native deer would be slightly less than current estimated numbers (approximately 250 axis deer and 860 fallow deer in 2003) but high densities of deer in certain areas would still be expected because of the tendencies of both species to congregate in large herds. Initially, only fallow deer numbers would be curtailed by yearly shooting. In the future, when axis deer numbers surpassed the pre-established limit (for purposes of this analysis, 350), this species would also be culled. The age, sex and numbers of deer culled would be determined by resource managers to ensure that populations were maintained at desired levels and to reduce risks of range expansion beyond Seashore boundaries. The impacts to natural resources would differ little between Alternatives B and C.

Impacts on Water Resources and Water Quality

Analysis

The types of impacts to water resources associated with the presence of non-native deer are described in Alternative A, and include:

- loss of riparian vegetation through trampling and consumption, with resulting increases in runoff and erosion;
- streambank destabilization and loss, which also adds to sedimentation in streams;
- changes in stream morphology including decreases in stream depth and increases in stream width; and
- increases in bacteria and nutrients associated with waste products.

Because fallow deer tend to congregate in large herds and remain in an area for a long period of time, these effects are likely to be noticeable over time.

In addition to these types of impacts, fallow deer rip and tear riparian vegetation during the rut when bucks aggressively rub and thrash their antlers. Impacts of fallow deer grazing and thrashing to riparian vegetation, hydrology and water quality are most acute within the pastoral zone in Olema Valley, where many riparian areas have been deliberately excluded (with fencing) from livestock grazing on order to restore canopy and natural hydrologic processes. In these areas, heavy grazing and antler rubbing by non-native deer have severely retarded revegetation efforts and natural regrowth (B. Ketcham, NPS, personal communication). Continual grazing of new shoots and seasonal thrashing by fallow deer prevents native riparian plants from growing beyond shrub height. As noted above, without vegetation, soils are much more likely to erode in streamside forests and shrublands and will degrade water quality.

Because it leads to decreased non-native deer numbers in the Seashore in the short-term, Alternative B will result in localized improvements to water resources and water quality compared to the No Action alternative. These improvements include increased streambank stabilization, regrowth of riparian vegetation and improved capacity for runoff absorption and sediments stabilization, lowered suspended solids and lowered sedimentation of streams as soils stabilize, and less likelihood that water will be contaminated with bacteria or nutrients associated with animal feces. However, although impacts to water resources and water quality would be less than those in Alternative A, they would remain minor in

intensity as the remaining fallow and axis deer would continue to congregate in areas adjacent to streams and have continued impacts as described above.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil erosion and potential for increased sedimentation of waterways. Alternative B specifies that NPS staff will attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country use of vehicles will rarely be used, particularly in wilderness and sensitive areas, adverse impacts to water resources from sedimentation resulting from this alternative are considered insignificant (See Appendix C- minimum tool analysis).

Past practice indicates that maintaining population sizes to 350 of axis and fallow deer is likely to keep them inside the Seashore boundaries. This is a potential substantial benefit of this alternative, compared to Alternative A, to regional water quality and water resources, since the expansion of the herds has the potential to exert the same types of impacts as described above on a regional scale if the No Action Alternative is adopted.

Unlike livestock impacts, where fencing and grazing limits may be enforced through permit authority, there are no means of mitigating for impacts of human introduced, non-native grazing herbivores to water resources and water quality.

Cumulative Impacts

Cumulative impacts of this alternative would be similar to those in Alternative A; that is, agricultural operations, removal of vegetation, burning and past logging practices have adversely affected many of the watersheds that are partially or completely inside the park, with the result that all watersheds inside the park exceed the recommended Total Suspended Solids standard. Restoration efforts, both inside the park and in partnership with other agencies are Beneficial impacts to park water quality are resulting from.

Maintaining populations of non-native deer long-term will perpetuate concentration-associated impacts to hydrologic process in the lands no longer managed for agriculture. This scenario may also reduce the success and effectiveness of riparian restoration projects due to grazing and thrashing pressure by non-native deer on recovering native riparian vegetation. Cumulative impacts will be adverse, minor and long-term.

Conclusion

Based on current and past data on fallow and axis deer, healthy non-native deer populations will remain, albeit at lower numbers, within the Seashore. No impairment to water resources would occur from implementing Alternative B. While benefits from slight population reductions would occur, continued presence of the two deer species will result in minor adverse impacts to hydrologic processes, aquatic habitat and water quality. Substantial benefits to water resources in the region relative to Alternative A are possible from reducing the risk of the expansion of non-native deer outside the Seashore.

Type of Impact:	Beneficial and adverse
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor

Impacts on Soil

Analysis

Alternative B would result in decreases in the number of fallow deer, and an increase to no more than 350 axis deer. Currently, fallow deer congregating in larger herds are responsible for the more noticeable impacts to soils, and a reduction from nearly 900 animals to 350 would reduce impacts from current levels.

The types of impacts non-native deer have on soils in the Seashore are described in the impacts of Alternative A. These include the compaction of soils, particularly in moist, riparian bottomlands of the Seashore, which leads to increased runoff and erosion. Axis and fallow deer also use riparian areas for feeding and shelter, and can consume large quantities of vegetation, or damage and destroy vegetation from trampling or breaking trails. Fallow deer trails are wider, cross streams and can erode substantially in the rainy season. Fallow bucks also destroy vegetation through behaviors during the rut, including polishing their antlers and scraping and pawing the ground. These areas of affected shrubland or forest can be quite obvious in the Seashore, as the bared ground is widespread over the area the herd has occupied and becomes erodable during the fall and winter. Each of these areas, where loss of vegetation and root stabilization has occurred, are subject to erosion and soil loss. If the impact is severe, it can be perpetuated indefinitely since vegetation does not grow back as readily where soils are compacted or where top layers are lost.

Unlike livestock, where fencing and grazing limits are effective, there are no means of mitigating for impacts of human introduced, non-native grazing herbivores to soil resources. However, the reduction in the number of animals in the park could mean at least some of these areas where deer congregate would not be occupied, or would be occupied with many fewer deer. It is possible that a negligible or minor improvement in soils in known fallow deer habitat would occur, although observations of impact when the herds have been maintained at 350 animals suggests the difference would not be highly noticeable. During the first few years, before axis herds increase and as fallow herds are thinned, a minor short-term benefit may occur.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil compaction. Alternative B specifies that NPS staff will attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country use of vehicles will rarely be used, particularly in wilderness and sensitive areas, adverse impacts to soils from compaction resulting from this alternative are considered negligible or minor.

The benefit of implementing this alternative to soils may be the much reduced risk of non-native deer expanding beyond park boundaries. If Alternative A were implemented, damage to soils could become regional in nature and major in its intensity. Relative to that alternative, maintaining the herds at 350 each could have substantial benefits to landowners outside the park.

Cumulative Impacts

Cumulative impacts to soils within the Seashore would be similar to those described for Alternative A. These include compaction, changed nutrient levels and denudation associated with livestock operations inside the park. The National Park Service conducts Residual Dry Matter surveys in the pastoral lands to insure that livestock do not denude the land through overgrazing. Tools to mitigate cattle overgrazing, included reducing stocking rates and rotational grazing have been implemented with success in the Seashore.

Soil compaction from cattle at the Seashore is restricted to the pastoral zone. Although non-native deer may feed in that zone as well, compaction by deer would not likely add more than negligible impacts to those caused by cattle. Parkwide, non-native deer may be adding to compaction in riparian areas and areas outside the pastoral zone.

Erosion from past practices like logging, and from the Vision Fire and development may add to impacts from non-native deer in the park.

Cumulative impacts will be adverse, minor and long-term.

Conclusion

Based on current and past data on fallow and axis deer, non-native deer populations would continue to adversely affect soils through trampling, compaction and denuding sites even at the lower population sizes that would exist if Alternative B were selected. No impairment to soils would occur from implementing Alternative B. A negligible to minor short-term improvement to soils in some localized areas currently used by deer could occur in the first few years, although the continued presence of large herds of axis and fallow deer would result in impacts similar to those in Alternative A, e.g. long-term minor, adverse impacts. Substantial benefits relative to Alternative A, from lower risk of non-native deer expanding outside the park and affecting soils regionally, are likely.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor

Impacts on Vegetation

Analysis

The types of impacts non-native deer can have on vegetation are described above under the Impacts of Alternative A. To summarize, they include consumption, trampling and loss from behaviors such as creating trails and antler thrashing during the rut. These, in turn, have indirect effects on vegetation, through increased compaction and erosion of soils, which make revegetation difficult; and through changes in nutrients and responses by plants to grazing. Deer also have impacts on the physical structure of vegetation, species richness and species composition across landscapes, as well as distribution of seeds and nutrients.

Heavy browsing by deer can remove the middle and lower levels of vegetation, and create a browse line that reaches from the ground to as high as the deer can reach. It can also keep trees and shrubs from reaching their full height, and can eliminate palatable species entirely from an area. In some cases, theses species are rare or protected, or the vegetative community affected by deer grazing is unique. In the extreme, ungulate grazing can change woodlands into grasslands, can prevent succession from open grasslands to shrublands or forests and can create vegetative communities composed of only a few species. In the park, one unique community that is heavily affected by fallow deer is riparian. Fallow deer congregate in streamside shrublands and forests, particularly during the rut, and may remain there for long periods of time. In addition to removing vegetation by grazing, deer trampling and compaction of soil, rutting behaviors and trail breaks can result in severe loss of riparian vegetation locally. In some cases, the park has deliberately attempted to restore riparian areas by fencing out cattle, only to have the fences breached by fallow deer and the riparian areas degraded. Densities of fallow deer can reach 80 per

square kilometer, several times higher than that of white-tailed deer in areas of Pennsylvania where significant changes in species richness and vegetative cover were noted (NPS unpublished data, deCalesta 1997).

Because it would quickly reduce total numbers of fallow deer in the Seashore, Alternative B would result in some short-term reduction of current minor, localized impacts to vegetative processes (associated with plant establishment and regrowth), habitat (associated soil erosion and plant growth rates), and plant diversity (associated with preferential grazing and browsing). However, as axis deer populations grow and the total number remains at 700, the difference in impacts to vegetation over the long term between this alternative and Alternative A are more likely to be negligible, and adverse minor impacts would persist indefinitely.

The benefit of implementing this alternative to vegetation may be the reduced risk of non-native deer expanding beyond park boundaries. If Alternative A were implemented, damage to vegetation could become regional in nature and major in its intensity. Relative to that alternative, maintaining the herds at 350 each could have substantial benefits to landowners outside the park.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor direct destruction of vegetation. Alternative B specifies that NPS staff will attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Indirect impacts from capture or culling operations would also include increased potential for the dispersal of non-native plant seed and vegetative propagules. In addition, operation of vehicles could compact soils and trample vegetation, making regrowth more difficult. Because cross-country use of vehicles will rarely be used, particularly in wilderness and sensitive areas, adverse impacts to vegetation from destruction resulting from this alternative are considered negligible or minor.

Cumulative Impacts

Cumulative impacts would be similar to those identified for Alternative A. These include ranching operations, as well as restoration operations conducted by the park. These restoration efforts include working with the agricultural community to modify operations within the lease areas to reduce adverse impacts associated with livestock concentration. Ranching operations have been reduced from their historic extent (the entire Point Reyes Peninsula) to only about 25% of the overall land area. Nearly all of the remaining 75% of Seashore lands are managed as natural or wilderness areas. Some of these areas are returning to shrub and forest communities without the “clearing” effects of livestock grazing.
In areas that are managed for agriculture, tools have been implemented to exclude livestock from sensitive areas, such as riparian zones and creeks.

Cumulative impacts are adverse, minor and long-term.

Conclusion

This alternative would maintain non-native deer at slightly reduced numbers within the Seashore and throughout Marin County. No impairment to vegetation would occur from implementing Alternative B. Based on current reports of damage to riparian and understory vegetation within the Seashore, the magnitude of current impacts to vegetation within NPS boundaries are currently considered minor in intensity. Under this alternative, the impact intensity is expected to decrease slightly initially, but remain at a minor because of localized high deer densities over the long term. Substantial benefits are likely relative to Alternative A from lowering the risk of non-native deer expansion outside the park and reducing impacts to vegetation regionally.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed - both short-term and long-term
Intensity of Impact:	Minor

Impacts on Wildlife

Analysis

In the following analysis, the best professional judgment of wildlife biologists, as well as research completed at the Seashore and elsewhere, have been used to provide guidance for evaluating impacts of increasing fallow and axis deer populations and range on other wildlife species.

Non-Native Cervids

The increased population size for axis deer, which would result from this alternative, would clearly benefit that species. Range would likely increase within the Seashore.

Because fallow deer populations would initially be reduced to 350, this alternative has adverse impacts for fallow deer in PRNS. Current fallow deer range maps suggest that fallow deer have spread recently towards the south and eastward borders of the Seashore. Any deer control program involving lethal removal of animals with firearms has the potential to scatter deer herds and push deer out of the Seashore into adjacent lands. Provisions in Alternative B that specify removing animals from the edges of the Seashore before culling animals deeper within the park would mitigate such scattering. However, large numbers of fallow deer on the Vedanta Society property would remain outside NPS management authority.

Impacts to non-native deer from Alternative B would be beneficial to axis deer and adverse to fallow deer. Because change in total deer numbers and range are expected to be small and Alternative B calls for maintenance of non-native deer in PRNS indefinitely, impact intensity is considered minor and long-term.

Alternative B, because it results in shooting of non-native deer, would cause a measure of pain and suffering to culled animals. The degree of pain and suffering would be mitigated by use of trained agency sharpshooters for all control operations. Efforts will be made to deliver immediately lethal shots to target animals and to minimize wounding. Sharpshooters would be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

Native Cervids

In their study of axis and fallow deer introductions nationwide, Feldhammer et al. (1993) stated:

> "We may expect competition between exotic and native artiodactyls both intuitively, and on the basis of previous field experiments with a variety of animal groups from various trophic levels and habitats…"

Native black-tailed deer are primarily browsers while both axis and fallow deer have been shown to be grazers. However, studies at PRNS have demonstrated that, during times of low forage availability, non-native deer adapt their feeding habits and consume larger amounts of forbs and browse (Elliott 1983, Elliott and Barrett 1985). Elliott could not detect statistically significant effects of non-native deer on black-tailed deer fawn production or survival. He suggested that densities of exotic deer present in 1973 ($\leq$ 17 deer / km² or 350 of each species) would not negatively affect the density of black-tailed deer. A

review of Elliott's 1982 dietary overlap study by Gary Fellers, a U.S. Geological Survey scientist, suggested that exotic deer at levels of 350 for each species could reduce the native black-tailed deer population size by up to 30%. If black-tailed deer numbers are strongly influenced by the energy content of their diet, the reduction in their population, when fallow deer number 350, could be as much as 40% below carrying capacity (Fellers 1983).

700 non-native deer would result in competition with native black-tailed deer for forbs and browse during droughts, at the end of summer, and year-round on poor quality ranges (Connolly 1981, Elliott 1983, Fellers 1983). Competition for limited forage would result in decreased condition in black-tailed deer (Brunetti 1976, Fellers 1983). It has been repeatedly shown in the scientific literature that poor condition in adult female cervids results in decreased reproductive capacity (Verme 1962 and 1967, Thorne et al. 1976, Keech et al. 2000). Competition for forage would likely result in reduced black-tailed doe fertility, decreased long-term fawn production and lower fawn survival, although, in the short-term, all these parameters would be improved over current levels. The magnitude of the impacts to black-tailed deer populations would depend on range conditions, precipitation patterns and non-native deer numbers but would likely range from minor to moderate and could be expected to last longer than two breeding cycles. It is important to note that adverse impacts to black-tailed deer from increased competition would occur throughout larger portions of the Seashore's pastoral zone and some natural areas if axis deer range expands in the future as a result of this alternative.

Continued presence of non-native deer in areas of the Seashore where free-ranging tule elk inhabit will likely inhibit expansion of the elk herd and may suppress elk numbers where the new free-ranging subpopulations are not well established. These areas include the southwestern wilderness areas of the park south of Drake's Estero and west of Inverness ridge.

Tule elk, like fallow and axis deer, are primarily grazers. Grasses constitute a large proportion of the diets of all three species year-round (Elliott and Barrett 1985, Gogan and Barrett 1985, Fallon-McKnight unpublished data). In addition to inhibiting further expansion of tule elk herds, 700 non-native deer in the Seashore will likely continue to adversely impact current elk populations in the Seashore through competition for forage (Brunetti 1976). Such impacts will be reflected in lower elk calving rates, delayed onset of reproduction in tule elk cows and reduced elk calf survival.

Direct behavioral competition between fallow deer and tule elk currently exists at PRNS and would likely continue, albeit at lower levels, with Alternative B. Researchers in the Zehusice Deer Park in the Czech Republic have documented behavioral exclusion of red deer (a subspecies of elk similar in size to tule elk) by fallow deer at high-density feeding sites (Bartos et al. 1996). Fallow deer at Zehusice were observed to: 1) be consistently more aggressive than red deer; 2) preferentially seek out feeding sites where red deer congregated; and 3) attack red deer from the rear as a strategy to overcome their larger opponents (Bartos 1996). In the Tomales Point Elk Reserve at PRNS, fallow bucks have been observed sparring with tule elk bulls (PRNS, unpublished data). In all observed instances, fallow bucks were successful in chasing away elk bulls in spite of a significant size disadvantage. The consequences of a decrease in behavioral competition are difficult to predict with certainty but could include *decreased exclusion* of elk from higher quality forage or habitat, improved condition of reproducing adults and ultimately, increased population growth.

Paratuberculosis, or Johne's disease, is an infectious and incurable diarrheal wasting disease of wild and domestic ungulates. In a study conducted at PRNS in 1979, paratuberculosis was documented in 9.6% and 8.1% of axis and fallow deer, respectively (Riemann et al. 1979). The disease has been documented in tule elk at Tomales Point Elk Reserve since 1980 but has never been found in PRNS black-tailed deer (Jessup et al. 1981, Sansome 1999, unpublished report). In 1998-1999, relocation of 45 adult tule elk from Tomales Point to the Limantour wilderness area included a 6-month quarantine and extensive testing for

Johne's disease (Manning et al., manuscript in press). Only those animals that consistently tested negative on all blood tests and fecal cultures were released in July 1999 to form a new free-ranging herd. This elk herd is currently made up of 34 animals. The goal of the relocation was to restore the dominant native herbivore to the Seashore's wilderness ecosystems.

Transmission of the organism that causes paratuberculosis (*Mycobacterium avium ss. paratuberculosis*) occurs primarily from infected adults to young animals. The period of greatest susceptibility for this infection is the first 6 months of life. The organism is shed by infected animals into feces that may contaminate feed, water, and pastures. The prevalence of the infection and the incidence of clinical disease may climb when an affected population approaches carrying capacity. At these high densities, affected herds experience the stressors of reduced forage nutritional quality and reduced ability to fight disease. This immunosuppression can result in increased transmission of infections, heavier parasite loads and progression to clinical illness. (Manning et al. 2003). Animals in the clinical phase of Johne's disease shed the organism more often and in greater numbers. Premise contamination with this hardy and long-lived organism may thus increase, a factor relevant to the health of numerous species. All cervids are believed to be susceptible to this infection (Manning and Collins 2001). In Alternative B, non-native deer populations would be controlled below carrying capacity. The potential for transmission to tule elk and black-tailed deer, which share their habitat, would be minor.

Genetic variability assists populations in adapting to environmental changes and reduces vulnerability to catastrophic events such as disease, abnormal weather cycles, pollution etc. Fewer than 4,000 of the 500,000 tule elk historically present in California, currently remain. Tule elk at PRNS have passed through four severe population reductions or "bottlenecks". With each bottleneck, the amount of genetic variability in the population has been reduced. It has been estimated that PRNS elk are among the most inbred in California, with a degree of relatedness equivalent to that resulting from three consecutive brother-sister matings (McCullough et al. 1996). Physical signs of inbreeding, such as cleft palate, have been observed in the Tomales Point herd (Gogan and Jessup 1985).

Management techniques to increase genetic diversity within and among wildlife populations include: 1) translocating animals between subpopulations, and 2) increasing the number of reproducing animals within each subpopulation (McCullough et al. 1996). For the past 5 years, NPS has cooperated with California Department of Fish and Game to transfer adult elk cows to Tomales Point, in order to increase genetic variability. One of the primary goals of the PRNS General Management Plan is to maintain viable populations of tule elk in the Seashore and to restore free-ranging elk to wilderness ecosystems. Alternative B would likely slow the growth of tule elk numbers required to increase genetic variability in the Limantour elk herd. Competition for resources with fallow deer and minor potential for transmission of paratuberculosis could adversely impact herd growth. Smaller numbers of breeding animals would result in lower genetic variability and increased risk of catastrophic population downswings.

Alternative B would result in:

- decreased tule elk and black-tailed deer food availability;
- slowed growth or reduction of tule elk and black-tailed deer numbers;
- decreased expansion of tule elk range; and
- reduced potential for increased genetic variability within a the PRNS tule elk population.

Depending on precipitation and range conditions, impacts to native cervids from Alternative B within and outside of NPS boundaries would be beneficial and minor in the short-term. In the long-term, continued presence of non-native deer in the Seashore would constitute minor to moderate adverse impacts.

Small Mammals

The impacts of 700 non-native deer on small mammals will occur in two ways: 1) by beneficial or adverse habitat alteration, influencing food supply and cover, and 2) by direct, adverse competition for resources, mainly, food (Flowerdew and Ellwood, 2001). In order to definitively demonstrate impacts of deer populations on small mammals at PRNS, large-scale deer exclosure experiments would have to be used to investigate responses at varied deer densities. Such experiments have not been carried out at PRNS. Evaluation of impacts to small mammals is guided by research completed in the U.S. and in the U.K. on fallow deer and white-tailed deer in lowland woodlands (Putman 1986, McShea 2000, Flowerdew and Ellwood 2001, Fuller 2001). Inventories of small terrestrial vertebrates, conducted at PRNS from 1998-2001 in the agricultural and ungrazed areas of the Seashore, were also considered in this analysis (Fellers and Pratt 2001).

In the Britain, heavy grazing pressure (100 deer/km²) by fallow deer in lowland forests caused reductions and even local extirpations of wood mice, bank voles and common shrews (Putman et al. 1989). The loss of palatable ground-level vegetation removes food sources for small herbivores and at the same time, changes microclimates and reduces protection from predators (Flowerdew and Ellwood 2001). Increased browsing of shrubs in forested habitat or on forest-grassland interfaces, as has been demonstrated in both axis and fallow deer at the end of summer and during droughts (Elliott 1982), could alter suitability of those areas for some species. High densities of fallow deer have been observed to alter riparian cover and vegetation at PRNS through browsing and antler thrashing (B. Ketcham, NPS, personal communication). Such high-density impacts could decrease cover and habitat for dusky-footed woodrat (*Neotoma fuscipes*).

Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). Densities of fallow deer in the Olema Valley areas of PRNS currently approach 80 deer/ km² (NPS 2002a) and could be expected to decrease in some of these areas with Alternative B. However, the Vedanta Society property, which supports the highest densities of fallow deer, is outside NPS management authority and no deer would be removed there. It is likely that deer densities would remain unchanged or might increase with Alternative B if deer from neighboring NPS lands are pushed on to Vedanta lands with park removal operations. Grazing pressure from deer in many Olema Valley sites is currently considered heavy. Should this grazing pressure continue or increase with Alternative B, species that could be adversely affected are the: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*). High, localized non-native deer densities resulting from Alternative B would likely reduce habitat for these species in limited areas of the Seashore. Higher axis deer densities resulting from Alternative B could impact small mammal habitat in other areas of the Seashore if axis deer range increases. The adverse impacts are considered minor and long-term.

Not all species decline with increasing deer grazing pressure. Grazing at intermediate and low deer densities has been shown to increase or have no effect on some plant and animal species in Britain (Fuller and Gill 2001). At PRNS, deer mice (*Peromyscus maniculatus*) were found more often in pastures grazed by cattle than in pastures where cattle were excluded (Fellers and Pratt 2002). It is possible that with the continued localized grazing pressure resulting from Alternative B, deer mouse abundance would increase in PRNS and countywide. The Valley pocket gopher (*Thomomys bottae*), another small mammal species that thrives in open grassland environments, could also remain unaffected or increase.

Direct competition for food between non-native deer and small mammals is a potentially adverse impact resulting from Alternative B. As stated before, definitive documentation of competition would require exclosure experiments. In the absence of such experimentation, evidence of dietary overlap between species has been evaluated. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). In addition, analyses of fallow and axis rumen and fecal samples have shown heavy use of many of the same species used by small mammals (Elliott 1982, Fallon-McKnight, unpublished data). Small mammals likely to be adversely affected by increasing competition for food are the: Pacific jumping mouse (*Zapus trinotatus*), California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus)*, western harvest mouse (*Reithrodontomys megalotis*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*).

Depending on local deer densities, weather patterns and the yearly mast crop, overall impacts to small mammals from Alternative B are considered to be adverse and range from mild to moderate in the Seashore. Because impacts will persist for longer than 2 breeding cycles, they are considered long-term.

Mammalian and Avian Predators

This category includes wildlife species, such as mountain lions (*Felis concolor*), coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), badgers (*Taxidea taxus*), weasels (*Mustela spp.*) and the raptors who prey on small mammals.

Although no research at PRNS has been conducted to document the extent to which non-native deer are preyed upon by carnivores, anecdotal and historical evidence suggest low-level predation, especially on fawns. Since their introduction in the 1940s, there has been a decrease in the proportion of observed white fallow deer, from 75% to 21%, suggesting that white individuals may be preferentially selected by predators (Wehausen 1973, NPS 2002a). An anecdotal report exists of an axis doe defending her fawn from a bobcat (NPS, unpublished data). Ranchers have reported coyotes preying on axis fawns in the pastoral zone (N. Gates, NPS, personal communication). However, because non-native deer congregate in large groups and prefer open habitat, it seems unlikely that they serve as a primary prey base for native mega- and meso-carnivores, who specialize on stalking black-tailed deer and small mammals. Alternative B would likely leave the prey base for mountain lions, coyotes and bobcats essentially unchanged over current conditions. The expected long-term decrease in both the black-tailed deer and small mammal prey base for these carnivores, foxes, weasels and badgers resulting from Alternative B would cause minor adverse impacts to these predators.

In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls (*Strix aluco*) and kestrels (*Falco tinnunculus*), especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely adverse long-term impact on their rodent prey base, especially in areas of high deer densities, Alternative B would have an adverse impact on birds of prey such as great-horned owls (*Bubo virginianus*), short-eared owls (*Asio otus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), red-shouldered hawks (*Buteo lineatus*), red-tailed hawks (*Buteo jamaicensis*), Northern harriers (*Circus cyaneus*), black-shouldered kites (*Elanus caeruleus*), sharp-shinned hawks (*Accipiter striatus*), and Cooper's hawks (*Accipiter cooperii*).

Overall, the adverse impacts of Alternative B to predators in the Seashore and in Marin County would be minor to moderate and long-term.

Other Birds

Little is known about the impacts of grazing wildlife on birds in the Seashore. In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle to ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Only one species, the savannah sparrow (*Passerculus sandwichensis*), was found in higher numbers in grazed grasslands.

Deer exclosure studies in Pennsylvania hardwood forests indicate that high densities of white-tailed deer (*Odocoileus virginianus*) cause declines in intermediate canopy-nesting songbirds. This study showed complete absence of certain songbird species, including American robins (*Turdus migratorius*), at deer densities over 25 deer/km² (deCalesta 1994). These declines are thought to occur because high deer numbers alter the structure of woody and herbaceous vegetation 0.5 - 7.5 meters above the ground (deCalesta 1994). Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests suggested that some bird species, namely understory nesters, declined with high deer grazing pressure while other species, namely bark foragers, benefited from reductions in understory vegetation. Researchers in British lowland forests determined that "losers" substantially outnumbered "winners" and that breeding populations of migrant birds were especially vulnerable to adverse impacts from heavy deer grazing pressure (Fuller 2001).

Table 10 lists the ground or low nesting bird species (nesting at approximately 0.3-3 meters) found in the Seashore. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). Impacts to the species listed would likely occur in a manner similar to the Pennsylvania study (deCalesta 1994). That is, there may be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. Impacts on reproductive success and survival are unknown. It should be noted that Table 10 primarily contains species breeding at PRNS and GGNRA and is not exhaustive. Two species that would likely be impacted, the San Francisco common yellowthroat (*Geothlypis trichas sinuosa*), and the California Swainson's thrush (*Catharus ustulatus oedicus*) are not listed in this table because they are either California Bird Species of Special Concern (CDFG) or Birds of Conservation Concern (USFWS) and are discussed in the Impacts on Special Status Species section.

Table 10. Bird species likely to be adversely impacted by Alternative B.

Common Name	Scientific Name
Allen's hummingbird	*Selasphorus sasin*
American goldfinch	*Carduelis tristis*
Bewick's wren	*Thryomanes bewickii*
Brewer's blackbird	*Euphagus cyanocephalus*
California towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Marsh wren	*Cistothorus palustris*
MacGillivray's warbler	*Oporornis tolmiei*
Orange-crowned warbler	*Vermivora celata*
Oregon junco	*Junco hyemalis thurberi*
Red-winged blackbird	*Agelaius phoeniceus*
Spotted towhee	*Pipilo maculatus*
Western meadowlark	*Sturnella neglecta*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*

In areas of PRNS and GGNRA, it is expected that overall avian species richness, abundance and diversity would decrease measurably in areas of continued heavy grazing pressure resulting from Alternative B. Beneficial impacts to a few grassland species would be offset by larger adverse impacts to relatively more species that depend on understory shrub layers for nesting, especially in impacted riparian and woody-grassland interfaces. The adverse impacts to various species would range from minor to moderate in

intensity, depending on precipitation and range conditions, and would be long-term within NPS boundaries.

Reptiles and Amphibians

Little is known about the impacts of large herds of grazing herbivores on reptiles and amphibians in the Seashore. During inventories of small vertebrates conducted at PRNS in 2001, northern alligator lizards (*Gerrhonotus coeruleus*) were not found in pastures grazed by cattle but were found in similar ungrazed sites (Fellers and Pratt 2002). Changes to woodland understory vegetation, especially in riparian areas, as has been documented with high densities of fallow deer at PRNS, would alter microclimates and habitats for frogs, lizards and salamanders. Adverse impacts could be expected for : alligator lizards, California slender salamanders (*Batrachoseps attenuatus*), rubber boas (*Charina bottae*), western skinks (*Eumeces skiltonianus*), racers (*Coluber constrictor*), garter snakes (*Thamnophis elegans)*, and Ensatina salamanders (*Ensatina eschscholtzii*).

Because of expected mild to moderate adverse impacts of Alternative B on small mammal abundance (see above), concomitant decreases can be expected in reptiles that prey on shrews and rodents. Species in this category are the: western terrestrial garter snake, rubber boa, and gopher snake (*Pituophis melanoleucus*).

Studies of British lowland forests heavily grazed by fallow deer have shown that as a result of decreasing rodent numbers, kestrels relied preyed more heavily on lizards (Putman 1986). Inside the Seashore, similar increases in predation by raptors and owls on lizards, frogs and snakes is likely to occur in areas of high non-native deer density.

Impacts to amphibians and reptiles in PRNS with Alternative B are expected to be adverse to a number of species. The impacts range from minor to moderate and are long-term.

Cumulative Impacts

Statewide deer estimates, which include all native subspecies of black-tailed deer, compiled by the California Department of Fish and Game (CDFG), suggest that deer numbers have decreased from record highs in the 1950s and 1960s. This decline is thought to have occurred because of declining deer habitat quality as a result of urbanization, fire suppression and changes in logging (CDFG 1996). Along with these statewide declines in black-tailed deer numbers, Alternative B would constitute a cumulative adverse impact to black-tailed deer populations.

Sudden Oak Death (SOD), a fungal-type disease that kills tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*) and black oaks (*Quercus kelloggii*), was first discovered in 1995. Since then it has been documented in 12 California counties including Marin. The disease causes oak death and the loss of acorn crops. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). Along with increasing countywide mast losses due to SOD, Alternative B would constitute a cumulative adverse impact to wildlife species dependent on acorns.

Non-native wild turkeys (*Maleagris gallopavo*) have existed in Marin County since their release by CDFG in the 1970s. Since 1995, increasing numbers have been observed in western Marin and within PRNS boundaries (PRNS unpublished data). Wild turkeys are generalists and acorns can make up a significant portion of their diets. As a result, turkeys compete directly with a number of wildlife species dependent on mast. Along with a countywide increase in wild turkey numbers, Alternative B would constitute a cumulative adverse impact to wildlife species dependent on acorns.

Cumulative impacts are adverse, moderate and long-term.

Conclusion

Data on current and past population growth of axis deer at PRNS indicate that this alternative will result in a decrease in total non-native deer numbers over current levels (to 700) within the Seashore. Axis deer range is expected to increase in pastoral and natural areas of the Seashore. No impairment to native wildlife would occur from implementing Alternative B. Based on research on impacts of non-native deer to wildlife in other countries as well as known impacts of grazing by cattle and white-tailed deer in the U.S., the impacts of Alternative B are expected to be beneficial to a few native species and adverse to a larger number of native species. Pockets of extremely high non-native deer density, such as those currently seen in Olema Valley, are likely to be found in the Vedanta property and limited areas within the Seashore. Native species richness and diversity would likely decrease in those high-density areas. Overall, the magnitude of impacts to native wildlife within and outside of NPS boundaries are considered mild to moderate in intensity, adverse and long-term.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed - both short-term and long-term
Intensity of Impact:	Mild to Moderate

Impacts on Special Status Species

This category includes federally listed wildlife species identified, other species of concern recognized by the state of California or Birds of Conservation Concern (U.S. Fish and Wildlife Service) include several species of nesting land birds and raptors.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect federally and state listed species, anecdotal and historical evidence and expert opinion can provide insights and guidance. The federally listed species that are likely to be affected by non-native deer include northern spotted owls (*Strix occidentalis caurina*), western snowy plover (*Charadrius alexandrinus nivosus*), California red-legged frog (*Rana aurora draytonii*), Coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorynchus mykiss*), and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

Analysis

Northern spotted owl

The northern spotted owl is a federally threatened species that reaches the southern limit of its range within GGNRA, PRNS and Muir Woods National Monument (MWNM) in Marin County, California. Data collected by the NPS indicates that these parks may support the highest density of spotted owls known. However, the population is geographically isolated and subject to unique threats including urban development, intense recreational pressure, habituation of owls to humans, potential for catastrophic wildfires, and changes in hazardous fuel management practices. Owls occur throughout the forested lands in the Seashore and the population is likely stable; however, owls have been monitored for only 7 years in the Seashore (NPS and PRBO, unpublished data). Owls prey almost exclusively on small mammals, particularly dusky-footed wood rats (*Neotoma fuscipes*) in the Seashore (Chow and Allen, unpublished data). Woodrats, in turn, are dependent on roots, stems, leaves, seeds and mast (Linsdale and Tevis 1951, Willy 1992).

Fallow deer have been recorded in areas where spotted owls nest and roost. To date, no direct effects have been noted on the productivity or survival of owls. However, deer compete with the prey species of owls, and therefore, likely have an indirect negative impact on food resources. By biting off buds and flowers they reduce the amount of seed and fruit available in autumn and winter. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls and kestrels, especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely minor adverse impact on rodent prey base due to competition for forage, Alternative B would have an indirect adverse impact on northern spotted owls. Overall, the adverse impacts of Alternative B to owls in the Seashore and in Marin County would be minor and long-term.

Western snowy plover

Western snowy plovers, federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS), nest along the sandy beaches of the Seashore, primarily on Point Reyes Beach between North Beach and Kehoe Beach. Historically, plovers also nested at South Beach, Drakes Beach and Limantour. Plover nesting success has increased slightly over the past few years due to intensive management by the Seashore; however, the species is vulnerable to numerous activities in the park including predation by ravens and disturbance by recreationists. Fewer than 20 chicks fledged in 2002 (Peterlein 2002). Cattle roaming on the beaches in the past were a potential source for disturbance; however, the Seashore now intensively restricts cattle from beaches. A large herd of 60 axis deer has been seen on South Beach within the last five years, and where the herd occurred, the ground was heavily impacted (S. Allen, NPS personal communication). The frequency of this activity by axis deer is unknown but likely does not occur with regularly. Because Alternative B results in higher populations of axis deer within the Seashore, such impacts may increase slightly in frequency. Consequently, the overall impact of Alternative B to plovers in the Seashore is likely minor, depending upon whether plovers nest again at South Beach or whether axis deer expand onto the North Beach to Kehoe Beach area.

California Red-legged frog

The California red-legged frog was Federally listed as a Threatened species on June 24, 1996. Red-legged frogs breed in ponds or pools during the wet season (December through March), and use ponds and/or riparian habitats during the rest of the year. Fallow deer regularly frequent riparian areas and will vigorously rub and thrash their antlers during the rut, resulting in maiming and destruction of riparian vegetation. While engaged in this activity, fallow deer may trample frogs. Damage to the vegetation could lead to degradation of non-breeding habitat. Overall, the adverse impacts of Alternative B to frogs in the Seashore and in Marin County would be minor and long-term.

Coho salmon and steelhead trout

Anadromous fish, listed as threatened by USFWS, occur in many of the streams of the Seashore, particularly in Olema Creek and Lagunitas Creek. The Seashore contains 10% of the last remaining wild population of Coho salmon for this Ecologically Significant Unit (ESU), and consequently, any loss of this population would have an impact on the ESU. The NPS, along with the National Marine Fisheries Service and the California Department of Fish and Game, have conducted intensive fish surveys and have funded and implemented numerous restoration projects along the streams that flow through the park and adjacent lands. Numerous culverts have been removed along with other blockages to fish passage. In addition, the agencies have installed fencing to restrict cattle from riparian areas. These fences, though, do not impede the movement of fallow deer.

Fallow deer regularly frequent riparian areas and damage the riparian vegetation, particularly during the rut when bucks thrash branches and leaves with their antlers. While engaged in this activity, fallow deer may indirectly affect the fish by damaging riparian plants, resulting in: reduced cover, warmer water in streams and drying up of streams due to exposure to sunlight. Increased numbers of fallow deer will increase the scope and intensity of this impact to riparian vegetation. In addition, continued presence of non-native deer will reduce the success and effectiveness of riparian restoration projects for salmon due to grazing and thrashing pressure on recovering native riparian vegetation. In some restoration areas, revegetation efforts and natural regrowth will be severely retarded due to heavy grazing and antler rubbing. Different from browsing where leaves are plucked from a stem, this constant grazing and thrashing prevents native riparian plants from growing beyond shrub height. In riparian areas where large numbers of fallow deer congregate or travel, fish redds can be trampled, adversely impacting reproduction in both species. Overall, the adverse impacts of Alternative B to anadromous fish in the Seashore and in Marin County would be minor and long-term.

California Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is listed by the USFWS as Endangered. The shrimp inhabits lower Lagunitas Creek and lower Olema Creek, within the current fallow deer range at PRNS. Shrimp are highly dependent on overhanging riparian vegetation, under which they live year-round. Fallow deer have not been observed within known shrimp habitat. However, in other areas of both Lagunitas and Olema Creeks, high densities of fallow deer have been observed to browse and trample riparian vegetation (Brannon Ketcham, NPS, personal communication). A decrease in fallow deer range resulting from Alternative B is not likely to cause either adverse or beneficial impacts to shrimp habitat or shrimp survival.

Myrtle's silverspot butterfly

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) (MSB) is one of three coastal subspecies of *S. zerene* in the Western United States. The USFWS listed the subspecies as endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992).

As of 1998, three populations are known to remain. The USFWS Myrtle's Silverspot Butterfly Recovery Plan (1998) estimated the three populations combined comprise 10,000 individuals. Two populations of MSB occur within the Seashore and the third is on private land in northern Marin County. The Center for Conservation Biology at Stanford monitored distribution and abundance of the MSB at Point Reyes National Seashore almost yearly from 1992 to 1998. The Stanford survey work shows a decline in MSB population levels during the six-year period and the central population to be "barely existing" (Launer et al.1998). Grazing is believed to deplete the MSB larval host plants. The Seashore is currently supporting an intensive survey of the habitat of the MSB and research on the current abundance and distribution of the larval host plant and adult nectar sources.

The PRNS coastal dune system and coastal prairie provide critical habitat for the federally endangered Myrtle's silverspot butterfly. Many different plants are used by the MSB's as nectar sources; native plants (*Grindelia rubicaulis, Abronia latifolia, Monardella undulata, Erigeron glaucus,* and *Wyethia sp*.) as well as non-native bull thistle (*Cirsium vulgare*) and Italian thistle (*Carduus pycnocephalu*s). The only known larval host plant is the western dog violet (*Viola adunca*).

Axis and fallow deer frequent coastal prairie habitat. To date, it is not known whether they browse on the preferred nectar or larval host plants of the MSB. Research in which deer-proof exclosures were monitored in the New Forest in England showed that fallow deer preferentially consumed a *Viola* species

in a 1969 but not in a repeat survey in 1978 (Putman 1986). In Hawaii, the introduction of axis deer and mouflon sheep to Lana`i have likely played a major role in the disappearance of *Viola lanaiensis* (USFWS 1995a). Another Hawaiian species, *Viola kauaensis* var. *wahiawahensis*, is also listed as endangered by USFWS because of perceived threats of habitat degradation by feral animals and axis deer (USFWS 1995b). It therefore seems likely that non-native deer, given the opportunity, would graze on the MSB's larval host plant.

Intensive localized grazing would further threaten the availability of these plants for the butterfly. If fallow and axis deer populations persist in the Seashore and axis deer range increases, potential adverse impacts to larval host plants and nectar sources persist. Overall, the adverse impacts of Alternative B to Myrtle's silverspot butterfly in the Seashore and in Marin County are considered moderate and long-term.

Bird species of concern

The Seashore has collaborated with the Point Reyes Bird Observatory (PRBO) over the past two decades to protect and restore habitat of nesting land birds within the boundaries of the Seashore. Many species of land birds are species of concern both under the California Bird Species of Special Concern (CDFG) and the Birds of Conservation Concern (FWS). Examples of species include common yellowthroat *(Geothlypis trichas sinuosa*), California Swainson's thrush *(Catharus ustulatus oedicus),* and tricolored blackbird *(Agelaius tricolor).*

Numerous restoration projects and fire management actions have strived to improve nesting success in land birds, particularly in riparian areas. In addition, the park is an active member of the Partner-in-Flight program, collaborating with other agencies and organizations to protect and restore populations of neotropical migratory songbirds. PRBO has monitored the reproductive success and species composition of birds for more than 30 years. Monitoring has taken place in areas of the park (Palo Marin) where fallow deer occur only rarely.

In areas where fallow deer are abundant, there often is a well-defined browse line on trees and shrubs between 1.5 and 2 meters above the ground. Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests have suggested that some bird species, namely understory nesters, declined with high deer grazing pressure (Fuller 2001). Similarly, ground or low nesting (approximately 0.0 – 3 meters) bird species found in the Seashore are vulnerable to heavy grazing by non-native deer. These species are found in habitats where the greatest impacts from large herds of non-native deer would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). There may be a decrease in abundance of low nesting species that depend on understory vegetation to place their nests. The potential impacts on reproductive success and survival are unknown. Overall, the adverse impacts of Alternative B to understory nesting songbirds of concern in the Seashore and in Marin County would be minor to moderate and long-term.

Plant Species of Special Concern

This category includes federal, state, and California Native Plant Society (CNPS) listed plant species.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect plant species of special concern, anecdotal and historical evidence and expert opinion can provide insights and guidance. Rare plants have been inventoried at Point Reyes National Seashore over the past twenty years. The preponderance of this information is presence/absence data for species of concern, with some additional data describing distribution of select species. Given the substantial amount of plant distribution data, it is important to note that this information only describes known rare plant occurrences. Obviously

there are many acres within the seashore that have not yet been surveyed for rare plants. Impacts related to rare plants, therefore, can only be estimated in terms of limited best available information.

Rare plants known to occur within current axis deer range include:

- *Arabis blepharophylla*, coast rock cress
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Cordylanthus maritimus* ssp. *palustris*, Point Reyes bird's beak *
- *Fritillaria liliaceae*, fragrant fritillary
- *Grindelia hirsutula* var. *maritima*, San Francisco Bay gumplant
- *Limnanthes douglasii* var. *sulphurea*, Point Reyes meadow foam*
- *Linanthus grandiflorus*, large-flowered linanthus
  Triphysaria floribundus, San Francisco owl's clover

Rare plants known to occur within current fallow deer range include:

- *Abronia umbellata ssp. breviflora*, pink sand-verbena
- *Agrostis blasdalei*, Blasdale's bent grass
- *Arabis blepharophylla*, coast rock cress
- *Arctostaphylos virgata*, Marin manzanita
- *Astragalus pycnostachyus* var. *pycnostachyus*, coastal marsh milk-vetch*
- *Calystegia purpurata* ssp. *saxicola*, coastal bluff morning-glory
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *gloriosus*, Point Reyes ceanothus
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Chorizanthe cuspidata* var. *cuspidata*, San Francisco bay spineflower
- *Cordylanthus maritimus* ssp. *palustris*, Point Reyes bird's beak *
- *Elymus californicus*, California bottlebrush grass
- *Fritillaria affinis* var. *tristulis*, Marin checkerlily
- *Fritillaria liliaceae*, fragrant fritillary
- *Gilia capitata* ssp. *chamissonis*, dune gilia
- *Grindelia hirsutula* var. *maritima*, San Francisco Bay gumplant
- *Linanthus grandiflorus* large-flowered linanthus
- *Microseris paludosa*, marsh microseris*
- *Perideridia gairdneri* ssp. *gairdneri*, Gairdner's yampah
- *Polygonum marinense*, Marin knotweed
- *Ranunculus lobbii*, Lobb's aquatic buttercup*
- *Sidalcea calycosa* ssp. *rhizomata*, Point Reyes checkerbloom*
- *Triphysaria floribundus*, San Francisco owl's clover

Non-native deer can impact rare plant species directly by consuming and trampling them. PRNS staff observed fallow deer digging up and eating *Fritillaria* bulbs within the burned area after the 1995 Vision Fire (Sarah Allen, NPS, personal communication). It should be noted that damage to *Fritillaria sp.* and other lily species has been observed outside exotic deer range, presumably caused by black-tailed deer or other herbivores (Michelle Coppoletta, NPS, personal communication). Based on analyses of deer diets conducted in Point Reyes, it can be inferred that after a major vegetation-changing event such as a wildfire, both axis and fallow deer will seek other food sources to supplement a depleted diet (Elliott 1983). This might include heavier foraging on bulb species.

Other species that may be impacted would be those occurring in areas of high-density herd congregations, where damage to plants through trampling would occur. Fallow deer herds have been observed most often in grassland, evergreen scrub, and Douglas fir/redwood plant communities (NPS 2001b). These communities provide habitat for each of the plant species listed above. Adverse impacts to rare plants in the Seashore are currently considered to be minor and short-term. Long-term, Alternative B would result in little overall change in densities for both species and would likely lead to adverse impacts which were minor and long-term.

Of the above listed species, several occur in wetlands or saltmarsh habitats. It is highly unlikely that these species are affected by non-native deer activities. These species are so noted with a "*".

There are no means of mitigating for impacts of non-native grazing herbivores to the species of special concern of the Seashore.

Cumulative Impacts

Cumulative impacts would be the same as those described for Alternative A.

Depending on the species of concern, adverse, long-term cumulative impacts might range from minor to major.

Conclusion

No impairment to special status species would occur from implementing Alternative B. All of the impacts on special status species, associated with the continued presence and/or expansion of non-native deer populations, are characterized as adverse. While short-term impacts of reduced fallow deer numbers may be beneficial to wildlife and plant species that currently suffer adverse impacts, long-term persistence of axis and fallow deer in the Seashore will result in adverse impacts of minor to moderate intensity.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed - both short-term and long-term
Intensity of Impact:	Minor to moderate

Impacts on Human Health and Safety

Analysis

Under Alternative B, the use of firearms by NPS staff as the sole method of control and maintenance of non-native deer numbers may increase related risk of injuries to staff and visitors. As this activity will continue indefinitely under Alternative B, minor, short-term (transitory, individual culling efforts) to long-term (indefinite duration of activity), adverse impacts to staff and visitor safety resulting from risk of firearms injuries are expected.

Under Alternative B, the numbers and range of both species of non-native deer are expected to decrease through lethal removal to a number totaling 700. A concomitant decrease in deer-vehicle collisions over current levels is expected, a minor, long-term benefit to human safety similar to effects expected under Alternative C.

Cumulative Impacts

There are no known cumulative impacts associated with Alternative B.

Conclusion

Alternative B would result in minor adverse impacts to human health and safety for Seashore visitors and staff over an indefinite period of time due to risk of firearms-related accidents. In addition, minor benefits to public safety can be expected through the likely reduction in deer-vehicle collisions under Alternative B. When compared to the No Action alternative, the use of firearms under this alternative would result in increased risks to human health and safety of indefinite duration. Conversely, decreasing numbers of non-native deer numbers under Alternative B would result in a slight reduction of human safety risks compared to Alternative A.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor

Impacts on Visitor Experience

Analysis

This alternative would eventual result in the reduction of non-native deer to fewer than are in the Seashore today. As a result, it is possible that those visitors with humanistic or aesthetic social values and who are aware of the non-native deer at the Seashore would notice the decrease in numbers of fallow deer, in particular, the white color variants of fallow deer. If populations of native black-tailed deer were to increase in number in the areas where fallow deer currently reside, opportunities for viewing deer would not change significantly and visitors with naturalistic or ecologistic social values may experience a slight positive impact. Opportunities to view axis deer would likely increase slightly because of increasing numbers and range, although the vast majority of visitors would not notice any change. Overall, because of changes in deer behavior resulting from the lethal control program, non-native deer viewing opportunities would be fewer and might require more time and effort on the part of the visitor, a long-term, minor adverse impact to the visitor particularly interested in non-native deer viewing, particularly white fallow deer. However, the reduction of non-native deer would provide additional habitat for native black-tailed deer, a negligible to minor, long-term benefit to those interested in viewing native ungulates.

Decreased numbers and density of non-native deer grazing in pastoral, wooded and riparian areas could change scenic viewsheds by allowing regrowth of undergrowth vegetation, shrubs and brush. The areas where such changes are most likely to be apparent to visitors are in Olema Valley (from fallow deer). In this area, agricultural grazing is the primary determinant of scenic viewsheds. The contribution which non-native deer make to altering viewsheds is likely to decrease over time with the reduction of non-native deer numbers under this alternative, and would ultimately have a negligible effect on the visitor experience related to viewshed enjoyment.

Under Alternative B, social values of visitors related to lethal removal or use of firearms would also be affected. Visitors with humanistic or moralistic values could experience short-term, adverse effects ranging from negligible to moderate depending on the visitor and the level of his/her objection to the use of the proposed management method. As mitigation for these potential adverse impacts, Alternative B mandates adherence to rigorous training of all agency sharpshooters at levels of intensity and frequency

required for law enforcement rangers. Consequently, wounding of animals would be minimized, and quick and selective death would be the goal for all targets. In addition, all deer management actions would be conducted in a manner that minimizes stress, pain and suffering to every extent possible.

Under this alternative, the management of non-native deer populations through lethal removal techniques (firearms) is proposed for an indefinite time period. The loss of peace and quiet during shooting operations is another possible adverse impact to the visitor experience. Although this Alternative calls for shooting to take place outside of peak visitation hours, visitors who come to the Seashore for solitude and quiet during non-peak times could be uncomfortable with the noise generated. Temporary area closures for large-scale deer management activities are a possibility with this alternative and may inconvenience some visitors. In addition, management by air could take place, as would monitoring. The noise of overflights would contribute negligibly to a loss of peace and quiet.

A small number of visitors may discover carcasses in the wilderness areas where retrieval by NPS sharpshooters is not possible. Moving any carcass near a heavily used trail to a more remote location to reduce odor problems or conflicts between humans and scavengers would mitigate this impact. Collectively, the impact of firearms use related to soundscape, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in negligible to moderate adverse impacts to the visitor experience. Impacts would be both short-term (individual management actions) and long-term (indefinite duration). The perceived intensity of the impact would depend on the numbers of visitor affected and the duration of each incident's effect.

Cumulative Impacts

PRNS has completed a comprehensive Fire Management Plan, which outlines fire prevention and prescribed burning activities for the foreseeable future. The preferred alternative calls for temporary area closures during prescribed fires. Because it could also result in some temporary area closures, Alternative B could restrict visitor access to some portions of the Seashore and result in minor, cumulative, adverse impacts.

Conclusions

This alternative will result in a permanent decrease in fallow deer and an increase in axis deer numbers within the Seashore. Adverse effects from this alternative to the visitor experience related to wildlife viewing; social values; and soundscape/access/visual intrusions are expected to range from negligible to moderate (depending on visitor goals and expectations) and would be both short- and long-term in duration. Negligible to minor, long-term benefits to visitor experiences with naturalistic or ecologistic social values related to wildlife viewing of native ungulates would also be realized under this alternative. When compared to the No Action alternative, Alternative B would result in decreased impacts to viewshed enjoyment and increased opportunities for viewing native deer. At the same time, adverse impacts regarding viewing of non-native deer, visitors with moralistic or humanistic social values, and soundscape preservation/access/visual intrusions are greater under this alternative than that expected under the No Action alternative.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Long-term and short-term
Intensity of Impact:	Negligible to Moderate

Impacts on Park Operations

Analysis

The control of a continued but reduced presence of non-native deer would constitute an increase in the scope and extent of current financial and personnel resources necessary to address environmental, social and health and safety concerns. This alternative results in the maintenance of a reduced number of non-native deer in the Seashore in perpetuity, the costs of which would be incurred indefinitely. Operational costs and commitments would be expected to increase from both internal deer control operations and from increased coordination and cooperation outside the park. If continued monitoring by resource management staff warranted a change in deer level goals, the following impacts would increase or decrease accordingly.

Costs related to the monitoring of large populations of non-native deer inhabiting the park are those associated with impacts to natural and cultural resources. In FY 2003, personnel costs for 1.5 FTE (full time employees) and the costs of equipment, vehicles, supplies and staff for non-native deer monitoring (including one census yearly) are projected to total $126,000. Administrative and interpretive costs, excluding the costs of completing this document, likely comprise another $15,000. These costs, currently 2.9 % of the total PRNS annual budget, can be expected to continue at this current level under Alternative B.

Continuing costs to the park of mitigating impacts of non-native deer under Alternative B are unknown and will continue indefinitely as a result of maintaining non-native deer species at the Seashore. These include:

- Costs of disease monitoring and testing in areas of high deer density and where non-native deer are in close contact with livestock.
- Costs of erecting exclosures or deer-proof fencing in areas where high deer densities are adversely impacting sensitive resources, i.e. riparian areas or populations of rare plants.
- Costs of monitoring native species, such as native cervids, songbirds and special status species, adversely impacted by growing non-native deer numbers and range.

The description of Alternative B outlines the likely deer removal numbers based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, Alternative B would require culling of up to 200 fallow deer per year to reduce the population to 350, with up to 75 animals per year removed thereafter. Axis deer, which currently number approximately 250, would not require culling until their numbers surpassed 350. Subsequent removals of up to 40 animals each year would be required to maintain total axis numbers at 350. It should be noted that these numbers are subject to change depending on weather, range conditions and herd growth parameters. Cited figures should be considered approximate guidelines for cost analysis purposes.

The costs of culling 250 deer yearly for the first 3-5 years of the program are estimated to be $187,000/year and include staff expenses (including one full time biotechnician), training, vehicles, transport, supplies and carcass disposal. Thereafter, costs (before inflation) of removing up to 65 animals per year would be approximately $52,000 per year, in perpetuity.

During the first 3-5 years of the program, costs of controlling non-native deer constitute a 132% increase in funds allocated to non-native deer. After this time, costs of maintaining each species at 350 animals will remain a 36% increase over current levels. See Figure 12 for a comparison of the costs of the alternatives considered.

Estimates for minimum costs for the implementation of Alternative B total approximately $3.5 million by the year 2020. Thereafter, annual costs of $190,000 could be expected indefinitely. The overall costs of implementing Alternative B will constitute 3% – 6% of the total PRNS annual budget, with higher costs occurring within the first 3-5 years of implementation.

Under Alternative B, non-native deer monitoring, mitigation of damage to natural resources caused by non-native deer, and the operation of the culling program would result in adverse impacts to park operations through increased budget expenditures for an indefinite period of time. Because culling operations would continue indefinitely, a permanent increase in operating costs and/or energy use for the park would be long-term in duration. As these increased costs would be greater than 5% of total park budget for the first 3-5 years of implementation, and less than 5% thereafter, adverse impacts are considered moderate in the short-term and minor in the long-term.

Cumulative Impacts

Cumulative impacts would not be different than those described for Alternative A.

Conclusion

Park operations under Alternative B would be affected as a result of demand on park staff to monitor and mitigate continued impacts to natural resources and to control deer numbers for an indefinite period of time. All of the impacts to park operations associated with the presence of non-native deer are characterized as adverse. Because controlling non-native deer populations indefinitely would represent a permanent increase in operating costs and/ or energy usage for the park, the impacts of Alternative B are considered long-term. Because additions in cost and/ or energy usage would be more than 5% of total park budget for the first 3-5 years of the control program and less than 5% thereafter, the impacts are considered to be moderate in the short-term and minor in the long-term. When compared to the No Action alternative, Alternative B would require a notably smaller (3-6% versus 5-15%) increase in budgetary commitments. However, as under No Action, these expenses would continue in perpetuity, a detriment to park operations.

Type of Impact:	Adverse
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Moderate (short-term) and minor (long-term)

Impacts on Regional Economy

Analysis

Non-native deer have no documented beneficial impacts to the regional economy. Currently there are an estimated 250 axis deer and 860 fallow deer in the Seashore. Alternative B would result in an increase in axis deer and a decrease in fallow deer. Range size would likely increase for axis deer within the Seashore and could decrease for fallow deer. The spread of fallow deer outside of Seashore boundaries would be curtailed.

Impacts of fallow deer to agricultural operations inside and outside of NPS boundaries could be expected to decrease with this alternative. Conversely, expansion of axis deer in the Seashore, as has been reported historically when total axis deer numbers were higher, is expected to lead to increased competition for pasture forage with livestock, damage to fences and depredation of agricultural products (hay and silage). Currently, these ranchers report that damage to their operations from axis deer includes:

- Fence repair costs ($500-$1000/yr/per ranch [4 reports])—damage by deer crossings.
- Costs of lost pasture forage (unknown costs [4 reports])—pasture forage consumption by non-native deer (refer to detail in Regional Economy section of Affected Environment).

These impacts would likely increase in magnitude with growing numbers of axis deer and would be long-term unless target deer levels were lowered in the future. In addition, other ranches, which now are only sporadically inhabited by few axis deer, could be expected to experience increasing impacts of similar types. Under Alternative B, the increase in axis deer could result in minor, long-term adverse impacts to the regional economy related to agricultural endeavors.

Under Alternative B, a smaller fallow deer population size and range would result in an amelioration of current impacts to Seashore ranches where fallow deer are seen year-round in significant numbers (M, L, and Stewart Ranches), including those related to:

- Costs of lost supplemental feed (unknown costs [1 report])—supplemental food put out for livestock eaten by non-native deer.
- Costs of reseeding pastures ($9000/yr/rancher [1 report])—overgrazing of fallow fields by non-native deer.
- Veterinary costs ($1200 in 2001 [1 report])—leptospirosis (refer to detail in Regional Economy section of Affected Environment).

This improvement would last as long as the deer control continued (in perpetuity). Costs of fence repair and lost pasture forage would decrease, as would the monetary impacts of lost supplemental feed, pasture reseeding and veterinary costs. Such effects would represent a minor, long-term benefit for agricultural concerns in and around the park.

Because this alternative might require occasional area closures but no park closures, there would be no effects to local tourist businesses. This alternative would not have significant and disproportionate effects on minority and low-income populations.

Cumulative Impacts

A Biological Assessment was prepared in 2002 to review the proposed renewal of livestock grazing permits for areas managed by Point Reyes National Seashore (PRNS) to determine to what extent renewing the leases may affect any of the federally listed threatened or endangered species (National Park Service 2002c). As mitigation for impacts of ranching operations on California red-legged frogs (*Rana aurora draytonii)*, western snowy plovers (*Charadrius alexandrinus nivosus*), coho salmon (*Oncorhynchus kisutch*), and a number of listed plant species, the Seashore is requiring permitees to alter some ranching practices. Examples of such changes include increasing setbacks for livestock from riparian areas, delaying silage mowing, and improving drainage of livestock waste. Along with new requirements for agricultural permittees, increased numbers of axis deer over a larger area of the Seashore resulting from this Alternative could constitute minor long-term adverse cumulative impacts to the regional economy.

Conclusion

This alternative will result in a decrease in fallow deer and an increase in axis deer numbers within the Seashore. The magnitude of impacts to agriculture within and outside of NPS boundaries created from an increased axis deer population is expected to increase over time, resulting in minor, long-term, adverse impacts to the regional economy. At the same time, the reduction of fallow deer numbers under this alternative would reduce agricultural impacts attributed to these deer below the current level--a minor,

long-term benefit to the regional economy. Comparatively, the No Action alternative would likely result in a greater number of adverse effects to the regional economy by way of agricultural impacts and potential impacts to low-income farm workers than would Alternative B

Type of Impact:	Mixed, Both Adverse and Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor

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

This alternative would control levels of fallow and axis deer to below carrying capacity, at numbers that would be both logistically sustainable with NPS staff and funding, and would not likely lead to extinction of either species. Techniques used to control deer would include both lethal removal (shooting by NPS staff) and treatment of does with the most effective contraceptive technology available. In the 1970s and 1980s park staff controlled deer to desired levels of 350 of each species. For purposes of analyzing impacts of this action alternative, the same levels (700 total non-native deer) will be assumed. Total numbers of non-native deer would be less than current estimated numbers (approximately 250 axis deer and 1,100 fallow deer) but high densities of deer in certain areas would still be expected because of the tendencies of both species to congregate in large herds. Initially, fallow deer numbers would be controlled by yearly shooting and contraception. In the future, when axis deer numbers surpassed the pre-established limit (for purposes of this analysis, 350), this species would also be culled and individuals would be treated with the most efficient contraceptive technology available. The age, sex, and numbers of deer culled will be determined by resource managers to ensure that populations are maintained at desired levels and to reduce risks of range expansion beyond Seashore boundaries.

The impacts to natural resources and the regional economy do not differ between Alternative B and C. Impacts of Alternative C to park operations, health and human safety and visitor experience differ slightly from those of Alternative B.

Impacts on Water Resources and Water Quality

Analysis

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to water resources would occur from implementing Alternative C.

Type of Impact:	Beneficial in the short-term, adverse in the long-term
Duration of Impact:	Mixed - both short-term and long-term
Intensity of Impact:	Minor

Impacts on Soil

Analysis

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to soils would occur from implementing Alternative C.

Type of Impact:	Beneficial in the short-term, adverse in the long-term

Duration of Impact: Mixed - both short-term and long-term
Intensity of Impact: Minor

Impact on Vegetation

Analysis

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to vegetation would occur from implementing Alternative C.

Type of Impact: Adverse
Duration of Impact: Long-term
Intensity of Impact: Minor

Impact on Wildlife

Analysis

Impacts, including cumulative impacts, to native species are not different from Alternative B. No impairment to native wildlife would occur from implementing Alternative C.

Although fewer non-native deer would be lethally removed in Alternative C than in Alternative B, pain and suffering would result from lethal removals as well as from fertility control. Some of this pain would be mitigated by use of trained sharpshooters in culling deer. Efforts will be made to deliver immediately lethal shots to target animals. Animals treated with contraceptive agents would undergo the stress of capture, restraint, injection and permanent marking (i.e., radio-collaring and ear-tagging) at least once during their lifetimes. Capture of wild ungulates will result in unavoidable injuries and some deaths.

Type of Impact: Adverse
Duration of Impact: Long-term
Intensity of Impact: Mild to Moderate

Impact on Special Status Species

Analysis

Impacts, including cumulative impacts, are not different from Alternative B. No impairment to special status species would occur from implementing Alternative C.

Type of Impact: Beneficial in the short-term, adverse in the long-term
Duration of Impact: Mixed - both short-term and long-term
Intensity of Impact: Minor

Impact on Human Health and Safety

Analysis

Under Alternative C, it is assumed that 75% of the non-native deer actively managed would be culled rather than given contraception and, therefore, the risk of firearm-related injuries to staff and visitors

would be noticeably increased over current levels. As culling would continue indefinitely under Alternative C, minor, short-term (transitory, individual culling periods) to long-term (indefinite duration of activity), adverse impacts to staff and visitor safety could result.

Depending on the agent used, Alternative C calls for treatment of up to 25% of fallow does with a long-acting contraceptive or sterilant. Treatment would require capture and immobilization of animals for permanent marking (ear-tagging and radio-collaring). Capture would be accomplished with a corral trap, a drop net, or with a net gun fired from a helicopter. Regardless of the technique used, wildlife capture and immobilization can result in injury to participating staff, either from the animals themselves or from equipment and aircraft. The number of people at risk from capture-related and treatment-related injury under Alternative C depends on the technique used, and is unknown at this time. Because this alternative requires fertility control activities to continue indefinitely, the total number of people at risk of injury during deer capture/treatment is also unknown. Adverse impacts to human safety of minor intensity are expected as a result of capture/treatment actions. Effects are expected to be short-term (transitory, individual capture/treatment incidents) and long-term (indefinite management period) in duration. The reduction of non-native deer numbers and the concomitant effects this may have on deer-vehicle collisions are similar to that described for Alternative B (long-term, minor benefit).

Cumulative Impacts

There are no known cumulative impacts associated with Alternative C.

Conclusions

Minor, long- and short-term, adverse impacts to human health and safety for Seashore staff could result from the use of firearms and contraceptive treatments proposed under Alternative C. Minor benefits to public health and safety resulting from reduced risk of deer-vehicle collisions are expected. Compared to the No Action alternative, the implementation of lethal controls and contraceptive operations under Alternative C would result in notably increased risks to human health and safety for an indefinite period of time. At the same time, the No Action alternative would likely represent a slight increase in risk to human safety as a result of potentially increased deer-vehicle collisions when compared to Alternative C.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor

Impact on Visitor Experience

Analysis

Effects on wildlife viewing of all deer under this alternative are similar to that described under Alternative B (minor, long-term, adverse for non-native deer; negligible to minor, long-term, beneficial for native ungulates).

Effects on the visitor experience related to viewshed enjoyment under this alternative are similar to those described under Alternative B (negligible).

Under this alternative, the visitor experience is also related to social values, particularly those of attitudes toward animals. Effects of the management techniques proposed (lethal removal/firearms and contraception) under Alternative C could result in adverse effects to the visitor experience to varying

degrees and for varying periods of time. These effects are similar to those described under Alternative B (negligible to moderate, short-term, adverse – depending on the visitor and his/her level of objection to the use of proposed methods). As proposed under Alternative C, if contraception proves effective in controlling and maintaining deer populations at specified levels (700), this alternative would represent a less lethal management approach than that proposed under Alternative B (lethal removal only). This less lethal approach has the potential to benefit or adversely affect visitor experience, depending on individual social values. Notably, while only 35% of polled Bay area residents supported lethal control of non-native deer, 65% supported contraception, suggesting fewer visitors would be adversely affected by this alternative than Alternative B. Mitigation measures proposed for this alternative are similar to that described under Alternative B.

Alternative C proposes the management of non-native deer through a combination of lethal controls and contraceptive methods; Alternative B proposes only the use of lethal methods (firearms). While the degree of effect differs slightly, impacts of firearms use related to soundscape, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in effects similar to that described under Alternative B (short- and long-term, negligible to moderate, adverse impacts, depending on the numbers of visitors affected and the duration of each incident's effect). Mitigation measures for such impacts are also similar to those described for Alternative B. In addition, the use of aircraft for monitoring, and for management of deer (shooting, herding into corrals, etc.) would adversely affect the soundscape.

Some visitors, especially those searching for a "wilderness experience" in the Seashore, might object to seeing permanent marks such as radio collars and ear tags on treated fallow does. Because the population control techniques in Alternative C will be used in perpetuity to maintain a target number of non-native deer populations, resulting visitor experience impacts will be long-term, minor, and adverse for those who find them offensive.

Cumulative Impacts

Cumulative impacts under Alternative C are similar to those described for Alternative B.

Conclusions

This alternative will result in a permanent decrease in fallow deer and an increase in axis deer numbers within the Seashore. Adverse effects from this alternative to the visitor experience related to wildlife viewing; social values; soundscape/access/visual intrusions; and wilderness experience are expected to range from negligible to moderate (depending on visitor goals and perceptions) and would be both short- and long-term in duration. Negligible to minor, long-term benefits to the visitor experience related to viewing of native deer are also possible under Alternative C. Compared to No Action, adverse impacts to social values, soundscape preservation/access/visual intrusions, and wilderness experience would be increased under Alternative C. Conversely, opportunities for viewing of native deer are increased under this alternative when compared to No Action.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Long-term and short-term
Intensity of Impact:	Negligible to moderate

Impacts on Park Operations

As in Alternative B, the impacts of continued presence of non-native deer would constitute an increase in the scope and extent of current financial and personnel resources necessary to address environmental, social and health and safety concerns. This alternative results in the maintenance of a reduced number of non-native deer in the Seashore in perpetuity, the costs of which would be incurred indefinitely. Operational costs and commitments would be expected to increase from both internal deer control operations and from increased coordination and cooperation outside the park. If continued monitoring by resource management staff warranted a change in deer level goals, the following impacts would increase or decrease accordingly.

Actions associated with monitoring of non-native deer and mitigation of deer impacts to natural resources under Alternative C are similar to those described under Alternative B.

The *Alternatives* chapter outlines the likely deer removal numbers under Alternative C, based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, Alternative C would require culling of up to 50% of fertile fallow females per year along with treatment of up to 25% of does per year with a long-lasting contraception to reduce the population to 350. Thereafter, up to 20 animals per year would be removed and treated. Axis deer, which currently number approximately 250, would not require culling or treatment until their numbers surpassed 350. Subsequent removals of 25-40 animals per year would be required to maintain total axis numbers at 350. Should a long-lasting contraceptive be developed for axis deer, numbers culled could decrease as axis does were treated. It should be noted that all of these numbers are subject to change depending on weather patterns, range conditions and herd growth parameters. Cited figures should be considered approximate guidelines for cost analysis purposes.

During the reduction phase of the control program, costs of culling up to 180 deer yearly include staff (including one full time biotechnician), training, vehicles, transport, supplies and carcass disposal, and are estimated to be $135,000 per year. Thereafter, during the maintenance phase of the control program, costs (before inflation) of removing up to 45-60 animals per year could reach $45,000 per year in perpetuity.

The costs of giving contraception to deer depends on the duration and effectiveness of the chosen agent and can only be approximated. An NPS proposal for a one-time administration of up to 70 fallow does was estimated to cost $148,000 or $2,100 per treated deer (NPS unpublished proposal, PMIS# 97426). Should Spayvac® prove effective in preventing reproduction for the life of fallow does, Hobbs' estimate of 176 does requiring treatment to control the population at 350 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.

During the first 3-5 years of the program, costs of controlling non-native deer with culling and long-lasting contraception constitute a 300% increase in funds currently allocated to non-native deer and between 3% and 12% of the total Seashore budget. After this time, costs will remain a 25-100% increase over current levels, and up to 5% of the total Seashore budget, depending on the extent to which contraception is used to maintain each species at 350 animals. See Figure 12 for a comparison of the costs of the alternatives considered.

Estimates of minimum costs for the implementation of Alternative C total approximately $3.6 million by the year 2020. Thereafter, annual costs of greater than $200,000 could be expected indefinitely. The costs of implementation of Alternative C would constitute an increase of 3-12% of the total PRNS budget.

Under Alternative C, non-native deer monitoring, natural resource damage mitigation, and deer culling and contraception operations could result in long-term, moderate, adverse impacts to park operations at PRNS resulting from increased financial commitments over an indefinite period of time.

Cumulative Impacts

Cumulative impacts of Alternative C are similar to those described under the No Action alternative.

Conclusions

Alternative C proposes the maintenance (lethal removal and contraception) of axis and fallow deer at specified levels indefinitely. In addition to cumulative Impacts, park operations under Alternative C would be adversely affected as a result of demand on park staff to monitor and mitigate continued impacts and to control deer numbers for an indefinite period of time. Because additions in cost and/or energy usage for non-native deer management would likely be more than more than 5% of total park budget indefinitely, the impacts are considered to be moderate and long-term. When compared to the No Action alternative (5-15% budget increase), Alternative C would require a relatively similar increase (3-12%) in budgetary commitments for an indefinite period of time.

Type of Impact:	Adverse
Duration of Impact:	Long-term
Intensity of Impact:	Moderate

Impacts on Regional Economy

Analysis

Impacts, including cumulative impacts, are not different from Alternative B.

Type of Impact:	Mixed, Both Adverse and Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor

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

This alternative would remove all fallow and axis deer from PRNS and PRNS–administered lands in 15 years. It is expected that large numbers of deer would be removed during the first 5 years of the program and that, because of increased wariness on the part of the deer and lower deer densities, a more gradual decrease over the next 10 years would follow. An effort would be made to remove deer in a manner that did not lead to increased migration outside of NPS boundaries, and it is expected that this alternative would not result in increased numbers of non-native deer on state park or private adjacent lands. However the Vedanta property, which currently contains the highest fallow deer densities in Olema Valley (up to 80 deer/km^2), is outside of NPS management jurisdiction and surrounded entirely by NPS lands. It is likely that during the removal program in the Seashore, deer densities on this inholding would increase.

Impacts on Water Resources and Water Quality

The impacts of non-native deer eradication in 15 years would constitute an alleviation of current impacts to water resources and water quality.

Analysis

Potential consequences of non-native deer eradication are reduced concentrations of animals adjacent to and within streams, ponds, and lakes. Fallow deer, typically found in large herds, tend to remain in areas for long periods of time. This behavior results in significant denudation of the area around the herds. In addition, fallow deer tend to return to the same locations annually, resulting in long-term degradation of areas. Alternative D would reduce and eventually eliminate this degradation, allowing regrowth of riparian vegetation.

As noted in other sections (see Impacts of Alternative A to water resources and water quality, for example), fallow deer also impact water quality by eliminating riparian vegetation during the rut, when the bucks tend to aggressively rub and thrash their antlers. Impacts of fallow deer grazing and thrashing are most acute within the pastoral zone in Olema Valley, where many riparian areas have been deliberately excluded from livestock grazing to restore canopy and natural hydrologic processes. In these areas, revegetation efforts and natural regrowth have been severely retarded due to heavy grazing and antler rubbing by the non-native deer (B. Ketcham, NPS, personal communication). Continual grazing of new shoots and seasonal thrashing by fallow deer prevents native riparian plants from growing beyond shrub height.

Within NPS boundaries, Alternative D would quickly result in localized beneficial impacts to hydrologic processes (associated with streambank breakdown and erosion), aquatic habitat (associated with excess delivery of sediment to the aquatic resources and impact to riparian vegetation and growth rates), and water quality (both sediment and nutrient related). In the long-term, non-native deer eradication could result in moderate or readily apparent beneficial impacts on hydrologic process, aquatic habitat, and water quality in the Seashore compared to Alternative A.

Because it would be a safe zone, deer populations could expand into private inholdings within Seashore boundaries, such as the Vedanta property in Olema Valley when agency shooting begins. Increased fallow deer densities around riparian areas in this vicinity could cause short-term, minor to moderate adverse impacts to hydrologic processes, aquatic habitat and water quality. In the long-term, eventual eradication of fallow deer in the Olema Valley would reverse these impacts and allow natural restoration of these areas.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil erosion and potential for increased sedimentation of waterways. Alternative D specifies that NPS staff will attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country use of vehicles will rarely be used, particularly in wilderness and sensitive areas, adverse impacts to water resources from sedimentation resulting from this alternative are considered short-term and insignificant.

Cumulative Impacts

Because all adverse impacts to water resources associated with non-native deer would be eliminated in this alternative, no cumulative impacts would occur.

Conclusion

No impairment to water resources would occur from implementing Alternative D. Both short-term and long-term impacts to water resources within the Seashore are characterized as beneficial and range from minor to moderate. Impacts to the water resources in the Vedanta inholding are characterized as adverse and minor in the short-term because of the likely temporary increase in deer densities on the property during the initial stages of the removal program. In the long term, water resources in the Vedanta property, like those within the Seashore, will benefit to a moderate extent from non-native deer eradication since current impacts to hydrologic processes, aquatic habitat and water quality will be removed.

Type of Impact:	Mixed – both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor in the short term, moderate in the long-term

Impacts on Soil

The impacts of non-native deer eradication in 15 years would constitute an alleviation of current impacts to soil.

Analysis

As noted in other sections of this document, non-native deer have the potential to increase erosion and soil compaction, particularly where they are congregated in large herds for long periods of times. Fallow and axis deer consume vegetation, trample and destroy it, and increase compaction of soils. Compaction in turn results in increased runoff and reduced infiltration. In combination with soils unanchored by root structures, increased erosion results under these conditions. Fallow and axis deer also increase bare ground in areas they occupy by rutting behaviors and by creating trails. Each of these behaviors has resulted in denuded areas, which are eroded during the fall and winter rainy season at the Seashore. Alternative D would reduce and eventually eliminate this degradation allowing regrowth of riparian vegetation.

Short-term expansion of deer populations into private inholdings within Seashore boundaries, such as the Vedanta property in Olema Valley, could result from NPS shooting operations. Increased fallow deer densities in the Vedanta Society property, causing increased trailing, compaction and erosion are possible short-term impacts from deer removals in the Seashore. In the long-term, eventual eradication of fallow deer in the Olema Valley would reverse these impacts and allow natural restoration of soils in Vedanta.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor soil compaction. Alternative D specifies that NPS staff will attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because cross-country vehicles would rarely be used, particularly in wilderness and sensitive areas, adverse impacts to soils from compaction resulting from this alternative are considered short-term and insignificant.

Substantial benefits would occur to park soils, as well as to regional soils compared to Alternative A if non-native deer were eradicated. Alternative A would almost certainly result in expanded herds outside of the Seashore, with regional, major impacts to soils similar to those experienced currently on a localized basis inside the park. Although localized minor impacts to soils at the Seashore would continue for a period of time until eradication is complete or near complete, in the long-term soils would no longer experience impact from non-native deer. Because impacts to soils are not yet severe, over time it is likely that vegetation would regrow in bare or compacted soils.

Cumulative Impacts

There are no cumulative impacts associated with Alternative D.

Conclusion

No impairment to soils would occur from implementing Alternative D. Both short-term and long-term impacts to soil within the Seashore are characterized as beneficial and minor. Impacts to soil resources in the Vedanta inholding are characterized as adverse and minor in the short-term because of the likely temporary increase in deer densities on the property during the initial stages of the removal program. In the long term, soil in the Vedanta property, like those within the Seashore, will benefit to a minor extent from non-native deer eradication since current compaction and erosion will be alleviated.

Type of Impact:	Mixed - both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor

Impacts on Vegetation

Analysis

As noted in the impact analysis of Alternative A, non-native deer can have a multitude of impacts on vegetation inside the park. These include consumption, compaction of soils, and loss of vegetation from trampling, rutting behavior, and breaking trails. Deer can affect the physical structure of vegetative communities, species composition, species richness and the level of nutrients through browsing and the addition of nutrients in the form of feces and urine. Deer can also adversely affect unique vegetative communities or consume species that are unique or protected. In the Seashore, fallow deer have had severe localized effects on riparian vegetation. Axis and fallow deer also eat some of the same foods as native deer and elk in the park, and so may have a cumulative adverse effect on plant species. Because

these impacts have been localized, they are minor in intensity and confined to areas within the park. However, the continuation of current management practices (e.g. adoption of Alternative A) would likely result in expansion of the herd and the spread of these impacts to vegetation across the region, with possible major impacts.

Alternative D would remove fallow and axis deer and over time and would eliminate the ongoing impact they have had on park vegetation. Because the impacts have been localized, it is likely that most would be restored over time. For example, fencing that has been successful in keeping cattle out of areas where no fallow deer graze has resulted in the restoration of riparian vegetation. If current impacts from non-native deer are no worse than those caused by cattle, restoration within a few years of their eradication is likely, even in highly disturbed riparian areas. It is possible that populations of native ungulates would increase following the eradication on non-native deer. If so, impacts across the park from their browsing may continue at a negligible or minor level, although the concentrated occupation of riparian habitat is not likely to occur.

Alternative D would result in both short and long-term minor localized beneficial impacts to vegetative processes (associated with plant establishment and regrowth), habitat (associated soil erosion and plant growth rates), and plant diversity (associated with preferential grazing and browsing). It would also offer substantial benefits relative to Alternative A by eliminating the risk of non-native species expanding their range to areas outside the Seashore.

A short-term influx of non-native deer populations into the Vedanta Society property from NPS lands, as a result of the lethal removal program, could cause minor adverse impacts to riparian vegetation there. With ultimate eradication of fallow deer in Olema Valley, these impacts will be reversed and restoration of affected areas would eventually occur.

Use of vehicles off-road to cull deer or remove carcasses could result in localized, minor direct destruction of vegetation. Alternative D specifies that NPS staff will attempt to remain on roads and trails whenever possible in order to avoid degrading soils, waterways and vegetation. Because vehicles will rarely be used off-trail, particularly in wilderness and sensitive areas, adverse impacts to vegetation resulting from this alternative are considered insignificant.

Cumulative Impacts

Managed populations of non-native deer will reduce concentration-associated impacts to vegetation at the seashore. This scenario may also improve the success and effectiveness of plant conservation and restoration projects due to the elimination of grazing and thrashing pressure by non-native deer on individual rare species and recovering native vegetation. This alternative does not require mitigation for vegetation impacts because it is a beneficial impact.

Conclusion

No impairment to vegetation would occur from implementing Alternative D. Based on current and past data on fallow and axis deer, eliminating non-native deer from the Seashore will positively affect vegetation communities within over 9,000 acres of current fallow deer range and over 600 acres of current axis deer range. Based on current reports of damage to riparian and understory vegetation within the Seashore, the magnitude of current impacts to vegetation within NPS boundaries are currently minor in intensity. Consequences of alleviating these impacts with the actions described in Alternative D would be beneficial, minor and long-term to Seashore vegetation. Impacts to vegetation on the Vedanta Property would be adverse and minor in the short-term and beneficial and minor in the long-term.

Substantial benefits to vegetation outside the park relative to Alternative A are likely from eliminating the risk of non-native species expanding their ranges.

Type of Impact:	Mixed- both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor

Impacts on Wildlife

Analysis

For this analysis, the best professional judgment of wildlife biologists, as well as research completed at the Seashore and elsewhere, have been used to determine impacts of eradicating fallow and axis deer populations on other wildlife species. In general, eventual disappearance of non-native deer would have beneficial impacts to other wildlife species in the Seashore.

Non-Native Cervids

Agency culling of non-native deer would adversely impact axis and fallow deer by removing reproducing animals from the population. In looking at the fallow population model developed by Gogan et al. (2001), culling a total 1,500 fallow deer and 700 axis deer would eradicate both species in 15 years (see Appendix A for model explanation). Total numbers culled depends on the sex and age of removed animals as well as the carrying capacity of their habitat and density dependent pressures on the herds.

Alternative D, because it results in shooting of non-native deer, would cause a measure of pain and suffering to culled animals. The degree of pain and suffering would be mitigated by use of trained agency sharpshooters for all control operations. Efforts will be made to deliver immediately lethal shots to target animals and sharpshooters will be required to complete NPS range qualifications at levels of intensity and frequency required for law enforcement rangers.

Native Cervids

In their study of axis and fallow deer introductions nationwide, Feldhammer et al. (1993) stated:

> "We may expect competition between exotic and native artiodactyls both intuitively, and on the basis of previous field experiments with a variety of animal groups from various trophic levels and habitats…."

Native black-tailed deer are primarily browsers while both axis and fallow deer have been shown to be grazers. Studies at PRNS have demonstrated however that, during times of low forage availability, non-native deer adapt their feeding habits and consume larger amounts of forbs and browse (Elliott 1983, Elliott and Barrett 1985). Decreasing numbers of non-native deer would result in decreased competition with native black-tailed deer for forbs and browse during droughts, at the end of summer, and year-round on poor quality ranges (Connolly 1981, Elliott 1983, Fellers 1983). Decreased competition for limited forage would result in improved condition in black-tailed deer (Brunetti 1976, Fellers 1983). Decreased competition for forage would likely result in improved black-tailed doe fertility, increased fawn production and higher fawn survival over current levels. The magnitude of the beneficial impacts to black-tailed deer populations would depend on range conditions and precipitation patterns but would likely range from minor to moderate and could be expected to last longer than two breeding cycles.

Biologists in New Zealand documented that established, high-density populations of fallow deer competitively excluded red deer (*Cervus elaphus scotticus*), an elk species native to Europe (Challies 1985). Red deer are considered the most widespread and successful of all deer species introduced to New Zealand except where their range overlaps with previously established fallow deer populations (Challies 1985). Decreased densities of fallow deer in areas of the Seashore where free-ranging tule elk inhabit will likely allow expansion of the elk herd.

Tule elk, like fallow and axis deer, are primarily grazers. Grasses constitute a large proportion of the diets of all three species year-round (Elliott and Barrett 1985, Gogan and Barrett 1985, Fallon-McKnight unpublished data). In addition to allowing further expansion of tule elk herds, lower numbers of non-native deer could beneficially impact current elk populations in the Seashore through decreased competition for forage (Brunetti 1976). Such impacts would be reflected in higher elk calving rates, earlier onset of reproduction in tule elk cows and improved elk calf survival.

Direct behavioral competition between fallow deer and tule elk currently exists at PRNS and would likely decrease with Alternative D. Researchers in the Zehusice Deer Park in the Czech Republic have documented behavioral exclusion of red deer by fallow deer at high-density feeding sites (Bartos et al. 1996). Fallow deer at Zehusice were observed to: 1) be consistently more aggressive than red deer; 2) preferentially seek out feeding sites where red deer congregated; and 3) attack red deer from the rear as a strategy to overcome their larger opponents (Bartos 1996). In the Tomales Point Elk Reserve at PRNS, fallow bucks have been observed sparring with tule elk bulls (PRNS, unpublished data). In all observed instances, fallow bucks were successful in chasing away elk bulls in spite of a significant size disadvantage. The consequences of decreased behavioral competition are difficult to predict with certainty but could include expansion of elk into higher quality forage or habitats, improved condition of reproducing adults and ultimately, increased population growth, or population stabilization.

Paratuberculosis, or Johne's disease, is an infectious and incurable diarrheal wasting disease of wild and domestic ungulates. In a study conducted at PRNS in 1979, paratuberculosis was documented in 9.6% and 8.1% of axis and fallow deer, respectively (Riemann et al. 1979). The disease has been documented in tule elk at Tomales Point Elk Reserve since 1980 but has never been found in PRNS black-tailed deer (Jessup et al. 1981, Sansome 1999, unpublished report). In 1998-1999, relocation of 45 adult tule elk from Tomales Point to the Limantour wilderness area included a 6-month quarantine and extensive testing for Johne's disease (Manning et al. 2003). Only those animals that consistently tested negative on all blood tests and fecal cultures were released in July 1999 to form a new free-ranging herd. This elk herd is currently made up of 34 animals. The goal of the relocation was to restore the dominant native herbivore to the Seashore's wilderness ecosystems.

Transmission of the organism that causes paratuberculosis (*Mycobacterium avium ss. paratuberculosis*) occurs primarily from infected adults to young animals. The period of greatest susceptibility for this infection appears to be the first 6 months of life. The organism is shed by infected animals into feces that may contaminate feed, water, and pastures. The prevalence of the infection and the incidence of clinical disease may climb when an affected population approaches carrying capacity. At these high densities, affected herds experience the stressors of reduced forage nutritional quality and reduced ability to fight disease. This immunosuppression can result in increased transmission of infections, heavier parasite loads and progression to clinical illness. (Manning et al. 2003). Animals in the clinical phase of Johne's disease shed the organism more often and in greater numbers. Premise contamination with this hardy and long-lived organism may thus increase, a factor relevant to the health of numerous species. All cervids are believed to be susceptible to this infection (Manning and Collins 2001).

Alternative D would result in lower densities of non-native deer in PRNS and outside of NPS boundaries. Because non-native deer could scatter into smaller herds as a result of the culling program, the prevalence

of paratuberculosis would decrease in these herds and the potential for transmission to tule elk and black-tailed deer that share their habitat with these smaller herds would decrease.

Genetic variability assists populations in adapting to environmental changes and reduces vulnerability to catastrophic events such as disease, abnormal weather cycles, pollution etc. Fewer than 4,000 of the 500,000 tule elk historically present in California currently remain. Tule elk at PRNS have passed through four severe population reductions or "bottlenecks." With each bottleneck, the amount of genetic variability in the population has been reduced. It has been estimated that PRNS elk are among the most inbred in California, with a degree of relatedness equivalent to that resulting from three consecutive brother-sister matings (McCullough et al. 1996). Physical signs of inbreeding, such as cleft palate, have been observed in the Tomales Point herd (Gogan and Jessup 1985).

Management techniques to increase genetic diversity within and among wildlife populations include: 1) translocating animals between subpopulations, and 2) increasing the number of reproducing animals within each subpopulation (McCullough et al. 1996). For the past 5 years, NPS has cooperated with California Department of Fish and Game to transfer adult elk cows to Tomales Point, in order to increase genetic variability. One of the primary goals of the PRNS General Management Plan is to maintain viable populations of tule elk in the Seashore and to restore free-ranging elk to wilderness ecosystems. Alternative D would likely accelerate the growth of the free-ranging tule elk herd. Greater numbers of breeding animals would result in higher genetic variability and decreased risk of catastrophic population downswings.

Alternative A would result in:

- increased tule elk and black-tailed deer food availability;
- increase in tule elk and black-tailed deer numbers;
- increased tule elk range; and
- increased genetic variability within a the PRNS tule elk population.

Impacts to native cervids from Alternative D inside and outside of NPS boundaries would be beneficial, moderate and long-term.

Small Mammals

The impacts of decreased non-native deer populations on small mammals will occur in two ways: 1) by habitat alteration, influencing food supply and cover, and 2) by direct, beneficial, competition for resources, mainly, food (Flowerdew and Ellwood 2001). In order to definitively demonstrate impacts of diminishing deer populations on small mammals at PRNS, large-scale deer exclosure experiments would have to be used to investigate responses at varied deer densities. Such experiments have not been carried out at PRNS and are discussed in Chapter 2 (Alternatives and Actions Considered but Rejected). Impacts to small mammals are extrapolated from research completed in the U.S. and in the U.K. on fallow deer and white-tailed deer in lowland woodlands (Putman 1986, McShea 2000, Flowerdew and Ellwood 2001, Fuller 2001). Inventories of small terrestrial vertebrates, conducted at PRNS from 1998-2001 in the agricultural and ungrazed areas of the Seashore, were also considered in this analysis (Fellers and Pratt 2001).

In the Britain, heavy grazing pressure (100 deer/km^2) by fallow deer in lowland forests caused reductions and even local extirpations of wood mice, bank voles and common shrews (Putman et al. 1989). The loss of palatable ground-level vegetation removes food sources for small herbivores and at the same time, changes microclimates and reduces protection from predators (Flowerdew and Ellwood 2001). Increased browsing of shrubs in forested habitat or on forest-grassland interfaces, as has been demonstrated in both

axis and fallow deer at the end of summer and during droughts (Elliott 1982), has likely altered suitability of those areas for some species. High densities of fallow deer have been observed to alter riparian cover and vegetation at PRNS through browsing and antler thrashing (B. Ketcham, NPS, personal communication). Reducing such impacts with Alternative D could increase cover and habitat for dusky-footed woodrat (*Neotoma fuscipes*).

Inventories of small mammals in non-wooded areas of the Seashore revealed fewer western harvest mice (*Reithrodontomys megalotis*) and California meadow voles (*Microtus californicus*) captured in those pastures heavily grazed by cattle than in moderately grazed pastures or similar non-wooded areas (Fellers and Pratt 2002). Densities of fallow deer in the Olema Valley areas of PRNS currently approach 80 deer/ km²(NPS 2002a) and could be expected to decrease in Alternative D. Grazing pressure from deer in many Olema Valley sites is currently considered heavy. Should this grazing pressure decrease with Alternative D, species that could benefit are the: Pacific jumping mouse (*Zapus trinotatus*), dusky-footed woodrat (*Neotoma fuscipes*), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Microtus californicus*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*). Decreased fallow deer densities and range resulting from Alternative D would likely increase habitat for these species in limited areas of the Seashore, for longer than 2 breeding cycles. The beneficial impacts could therefore be considered moderate and long-term.

Not all species decline with increasing deer grazing pressure. Grazing at intermediate and low deer densities has been shown to increase or have no effect on some plant and animal species in Britain (Fuller and Gill 2001). At PRNS, deer mice (*Peromyscus maniculatus*) were found more often in pastures grazed by cattle than in pastures where cattle were excluded (Fellers and Pratt 2002). It is possible that with decreased deer grazing pressure in PRNS, deer mouse abundance would decrease. Other small mammal species that thrive in open grassland environments, such as the Valley pocket gopher (*Thomomys bottae*), could also remain unaffected or decrease.

Direct competition for food between non-native deer and small mammals is a potential adverse impact resulting from Alternative D. In the absence of definitive data from park exclosure experiments, evidence of dietary overlap between species has been evaluated. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). In addition, analyses of fallow and axis rumen and fecal samples have shown heavy use of many of the same species used by small mammals (Elliott 1982, Fallon-McKnight, unpublished data). Small mammals likely to benefit from decreasing competition for food are the: Pacific jumping mouse (*Zapus trinotatus*), California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus)*, western harvest mouse (*Reithrodontomys megalotis*), black-tailed jack rabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*).

Depending on local deer densities, weather patterns and the yearly mast crop, beneficial impacts to small mammals from Alternative D range from mild to moderate throughout the Seashore. Because they persist for longer than 2 breeding cycles, impacts are considered long-term.

Mammalian and Avian Predators

This category includes wildlife species, such as mountain lions (*Felis concolor*), coyotes (*Canis latrans*), grey foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), badgers (*Taxidea taxus*), weasels (*Mustela spp.*) and the raptors that prey on small mammals.

Although no research at PRNS has been conducted to document the extent to which non-native deer are preyed upon by carnivores, anecdotal and historical evidence suggest low-level predation, especially on fawns. Since their introduction in the 1940s, there has been a decrease in the proportion of observed

white fallow deer, from 75% to 21%, suggesting that white individuals may be preferentially selected by predators (Wehausen 1973, NPS 2002a). An anecdotal report exists of an axis doe defending her fawn from a bobcat (NPS, unpublished data). Ranchers have reported coyotes preying on axis fawns in the pastoral zone (N. Gates, NPS, personal communication). However, because non-native deer congregate in large groups and prefer open habitat, it seems unlikely that they serve as a primary prey base for native mega- and meso-carnivores that specialize on stalking black-tailed deer and small mammals. Alternative D would decrease the non-native deer prey base for mountain lions, coyotes and bobcats. This beneficial impact would likely be offset by an increase in both the black-tailed deer and small mammal prey base for these carnivores, foxes, weasels and badgers.

In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls (*Strix aluco*) and kestrels (*Falco tinnunculus*), especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely beneficial impact on their rodent prey base, Alternative D would benefit birds of prey such as great-horned owls (*Bubo virginianus*), short-eared owls (*Asio otus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), red-shouldered hawks (*Buteo lineatus*), red-tailed hawks (*Buteo jamaicensis*), Northern harriers (*Circus cyaneus*), black-shouldered kites (*Elanus caeruleus*), sharp-shinned hawks (*Accipiter striatus*) and Cooper's hawks (*Accipiter cooperii*).

Overall, the beneficial impacts of Alternative D to predators in the Seashore and in Marin County would be moderate and long-term.

Other Birds

Little is known about the impacts of grazing wildlife on birds in the Seashore. In 1997-1998, researchers at the Point Reyes Bird Observatory compared avian abundance and species richness in areas grazed by cattle to ungrazed areas (Holmes et al. 1999). Results showed that in all habitat types except coastal scrub, cattle-grazed areas had lower diversity, lower species richness and lower relative abundance of passerines and near-passerines (hummingbirds, woodpeckers and doves). Only one species, the savannah sparrow (*Passerculus sandwichensis*), was found in higher numbers in grazed grasslands.

Deer exclosure studies in Pennsylvania hardwood forests indicate that high densities of white-tailed deer (*Odocoileus virginianus*) cause declines in intermediate canopy-nesting songbirds. This study showed complete absence of certain songbird species, including American robins (*Turdus migratorius*), at deer densities over 25 deer/km² (deCalesta 1994). These declines are thought to occur because high deer numbers alter the structure of woody and herbaceous vegetation 0.5 – 7.5 meters above the ground (deCalesta 1994). Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests suggested that some bird species, namely understory nesters, declined with high deer grazing pressure while other species, namely bark foragers, benefited from reductions in understory vegetation. Researchers in British lowland forests determined that "losers" substantially outnumbered "winners" and that breeding populations of migrant birds were especially vulnerable to adverse impacts from heavy deer grazing pressure (Fuller 2001).

Table 11 lists the ground or low nesting bird species (nesting at approximately 0.3-3 meters) found in the Seashore. These species are found in habitats where the greatest impacts from large herds of non-native deer currently would occur (T. Gardali, Point Reyes Bird Observatory, personal communication, Shuford and Gardali, in review). It is likely that Alternative D would cause an increase in abundance of low nesting species that depend on understory vegetation to place their nests. Impacts on reproductive success and survival are unknown. It should be noted that Table 11 primarily contains species breeding at PRNS and GGNRA and is not exhaustive. Two species that would likely be impacted, the San Francisco common yellowthroat (*Geothlypis trichas sinuosa*) and the California Swainson's thrush (*Catharus*

ustulatus oedicus) are not listed in this table because they are either California Bird Species of Special Concern (CDFG) or Birds of Conservation Concern (USFWS) and are discussed in the Impacts on Special Status Species section.

Table 11. Bird species likely to benefit from Alternative D.

Common Name	**Scientific Name**
Allen's hummingbird	*Selasphorus sasin*
American goldfinch	*Carduelis tristis*
Bewick's wren	*Thryomanes bewickii*
Brewer's blackbird	*Euphagus cyanocephalus*
California towhee	*Pipilo crissalis*
California quail	*Callipepla californica*
Hermit thrush	*Catharus guttatus*
Horned lark	*Eremophila alpestris*
Lark sparrow	*Chondestes grammacus*
Lazuli bunting	*Passerina amoena*
Marsh wren	*Cistothorus palustris*
MacGillivray's warbler	*Oporornis tolmiei*
Orange-crowned warbler	*Vermivora celata*
Oregon junco	*Junco hyemalis thurberi*
Red-winged blackbird	*Agelaius phoeniceus*
Spotted towhee	*Pipilo maculatus*
Western meadowlark	*Sturnella neglecta*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wrentit	*Chamaea fasciata*

It is expected that overall avian species richness, abundance and diversity would increase measurably with reduction of the heavy grazing pressure resulting from Alternative D. Adverse impacts to a few grassland species would be offset by larger benefits to relatively more species that depend on understory shrub layers for nesting, especially in the riparian and woody-grassland interfaces currently impacted by high densities of non-native deer. The beneficial impacts to various species would be moderate and long-term within the Seashore.

Reptiles and Amphibians

Little is known about the impacts of large herds of grazing herbivores on reptiles and amphibians in the Seashore. During inventories of small vertebrates conducted at PRNS in 2001, northern alligator lizards (*Gerrhonotus coeruleus*) were not found in pastures grazed by cattle but were found in similar ungrazed sites (Fellers and Pratt 2002). Changes to woodland understory vegetation, especially in riparian areas, as has been documented with high densities of fallow deer at PRNS, would alter microclimates and habitats for frogs, lizards and salamanders. Adverse impacts under current non-native deer densities could be expected for alligator lizards, California slender salamanders (*Batrachoseps attenuatus*), rubber boas (*Charina bottae*), western skinks (*Eumeces skiltonianus*), racers (*Coluber constrictor*), garter snakes (*Thamnophis elegans)*, and Ensatina salamanders (*Ensatina eschscholtzii*). By allowing regrowth of understory vegetation with reduced deer densities, Alternative D would benefit these species.

Because of expected mild to moderate beneficial impacts of Alternative D on small mammal abundance (see above), concomitant increases can be expected in reptiles that prey on shrews and rodents. Species

in this category are the: western terrestrial garter snake, rubber boa, and gopher snake (*Pituophis melanoleucus*).

Studies of British lowland forests heavily grazed by fallow deer have shown that as a result of decreasing rodent numbers, kestrels relied preyed more heavily on lizards (Putman 1986). Inside the Seashore, decreases in predation by raptors and owls on lizards, frogs and snakes is likely to occur in areas of decreased non-native deer density.

Impacts to amphibians and reptiles in PRNS with Alternative D are expected to be beneficial to a moderate number of species. The impacts are moderate and long-term.

Cumulative Impacts

There are no cumulative impacts anticipated with Alternative D.

Conclusion

This alternative will result in a marked decrease in total non-native deer numbers and range over current levels over the next 15 years in the Seashore. No impairment to native wildlife would occur from implementing Alternative D. Based on research on impacts of non-native deer to wildlife in other countries as well as known impacts of grazing by cattle and white-tailed deer in the U.S., the impacts of Alternative D are expected to be beneficial, within NPS boundaries, to a large number of native species and adverse to a much smaller number of native species. Because the Vedanta property is surrounded by NPS lands but outside of NPS management authority, it is likely that deer densities there would increase initially, as a result of lethal removals in the Seashore. Short-term, native species richness and diversity would likely decrease in those high-density areas. Overall and in the long-term, the magnitude of impacts to native wildlife within and outside of NPS boundaries are considered moderate in intensity and beneficial.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Moderate

Impacts on Special Status Species

This category includes federally listed wildlife species identified, other species of concern recognized by the state of California or Birds of Conservation Concern (U.S. Fish and Wildlife Service) include several species of nesting land birds and raptors.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect federally and state listed species, anecdotal and historical evidence and expert opinion can provide insights and guidance. The federally listed species that are likely to be affected by non-native deer include northern spotted owls (*Strix occidentalis caurina*), western snowy plover (*Charadrius alexandrinus nivosus*), California red-legged frog (*Rana aurora draytonii*), Coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorynchus mykiss*), and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

Analysis

Northern spotted owl

The northern spotted owl is a federally threatened species that reaches the southern limit of its range within GGNRA, PRNS and Muir Woods National Monument (MWNM) in Marin County, California. Data collected by the NPS indicates that these parks may support the highest density of spotted owls known. However, the population is geographically isolated and subject to unique threats including urban development, intense recreational pressure, habituation of owls to humans, potential for catastrophic wildfires, and changes in hazardous fuel management practices. Owls occur throughout the forested lands in the Seashore and the population is likely stable; however, owls have been monitored for only 7 years in the Seashore (NPS and PRBO, unpublished data). Owls prey almost exclusively on small mammals, particularly dusky-footed wood rats (*Neotoma fuscipes*) in the Seashore (Chow and Allen, unpublished data). Woodrats, in turn, are dependent on roots, stems, leaves, seeds and mast (Linsdale and Tevis 1951, Willy 1992).

Fallow deer have been recorded in areas where spotted owls nest and roost. To date, no direct effects have been noted on the productivity or survival of owls. However, deer compete with the prey species of owls, and therefore, likely have an indirect negative impact on food resources. By biting off buds and flowers they reduce the amount of seed and fruit available in autumn and winter. In California and elsewhere, fallow deer are known to feed on acorns, an important food source for many small mammals (Poli 1996, Jurek 1977). In the New Forest in Britain, heavy grazing, mainly from fallow deer, was shown to result in lowered reproduction in tawny owls and kestrels, especially during severe weather cycles and poor mast crop years (Putman 1986). Because of the likely beneficial impact on rodent prey base due to reduced competition for food and cover, Alternative D would have a beneficial impact on northern spotted owls. Overall, the beneficial impacts of Alternative D to owls in the Seashore and in Marin County would be minor and long-term.

Western snowy plover

Western snowy plovers, federally listed as threatened by the U.S. Fish and Wildlife Service (USFWS), nest along the sandy beaches of the Seashore, primarily on Point Reyes Beach between North Beach and Kehoe Beach. Historically, plovers also nested at South Beach, Drakes Beach and Limantour. Plover nesting success has increased slightly over the past few years due to intensive management by the Seashore; however, the species is vulnerable to numerous activities in the park including predation by ravens and disturbance by recreationists. Fewer than 20 chicks fledged in 2002 (Peterlein 2002). Cattle roaming on the beaches in the past were a potential source for disturbance; however, the Seashore now intensively restricts cattle from beaches. A large herd of 60 axis deer has been seen on South Beach within the last five years, and where the herd occurred, the ground was heavily impacted (S. Allen, NPS personal communication). The frequency of this activity by axis deer is unknown but likely does not occur with regularly. Consequently, the overall beneficial impact of Alternative D to plovers in the Seashore is likely minor.

California Red-legged frog

The California red-legged frog was Federally listed as a Threatened species on June 24, 1996. Red-legged frogs breed in ponds or pools during the wet season (December through March), and use ponds

and/or riparian habitats during the rest of the year. Currently, fallow deer regularly frequent riparian areas and will vigorously rub and thrash their antlers during the rut, resulting in maiming and destruction of riparian vegetation. While engaged in this activity, fallow deer may trample frogs. Damage to the vegetation may be degrading non-breeding frog habitat. Overall, the beneficial impacts of Alternative D to frogs in the Seashore would be minor and long-term.

Coho salmon and steelhead trout

Anadromous fish, listed as threatened by USFWS, occur in many of the streams of the Seashore, particularly in Olema Creek and Lagunitas Creek. The Seashore contains 10% of the last remaining wild population of Coho salmon for this Ecologically Significant Unit (ESU), and consequently, any loss of this population would have an impact on the ESU. The NPS, along with the National Marine Fisheries Service and the California Department of Fish and Game, have conducted intensive fish surveys and have funded and implemented numerous restoration projects along the streams that flow through the park and adjacent lands. Numerous culverts have been removed along with other blockages to fish passage. In addition, the agencies have installed fencing to restrict cattle from riparian areas. These fences, though, do not impede the movement of fallow deer.

Currently, fallow deer regularly frequent riparian areas and damage riparian vegetation, particularly during the rut when bucks thrash branches and leaves with their antlers. While engaged in this activity, fallow deer may be indirectly affecting the fish by damaging riparian plants, resulting in: reduced cover, warmer water in streams and drying up of streams due to increased sedimentation and exposure to sunlight. Eradicating fallow deer will remove this impact to riparian vegetation. In addition, removing non-native deer will improve the success and effectiveness of riparian restoration projects for salmon. In restoration areas, revegetation efforts and natural regrowth will no longer be retarded due to heavy grazing and antler rubbing. This alternative reduces the risk of fish redds being trampled in riparian areas where large numbers of fallow deer currently congregate or travel. Overall, the beneficial impacts of Alternative D to anadromous fish in the Seashore would be minor and long-term.

California Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is listed by the USFWS as endangered. The shrimp inhabits lower Lagunitas Creek and lower Olema Creek, within the current fallow deer range at PRNS. Shrimp are highly dependent on overhanging riparian vegetation, under which they live year-round. Fallow deer have not been observed within known shrimp habitat. However, in other areas of both Lagunitas and Olema Creeks, high densities of fallow deer have been observed to browse and trample riparian vegetation (Brannon Ketcham, NPS, personal communication). A decrease in fallow deer range resulting from Alternative D is not likely to cause either adverse or beneficial impacts to shrimp habitat or shrimp survival.

Myrtle's silverspot butterfly

Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) (MSB) is one of three coastal subspecies of *S. zerene* in the Western United States. The USFWS listed the subspecies as endangered in 1992, citing habitat loss and degradation as the primary threats (USFWS 1992).

As of 1998, three populations are known to remain. The USFWS Myrtle's Silverspot Butterfly Recovery Plan (1998) estimated the three populations combined comprise 10,000 individuals. Two populations of MSB occur within the Seashore and the third is on private land in northern Marin County. The Center for Conservation Biology at Stanford monitored distribution and abundance of the MSB at Point Reyes

National Seashore almost yearly from 1992 to 1998. The Stanford survey work shows a decline in MSB population levels during the six-year period and the central population to be "barely existing" (Launer et al. 1998). Grazing is believed to deplete the MSB larval host plants. The Seashore is currently supporting an intensive survey of the habitat of the MSB and research on the current abundance and distribution of the larval host plant and adult nectar sources.

The PRNS coastal dune system and coastal prairie provide critical habitat for the Myrtle's silverspot butterfly. Many different plants are used by the MSB's as nectar sources; native plants (*Grindelia rubicaulis, Abronia latifolia, Monardella undulata, Erigeron glaucus,* and *Wyethia sp*.) as well as non-native bull thistle (*Cirsium vulgare*) and Italian thistle (*Carduus pycnocephalu*s). The only known larval host plant is the western dog violet (*Viola adunca*).

Axis and fallow deer frequent coastal prairie habitat. To date, it is not known whether they browse on the preferred nectar or larval host plants of the MSB. Research in which deer-proof exclosures were monitored in the New Forest in England showed that fallow deer preferentially consumed a *Viola* species in a 1969 but not in a repeat survey in 1978 (Putman 1986). In Hawaii, the introduction of axis deer and mouflon sheep to Lana`i have likely played a major role in the disappearance of *Viola lanaiensis* (USFWS 1995a). Another Hawaiian species, *Viola kauaensis* var. *wahiawahensis,* is also listed as endangered by USFWS because of perceived threats of habitat degradation by feral animals and axis deer (USFWS 1995b). It therefore seems likely that non-native deer, given the opportunity, currently graze on the MSB's larval host plant.

Decreased grazing would increase availability of these plants for the butterfly. If the fallow and axis deer populations were eradicated, adverse impacts to the vegetation used by this butterfly will likely decrease. Overall, the impacts of Alternative D to Myrtle's silverspot butterfly in the Seashore would be beneficial, moderate to major and long-term.

Bird species of concern

The Seashore has collaborated with the Point Reyes Bird Observatory (PRBO) over the past two decades to protect and restore habitat of nesting land birds within the boundaries of the Seashore. Many species of land birds are species of concern both under the California Bird Species of Special Concern (CDFG) and the Birds of Conservation Concern (FWS). Examples of species include common yellowthroat *(Geothlypis trichas sinuosa*), California Swainson's thrush *(Catharus ustulatus oedicus),* and tricolored blackbird *(Agelaius tricolor).*

Numerous restoration projects and fire management actions have strived to improve nesting success in land birds, particularly in riparian areas. In addition, the park is an active member of the Partner-in-Flight program, collaborating with other agencies and organizations to protect and restore populations of neotropical migratory songbirds. PRBO has monitored the reproductive success and species composition of birds for more than 30 years. Monitoring has taken place in areas of the park (Palo Marin) where fallow deer occur only rarely.

In areas where fallow deer are currently abundant, there often is a well-defined browse line on trees and shrubs between 1.5 and 2 meters above the ground. Studies of fallow deer, roe deer (*Capreolus capreolus*) and muntjac deer (*Muntiacus reevesi*) in British lowland forests have suggested that some bird species, namely understory nesters, declined with high deer grazing pressure (Fuller 2001). Similarly, ground or low nesting (approximately 0.0 – 3 meters) bird species found in the Seashore are presently vulnerable to heavy grazing by non-native deer. These species are found in habitats where the greatest impacts from large herds of non-native deer are likely occurring (T. Gardali, Point Reyes Bird Observatory, personal communication; Shuford and Gardali, in review). Current non-native deer

numbers may be limiting nesting species that depend on understory vegetation to place their nests. Current impacts on reproductive success and survival are unknown. Overall, the adverse impacts of Alternative D to understory nesting songbirds of concern in the Seashore and in Marin County are likely to be beneficial, moderate to major and long-term.

Plant Species of Special Concern

This category includes federal, state, and California Native Plant Society (CNPS) listed plant species.

Although no research at PRNS has been conducted to document the extent to which non-native deer affect plant species of special concern, anecdotal and historical evidence and expert opinion can provide insights and guidance. Rare plants have been inventoried at Point Reyes National Seashore over the past twenty years. The preponderance of this information is presence/absence data for species of concern, with some additional data describing distribution of select species. Given the substantial amount of plant distribution data, it is important to note that this information only describes known rare plant occurrences. Obviously there are many acres within the Seashore that have not yet been surveyed for rare plants. Impacts related to rare plants, therefore, can only be estimated in terms of limited best available information.

Rare plants known to occur within current axis deer range include:

- *Arabis blepharophylla*, coast rock cress
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Cordylanthus maritimus* ssp. *palustris*, Point Reyes bird's beak *
- *Fritillaria liliaceae*, fragrant fritillary
- *Grindelia hirsutula* var. *maritima*, San Francisco Bay gumplant
- *Limnanthes douglasii* var. *sulphurea*, Point Reyes meadow foam*
- *Linanthus grandiflorus*, large-flowered linanthus
  Triphysaria floribundus, San Francisco owl's clover

Rare plants known to occur within current fallow deer range include:

- *Abronia umbellata ssp. breviflora*, pink sand-verbena
- *Agrostis blasdalei*, Blasdale's bent grass
- *Arabis blepharophylla*, coast rock cress
- *Arctostaphylos virgata*, Marin manzanita
- *Astragalus pycnostachyus* var. *pycnostachyus*, coastal marsh milk-vetch*
- *Calystegia purpurata* ssp. *saxicola*, coastal bluff morning-glory
- *Campanula californica*, swamp harebell*
- *Ceanothus gloriosus* var. *gloriosus*, Point Reyes ceanothus
- *Ceanothus gloriosus* var. *porrectus*, Mt. Vision ceanothus
- *Chorizanthe cuspidata* var. *cuspidata*, San Francisco bay spineflower
- *Cordylanthus maritimus* ssp. *palustris*, Point Reyes bird's beak *
- *Elymus californicus*, California bottlebrush grass
- *Fritillaria affinis* var. *tristulis*, Marin checkerlily
- *Fritillaria liliaceae*, fragrant fritillary
- *Gilia capitata* ssp. *chamissonis*, dune gilia
- *Grindelia hirsutula* var. *maritima*, San Francisco Bay gumplant
- *Linanthus grandiflorus* large-flowered linanthus
- *Microseris paludosa*, marsh microseris*
- *Perideridia gairdneri* ssp. *gairdneri*, Gairdner's yampah

- *Polygonum marinense*, Marin knotweed
- *Ranunculus lobbii*, Lobb's aquatic buttercup*
- *Sidalcea calycosa* ssp. *rhizomata*, Point Reyes checkerbloom*
- *Triphysaria floribundus*, San Francisco owl's clover

Non-native deer can impact rare plant species directly by consuming and trampling them. PRNS staff observed fallow deer digging up and eating *Fritillaria* bulbs within the burned area after the 1995 Vision Fire (Sarah Allen, NPS, personal communication). It should be noted that damage to *Fritillaria sp.* and other lily species has been observed outside exotic deer range, presumably caused by black-tailed deer or other herbivores (Michelle Coppoletta, NPS, personal communication). Based on analyses of deer diets conducted in Point Reyes, it can be inferred that after a major vegetation-changing event such as a wildfire, both axis and fallow deer would seek other food sources to supplement a depleted diet (Elliott 1983). This might include heavier foraging on bulb species.

Other plant species that may be currently impacted by non-native deer are those occurring in areas of high deer densities, where damage to plants is through trampling. Fallow deer herds have been observed most often in grassland, evergreen scrub, and Douglas fir/redwood plant communities (NPS 2001b). These communities provide habitat for each of the plant species listed above. Adverse impacts to rare plants in the Seashore are currently considered to be minor and short-term. Alternative D will result in beneficial impacts to rare plants, which are minor and long-term.

Of the above listed species, several occur in wetlands or saltmarsh habitats. It is highly unlikely that these species are affected by non-native deer activities. These species are so noted with a "*".

There are no means of mitigating the impacts of non-native grazing herbivores to the species of special concern of the Seashore.

Cumulative Impacts

Cumulative impacts would not be different than in Alternative A.

Conclusion

No impairment to special status species would occur from implementing Alternative D. All of the impacts associated with the eradication of non-native deer are characterized as beneficial to plant and animal species of concern. Depending on the special status species in question, the impacts of Alternative D range from minor to moderate and are long-term.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Mixed - minor to moderate

Impacts on Human Health and Safety

Analysis

Under this alternative, all non-native deer would be removed from the Seashore within a 15-year period through the use of firearms by NPS staff. With adherence to applicable regulations and policies the potential risk to human health and safety would be kept to minor, adverse impacts. Because impacts of

individual treatment efforts are transitory, they are characterized as short-term, while additional long-term impacts are expected as a result of the 15-year period of eradication efforts.

Under this alternative, the numbers and range of both species of non-native deer are expected to decrease to zero in 15 years. A concomitant decrease in deer-vehicle collisions over current levels is expected, a minor to moderate, long-term benefit to human safety related to the significant reduction risk of deer-vehicle collisions, an effect similar to that expected under Alternative E.

Cumulative Impacts

There are no known cumulative impacts associated with Alternative D.

Conclusion

The risk of firearms-related injury is increased under this alternative when compared to existing conditions, a minor, adverse impact to human safety, of short- and long-term duration. Minor to moderate benefits to public health and safety resulting from reduced risk of deer-vehicle collisions are expected. When compared to No Action, this alternative poses a higher potential level of risk to human safety related to the use of firearms. At the same time, when compared to No Action, risks to human safety are slightly reduced under this alternative related to the potential decrease in deer-vehicle collisions.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor to moderate

Impacts on Visitor Experience

Analysis

The 15-year goal of this alternative is the eradication of all non-native deer within the Seashore, resulting in minor, long-term, adverse effects to wildlife viewing opportunities, particularly for those interested in fallow deer. However, under this alternative the native black-tailed deer may increase in numbers as it moves into areas previously occupied by non-native deer. This would represent a minor to moderate, long-term benefit to the related visitor experience. If this should occur, the effects on overall wildlife (deer) viewing opportunities would be negligible.

Effects on the visitor experiences related to viewshed enjoyment under this alternative are similar to those described under Alternative B (negligible).

Visitor experience also relates to social values, particularly those of attitudes towards animals. Effects of the management technique proposed under this alternative (lethal removal/firearms) could result in adverse effects to visitors, particularly those with humanistic and moralistic values, to varying degrees and for varying periods of time. These effects are similar to those described under Alternative B (negligible to moderate, short-term, adverse--depending on the visitor and his/her level of objection to the use of the proposed method). Mitigation measures for this alternative are similar to that described under Alternative B.

Under Alternative D, deer management techniques are comprised solely of lethal removal with firearms, planned for a 15-year time period. The loss of peace and quiet during shooting operations, including from the air, has the potential to adversely impact the visitor experience. Although all alternatives call for

shooting to take place outside of peak visitation hours, visitors who come to the Seashore for solitude and quiet during non-peak times could be uncomfortable with the noise generated. Temporary area closures for large-scale deer management activities are a possibility with this alternative and may inconvenience some visitors. In addition, a small number of visitors may discover carcasses in the wilderness areas where retrieval by NPS sharpshooters is not possible. Moving any carcass near a heavily used trail to a more remote location to reduce odor problems or conflicts between humans and scavengers will mitigate this impact. Collectively, the impacts of firearms use to the soundscape, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in short-term, negligible to moderate adverse impacts to the visitor experience. The intensity of the impact would depend on the numbers of visitors affected and their particular experience (e.g., distance from impact, level of recreational disruption, duration of each management incident, etc.).

Cumulative Impacts

Cumulative impacts under Alternative D are similar to those described for Alternative B.

Conclusions

This alternative results in eradication of non-native deer from the Seashore by 2020. Adverse impacts to the visitor experience are related to wildlife viewing (minor, long-term); social values (negligible to moderate, short-term); and soundscape/access/visual intrusions (negligible to moderate, short-term). Minor to moderate benefits to visitor experience related to viewing of native deer are also expected under this alternative. Compared to the No Action alternative, Alternative D would result in increased benefits related to viewing native deer, and increased adverse impacts related to viewing of non-native deer, social values, and soundscape/access/visual intrusions.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Negligible to moderate

Impacts on Park Operations

Analysis

Removal of all non-native deer within the Seashore under this alternative would result in the elimination of associated resource and operational impacts by 2020. Operational costs would increase substantially from 2005 to 2018 due to personnel, material, services and administrative costs of the eradication program. Over time, as population numbers decline, per-unit costs could be expected to increase based upon an increasing level of effort to find remaining animals, but overall costs for the program would diminish. Similarly, other costs of mitigating adverse impacts of non-native deer to natural resources would decline as axis and fallow population sizes diminish.

The types of actions associated with the monitoring of non-native deer and the mitigation of damage to natural resources by deer to natural resources under Alternative D are initially similar to those described under Alternative B. However, impacts (and associated expenses) under Alternative D would be completely eliminated with the eradication of non-native deer populations by 2020, while impacts under Alternative B would continue indefinitely.

The *Alternatives* chapter outlines the likely deer removal numbers required in Alternative D, based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, this alternative

will require culling of up to 200 non-native deer per year (approximately 150 fallow deer and approximately 50 axis deer) to eradicate the population by the year 2016. It should be noted that these numbers are subject to change depending on precipitation, range conditions and herd growth parameters. Cited figures should be considered approximate guidelines for cost analysis purposes.

The costs of culling of approximately 200 deer yearly includes staff (including one full-time biotechnician), training, vehicles, transport, supplies and carcass disposal and are estimated to be $115,000 per year. During the eradication program, estimated to last from 2005 to 2018, costs of controlling non-native deer constitute a 132% increase in funds allocated to non-native deer. See Figure 12 for a comparison of the costs of the alternatives considered.

Estimates of minimum cost of implementation of Alternative D total approximately $3.8 million by the year 2020. Thereafter, as a result of non-native deer eradication, no costs are expected. The costs of implementing Alternative D, an increase of 4.5% in the total PRNS annual budget, can be expected to decrease to zero in the future.

Under Alternative D, non-native deer monitoring, natural resource mitigation and elimination (lethal removal) of all deer by 2020 could result in minor, short-term, adverse impacts to park operations. Such impacts result from the increased budgetary expenditures required for implementation. Conversely, moderate, long-term benefits to park operations are expected as all non-native deer management costs decrease and are eventually eliminated within PRNS.

Cumulative Impacts

Cumulative impacts for Alternative D are similar to those described for the No Action alternative.

Conclusions

Adverse impacts to park operations under Alternative D associated with eradication of non-native deer populations would be minor and short-term. This is because additions in cost and/or energy usage would represent an approximately budgetary increase of 4.6% of the total park budget and would last only until all actions are completed (by 2020). Beneficial, long-term impacts to park operations under this alternative are characterized as moderate as costs associated with non-native deer management would eventually decrease to zero permanently. When compared to the No Action alternative and its significant projected budgetary increase (5-15%, in perpetuity), Alternative D offers a notably reduced budgetary commitment (4.5% increase), a benefit to park operations. *Alternative D is the least expensive of any of the alternatives.*

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor
Type of Impact:	Mixed – adverse in the short-term, beneficial in the long-term
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor

Impacts on the Regional Economy

Non-native deer have no documented beneficial impacts to the regional economy. Currently there are an estimated 250 axis deer and approximately 860 fallow deer in the Seashore. This alternative would decrease, and eventually eliminate all non-native deer and their associated impacts to the local economy.

Current impacts to those permittees who see non-native deer year-round include (please refer to the *Regional Economy* section of *Affected Environment* for greater detail):

- Fence repair costs ($500-$1000/yr/per ranch [4 reports])—damage by deer crossing.
- Costs of lost pasture forage (unknown costs [4 reports])—pasture forage consumption by non-native deer.
- Costs of lost supplemental feed (unknown costs [1 report])—supplemental food put out for livestock eaten by non-native deer.
- Costs of reseeding pastures ($9000/yr/rancher [1 report])—overgrazing of fallow fields by non-native deer.
- Veterinary costs ($1200 in 2001 [1 report])—leptospirosis.

Although it is likely that native black-tailed deer numbers would increase as a result of decreased competition for forage, black-tailed deer are primarily browsers and not likely to significantly impact livestock pastures, reseeded fields or supplemented hay. In addition, black-tailed deer do not congregate and travel in large herds as do axis and fallow deer, and rarely cause fence damage. Although black-tailed deer do carry diseases of concern to ranchers, the risks of transmission from small, dispersed groups of native deer are less than those from the large groups of non-native deer which can be found close to stock ponds, ranch horses and cows. Even with an increase in black-tailed deer numbers as a result of non-native deer removal, costs of fence damage and other deer depredation to ranchers will decrease significantly over current levels. Impacts of fallow deer to agricultural operations outside of NPS boundaries but within Olema Valley are also expected to decrease with this alternative. The eventual elimination of the non-native deer populations within the park and their associated adverse impacts to agricultural concerns would result in a minor, long-term benefit to the regional economy.

This alternative would not have significant and disproportionate effects on minority and low-income populations.

Because this alternative might require occasional area closures but no park closures, there are no expected effects on local tourist businesses.

Cumulative Impacts

There are no cumulative impacts to the regional economy resulting from this alternative.

Conclusions

This alternative would result in removal of all fallow deer and axis deer within the Seashore and a prevention of their spread throughout Marin County. The action will result in minor benefits to agriculture and the regional economy within and outside of NPS boundaries. Because this alternative results in permanent eradication of non-native deer, the beneficial impacts to the local economy are long-term. Comparatively, the No Action alternative would likely result in the greatest number of adverse effects to the regional economy by way of agricultural impacts and potential impacts to low-income farm workers.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor

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

This alternative would remove all fallow and axis deer from PRNS and PRNS–administered lands in 15 years, through a combination of lethal and non-lethal techniques. Until contraceptive technology advanced, only fallow does would be treated with contraceptives while both fallow and axis deer would be lethally removed. It is expected that large numbers of deer would be lethally removed in the first 5 years of the program and that because of increased wariness on the part of the deer and lower deer densities, a more gradual decrease over the next 10 years would follow. Similarly, most of the treatment of does with contraceptives would occur in the first 5 years of the program, in order to decrease recruitment of fawns and thereby reduce the total number of animals culled. Because animals on contraception would not be removed from the park, it is expected that deer numbers would not decrease as rapidly with this alternative as with Alternative D (Removal of All Non-Native Deer by Agency Shooting). An effort would be made to remove or treat deer in a manner that did not lead to increased migration outside of NPS boundaries and it is expected that this alternative would not result in increased numbers of non-native deer on adjacent state park or private lands. However the Vedanta property, which currently contains the highest fallow deer densities in Olema Valley (up to 80 deer/km^2), is outside of NPS management jurisdiction and surrounded entirely by NPS lands. It is likely that during the lethal removal program in the Seashore, deer densities on this inholding would increase.

The impacts to natural resources and the regional economy do not differ between Alternative D and E. Impacts of Alternative E to park operations, health and human safety and visitor experience differ slightly from those of Alternative D.

Impacts on Water Resources and Water Quality

Analysis

Impacts, including cumulative impacts, are not different from Alternative D. The impacts of non-native deer eradication in 15 years would constitute an alleviation of current impacts to water resources and water quality.

Type of Impact:	Mixed – both adverse and beneficial
Duration of Impact:	Mixed - both short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor in the short term, moderate in the long-term

Impacts on Soil

Analysis

Impacts, including cumulative impacts, are not different from Alternative D. Non-native deer eradication in 15 years would constitute an alleviation of current impacts to soil.

Type of Impact:	Mixed - both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor

Impacts on Vegetation

Analysis

Impacts, including cumulative impacts, are not different from Alternative D. Potential consequences of non-native deer eradication are lower concentrations of animals within a variety of plant communities. Alternative E would alleviate current impacts to vegetation including direct effects of deer foraging, congregating, and antler rubbing.

Type of Impact:	Mixed- both adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Minor

Impacts on Wildlife

Analysis

Impacts, including cumulative impacts, to native species are not different from Alternative D. In general, eventual disappearance of non-native deer would have beneficial impacts to other native wildlife species in the Seashore.

Although fewer non-native deer would be lethally removed in Alternative E than in Alternative D, pain and suffering would result from lethal removals as well as from fertility control. Some of this pain would be mitigated by use of trained sharpshooters in culling deer. Efforts will be made to deliver immediately lethal shots to target animals. Animals treated with contraceptive agents would undergo the stress of capture, restraint, injection and permanent marking (i.e., radio-collaring and ear-tagging) at least once during their lifetimes. Capture of wild ungulates will result in unavoidable injuries and some deaths.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Moderate

Impacts on Special Status Species

Analysis

Impacts, including cumulative impacts, are not different from Alternative D. All of the impacts associated with the eradication of non-native deer are characterized as beneficial to plant and animal species of concern.

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Mixed - minor to moderate

Impacts on Human Health and Safety

Under this alternative, it is assumed that approximately 75% of fallow and 100% of axis deer are eradicated over a 15-year period through the use of firearms by NPS staff, posing risks of firearms-related

injury to staff and visitors. With adherence to appropriate regulations and policies, these risks would be minimized and would keep impacts to human safety at minor levels.

Depending on the agent used, Alternative E calls for treatment of up to 25% of fallow does with a long-acting contraceptive or sterilant. Treatment would require capture and immobilization of animals for permanent marking (ear-tagging and radio-collaring). Capture would be accomplished with a corral trap, a drop net, or with a net gun fired from a helicopter. Regardless of the technique used, wildlife capture, and immobilization could result in injury to participating staff, either from the animals themselves or from equipment and aircraft. The number of people at risk of treatment-related injury under Alternative E could range from 20-50 per effort, depending on the capture/treatment techniques used over a period of 15 years. Adverse impacts to human safety of minor intensity would be likely. Impacts could be expected to be both short-term (transitory, individual capture/treatment incidences) and long-term (15-year period) in duration.

The effect on human health and safety related to non-native deer population reduction efforts and deer-vehicle collisions under this alternative are similar to that expected under Alternative D (long-term, minor to moderate benefits).

Cumulative Impacts

There are no known cumulative impacts associated with Alternative E.

Conclusion

The risk of injury related to firearms and contraceptive treatments is increased under Alternative E when compared to existing conditions; a minor, adverse impact to human health and safety of short- and long-term duration. Minor benefits to human safety could be realized as a result of likely reductions in numbers of deer-vehicle collisions under this alternative. When compared to No Action, Alternative E would result in increased risks to human safety as a result contraceptive treatments and the use of firearms. Conversely, when compared to No Action, Alternative E offers slight benefits related to potentially decreased deer-vehicle collisions.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Minor

Impacts on Visitor Experience

Analysis

Under this alterative, effects on wildlife viewing, particularly non-native and native deer species, are similar to those described under Alternative D (non-native deer--minor, long-term, adverse; native deer—minor to moderate, long term benefits).

Effects on the viewshed related to the visitor experience under this alternative are similar to those described under Alternative B (negligible).

Under this alternative, visitor experience is also related to social values, particularly those of attitudes towards animals. Effects of the management techniques proposed under this alternative (lethal removal and contraceptive methods) could result in adverse effects to the visitor experience to varying degrees and

for varying periods of time. These effects are similar to those described under Alternative B (negligible to moderate, short-term, adverse – depending on the visitor and his/her level of objection to proposed methods). As proposed under Alternative E, if contraception proves effective in aiding the eradication of deer populations, this alternative would represent a less lethal management approach than that proposed under Alternative D (lethal removal only). This less lethal approach has the potential to benefit or adversely affect visitor experience, depending on individual social values. Mitigation measures under this alternative are also similar to that described under Alternative B.

Alternative E proposes the management of non-native deer through a combination of lethal controls and contraceptive methods to eradicate non-native deer populations over a 15-year period (Alternative D proposes only the use of lethal methods -firearms- to accomplish the same goal). While the degree and type of effect differs slightly, impacts of firearms and helicopter use related to the soundscape, the potential temporary closures of deer management areas, and the possibility of encountering visual intrusions (carcasses) would likely result in effects similar to that described under Alternative D (short-term, negligible to moderate, adverse impacts – depending on the numbers of visitor affected and the duration of each incident's effect). Such impacts would be totally eliminated within 15 years.

Some visitors, especially those searching for a "wilderness experience" in the Seashore, might object to seeing permanent marks such as radio collars and ear tags on treated fallow does. Because the population control techniques in Alternative E will be used for a maximum of 15 years and are therefore transitory, impacts to visitor experience are characterized as short-term, minor, and adverse.

Cumulative Impacts

Cumulative impacts associated with Alternative E are similar to those described for Alternative B.

Conclusions

This alternative will result in the permanent removal of all fallow and axis deer within the Seashore within a 15-year period. Adverse impacts to the visitor experience are related to wildlife viewing (minor, long-term); social values (negligible to moderate, short-term); soundscape/access/visual intrusions (negligible to moderate, short-term); and wilderness experience (minor, short-term). Minor to moderate benefits to the visitor experience related to increased opportunities of viewing native deer species are also expected. When compared to No Action, additional adverse impacts can be expected under Alternative E related to social values, soundscape/access/visual intrusions, and wilderness experience.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term and long-term
Intensity of Impact:	Negligible to moderate

Impacts on Park Operations

Removal of all non-native deer within the Seashore under this alternative would result in the elimination of associated resource and operational impacts of continued non-native deer management by 2020. Operational costs would increase substantially from 2005 to 2020 due to the personnel, material, services and administrative costs of the lethal removal and contraception programs. Over time, as population numbers decline, per-unit costs of lethal removal could be expected to increase based upon an increasing level of effort to find remaining animals, but overall costs for the program would diminish. Similarly, other costs of mitigating adverse impacts of non-native deer to natural resources would decline as axis and fallow population sizes diminish.

The types of actions associated with the monitoring of non-native deer and the mitigation of damage by non-native deer to natural resources under Alternative E are similar to those described under Alternative D.

The *Alternatives* chapter outlines the likely deer removal and treatment numbers required in Alternative E, based on population modeling by Barrett (2001) and Hobbs (2003). It is estimated that, initially, this alternative will require culling of up to 200 non-native deer per year (up to 150 fallow deer the first year with decreasing numbers thereafter, and approximately 50 axis deer) to aid in the eradication of the population by the year 2020. It should be noted that these numbers are subject to change depending on precipitation, range conditions and herd growth parameters. If target cull numbers are a percentage of total doe numbers, they will decrease rapidly with time. Cited figures should be considered approximate guidelines for cost analysis purposes.

The costs of culling of approximately 200 deer in the first year includes staff (including one to two full-time biotechnicians), training, vehicles, transport, supplies and carcass disposal and are estimated to be $115,000 per year (similar to costs projected under Alternative D). Costs of removing fewer animals in later years would decrease, but cost of removal per animals would increase because of increased effort required to locate animals.

The costs of treating 100 does with a lifetime-effect contraceptive (if available) in year 1 of the program are estimated to be $210,000. Costs of monitoring treated animals in future years would be approximately $45,000 per year for the next 6-12 years (the lifetime of treated animals). Should available contraceptives remain effective for less than the reproductive life of the does (less than 8-10 years), the cost of treating animals will be significantly higher.

During the culling and contraceptive programs, estimated to last from 2005 to 2020, costs constitute a 132% increase in funds allocated to non-native deer. See Figure 12 for a comparison of the costs of the alternatives considered.

Estimates of minimum cost for implementation of Alternative E total approximately $4.5 million by the year 2020; thereafter, as a result of the eradication of all non-native deer, no costs are expected. The costs of implementing Alternative E constitute an increase of 5% – 9% of the total PRNS annual budget, and can be expected to decrease to zero in the future.

Under Alternative E, non-native deer monitoring, natural resource mitigation, and lethal removal and contraception operations would result in short-term, moderate, adverse impacts to park operations as a result of increased (5-9%) budgetary expenditures. In addition, moderate, long-term benefits to park operations would be realized resulting from the eventual elimination of all non-native deer management activities.

Cumulative Impacts

Cumulative impacts for Alternative E are similar to those described for the No Action alternative.

Conclusions

In addition to cumulative impacts, adverse impacts to park operations associated with eradication of non-native deer populations under Alternative E are characterized as moderate and short-term due to a projected 5-9% increase in cost and/or energy usage of the existing park budget. These costs would be incurred until all actions are completed (2020). Beneficial impacts to park operations from this

alternative are characterized as moderate and long-term due to the elimination of non-native deer management costs that would eventually decrease to zero. When compared to the No Action alternative and its projected increase in budget commitments (5-15%, in perpetuity), smaller budgetary commitments under Alternative E (5-9%) would eventually be eliminated by the year 2020, constituting an overall positive effect on park operations.

Type of Impact:	Adverse and beneficial
Duration of Impact:	Short-term (adverse) and long-term (beneficial)
Intensity of Impact:	Moderate

Impacts on Regional Economy

Analysis

Impacts are not different from Alternative D. Impacts associated with the eradication of non-native deer within the park are characterized as beneficial to the regional economy

Type of Impact:	Beneficial
Duration of Impact:	Long-term
Intensity of Impact:	Minor

Unavoidable Adverse Impacts

The impacts identified below for each alternative are those, which cannot be fully mitigated or fully avoided.

Alternative A: No Action

The No Action alternative, by definition, contains no measures to mitigate impacts to resources. Continued population growth and range expansion of non-native deer would result in unmitigated, significant, adverse impacts to soils, water resources, vegetation, wildlife, and special status species, both within and outside of NPS boundaries.

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

Within the Seashore and on the Vedanta Society property, there would be a continuation, albeit at lower levels, of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species.

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

Within the Seashore and on the Vedanta Society property, there would be a continuation, albeit at lower levels, of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species.

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

There would be a continuation of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species for the 15-year removal period. The intensity of these adverse impacts would decrease as the number of non-native deer in PRNS decreased.

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

There would be a continuation of current adverse effects of non-native deer on soils, water resources, vegetation, wildlife, and special status species for the 15-year removal period. The intensity of these adverse impacts would decrease as the number of non-native deer in PRNS decreased.

Relationship Between Local Short-Term Uses and Long-Term Productivity

Alternative A: No Action

Under the No Action alternative, increasing non-native deer numbers would degrade long-term natural productivity.

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

Reduction of total non-native deer numbers would enhance, to some degree, the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration, albeit incomplete, of overgrazed areas, trampled riparian environments, and would reduce competition with native ungulates.

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

Reduction of total non-native deer numbers would enhance, to some degree, the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration, albeit incomplete, of overgrazed areas, trampled riparian environments, and would reduce competition with native ungulates.

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

Eradication of non-native deer would enhance the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration of overgrazed areas, trampled riparian environments, would reduce competition with native ungulates and eliminate impacts to other native species.

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

Eradication of non-native deer would enhance the long-term productivity of the PRNS and GGNRA environments. The actions called for in this alternative would allow restoration of overgrazed areas, trampled riparian environments, would reduce competition with native ungulates and eliminate impacts to other native species.

Irreversible or Irretrievable Commitments of Resources

Irreversible commitments are those that cannot be reversed. Extinction of a species is an example of an irreversible loss. *Irretrievable* commitments are those that are lost and cannot be replaced. Deterioration past repair of a culturally significant building is an example of an irretrievable loss. The following section identifies irreversible or irretrievable commitments of resources resulting from the various alternatives.

Alternative A: No Action

Under the No Action alternative, loss of soil to erosion and potential extirpation of rare or special status species represent irreversible and irretrievable loss of resources.

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

Under this alternative, loss of soil to erosion and potential extirpation of rare or special status species represent irreversible and irretrievable loss of resources.

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

Under this alternative, loss of soil to erosion and potential extirpation of rare or special status species represent irreversible and irretrievable loss of resources.

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

Under this alternative, there would be no irreversible or irretrievable loss of resources due to identified actions.

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

Under this alternative, there would be no irreversible or irretrievable loss of resources due to identified actions.