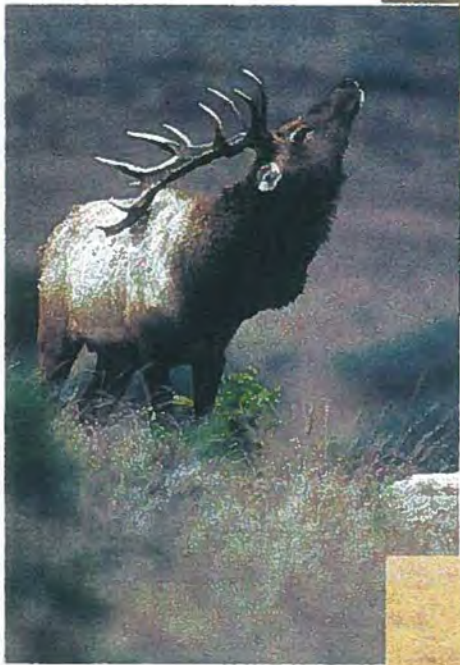
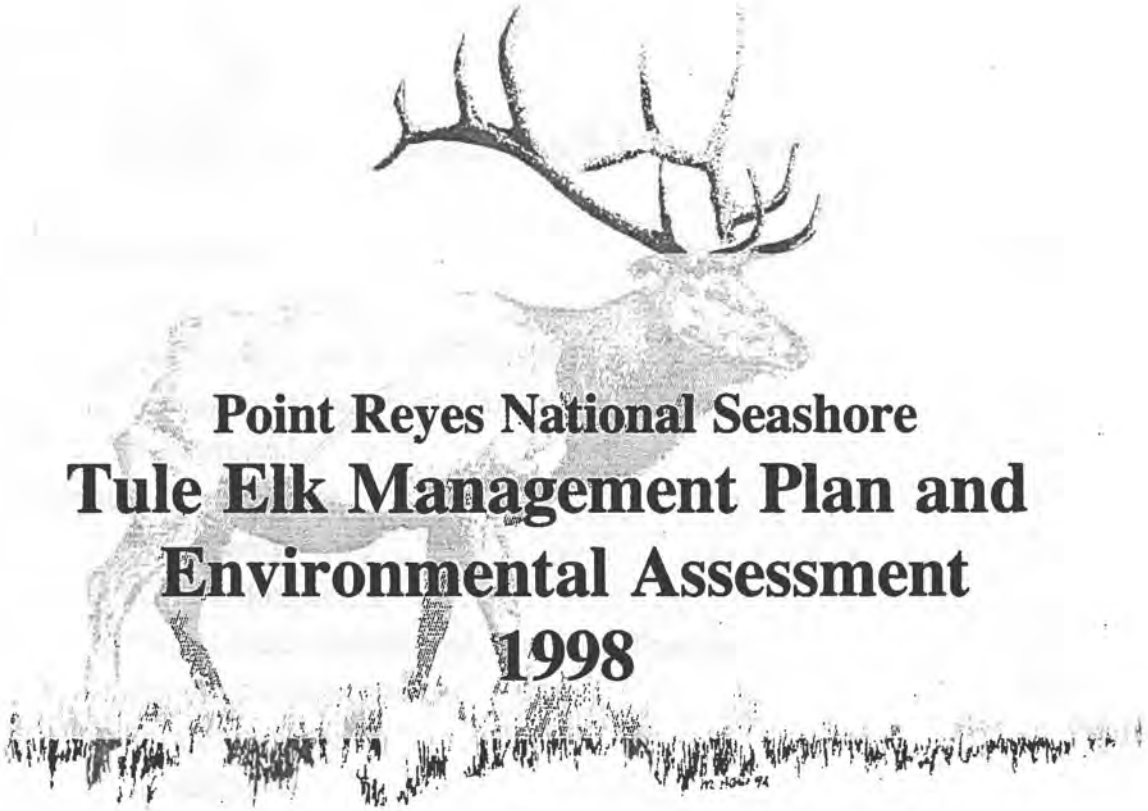


Point Reyes National Seashore  
Tule Elk Management Plan  
and  
Environmental Assessment



1998





**Point Reyes National Seashore  
Tule Elk Management Plan and  
Environmental Assessment  
1998**

*Looking to the future, in view of the needs of elk and the exacting requirements of recreation based on multiple use, the safest course is to model elk management along natural lines, not only to preserve the elk as a living animal, but also, so far as is reasonably possible, to preserve its distinctive habits as well as its habitat.*

Olaus Murie, *The Elk of North America*, 1951



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Point Reyes, California 94956



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## Introduction

### Purpose and Need

The purpose of this plan and environmental assessment is to guide the management, monitoring, and research of tule elk, *Cervus elaphus nannodes*, at Point Reyes National Seashore for the next five to ten years. This action is needed to provide for the protection of tule elk that is consistent with scientifically sound principles, takes into account the interests of the public, and meets the objectives for which the Seashore was established.

Management plans in the National Park Service (NPS) describe the resources, potential actions to be undertaken, and effects of alternatives in compliance with laws and policies regulating federal land management agencies.

This *Tule Elk Management Plan* has been developed in response to numerous issues that have arisen in the last 15 years. Concern has centered on tule elk at Point Reyes overpopulating a limited, enclosed range and the potential consequences to other protected species and ecosystems. The NPS proposed action and three alternatives are described herein.

### Authorities, Laws, and Policies

Point Reyes National Seashore operates as a unit of the National Park Service, U.S. Department of the Interior, and is subject to the laws and regulations that provide authority for its management. The National Park Service Act of 1916 that created the National Park Service (USC Title 16, Subchapter 1) states its purpose:

...is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same and in such manner and by such means as will leave them unimpaired for the enjoyment of future generations

Wildlife management in parks is subject to *Title 36 CFR 2.2* on Wildlife Protection and *Title 50 CFR 30* on Range and Feral Animal Management. *NPS Management Policies* provides the following guidance on preserving parks and wildlife:

The primary objective in natural zones will be the protection of natural resources and values for appropriate types of enjoyment while ensuring their availability to future generations. Natural resources will be managed with a concern for fundamental ecological processes as well as for individual species and features. Managers and resource specialists will not attempt solely to preserve individual species (except threatened and endangered species) or individual natural processes; rather, they will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and ecological integrity of the plants and animals... The National Park Service will seek to perpetuate the native animal life as part of the natural ecosystems of parks. Management emphasis will be on minimizing human impacts on natural animal population dynamics... Individual animals within a population may be removed only when control of animals is required for park ecosystem maintenance, or is necessary for human safety and health, or to protect property or landscaped areas, or removal is part of an NPS research project, or removal will restore native populations in other parks or cooperating areas without diminishing viability... Natural processes will be relied on to control populations of native species to the greatest extent possible. Unnatural concentrations of native species caused by human activities may be controlled if the activities causing the concentrations cannot be controlled.

Point Reyes National Seashore was established in 1962 by Public Law 87-657 (16 USC LXIII 459c) for "purposes of public recreation, benefit, and inspiration, a portion of the diminishing seashore of the United States that remains undeveloped." Wilderness areas were established at Point Reyes National Seashore in 1976 by the National Wilderness Preservation System (Public Law 94-544), which further stated that Point Reyes:

Shall be administered by the Secretary without impairment of its natural values, in a manner which provides for such recreational, educational, historic preservation, interpretation, and scientific research opportunities as are consistent with, based upon, and supportive of the maximum protection, restoration, and preservation of the natural environment within the area.

Specifically addressing the management of California tule elk, Public Law 94-389, *Preservation of Tule Elk Population—California* in 1976 states that:

The Secretary of the Interior, the Secretary of Agriculture, and the Secretary of Defense shall cooperate with the State of California in making lands under their respective jurisdictions reasonably available for the preservation and grazing of tule elk in such manner and to such extent as may be consistent with Federal Law.

The law goes on to say:

The Secretary of the Interior, in coordination with all Federal, State, and other officers having jurisdiction over lands on which tule elk herds are located or lands which would provide suitable tule elk habitat, shall develop a plan for tule elk restoration and conservation, including habitat management, which shall be integrated with the comparable plans of the State and local authorities of California.

### **State Law and Policies**

In 1971 the State of California enacted Section 3951 and amended Section 332 of the Fish and Game Code to provide for the relocation of elk to suitable habitats and set a goal of reaching 2,000 tule elk statewide. The National Park Service cooperates with the State in meeting its objectives in managing tule elk. Federal jurisdiction applies within the boundaries of Point Reyes National Seashore, and some state regulations are applicable. The Seashore signed a Memorandum of Agreement in February 1998 with the California Department of Fish and Game (CDFG) on the management of tule elk at Point Reyes (see appendix A). Earlier agreements with the CDFG on tule elk were signed in 1969, 1974 and 1978.

### **Management Issues not covered by this Plan**

A number of management issues are discussed in this plan where they relate to tule elk, but are not intended to be analyzed or assessed for environmental compliance by this plan. One set of issues is the management of elk and other ungulates on lands outside the regional area of Point Reyes National Seashore. This includes other federal, state, local and private lands whether elk are present or not. Such planning in other regions of the state or for other national park units is beyond the scope of this document.



Another set of closely related management objectives includes decisions concerning the control of non-native ungulates in Point Reyes, which include axis deer (*Axis axis*) and fallow deer (*Dama dama*). While their management affects tule elk, the issues involved with their control or elimination are not covered by this plan.

## Background

### Seashore Description

Point Reyes National Seashore is located about 30 miles north of San Francisco, California, and contains 71,000 acres of coastal beaches, dunes, grasslands, hills, forests and mountains (see figure 1). The Seashore has 32,000 acres of wilderness, including the area of Tomales Point where the existing tule elk range is located. The Seashore had 2.2 million visitors in 1995, including many who visited the Tomales Point elk range. Elk are an attraction for many who visit the area, and although visitors have never been surveyed on the subject, abundant experience from visitor comments and public meetings shows that the elk are a highly visible attraction that draws visitors to Tomales Point.

### History of Elk in California

Elk (*Cervus elaphus*) is a large deer species widely distributed in temperate zones of North America, Europe, and Asia. Once distributed throughout the United States, elk today exist primarily in western states within large forest and range areas (Murie 1951, Boyce and Hayden-Wing 1979, Thomas and Toweill 1982).

Tule elk are a distinct subspecies of elk (Merriam 1905) endemic to California that was given special protective emphasis by State and Federal agencies (Phillips 1976), although it is not a state or federally listed threatened or endangered species. While the distinguishing characteristics of tule elk as a subspecies are a topic of research, their separate taxonomic status is supported in the scientific literature (McCullough 1969, Dratch 1983, Chambers and Bayless 1983, Schonewald-Cox et al. 1985, Kucera 1991).

Tule elk were abundant at the time the first Europeans came to California and occurred throughout the coast, central valley, and foothills of the State with an estimated population in 1850 of 500,000 animals (McCullough 1969). As the State was settled and agriculture expanded, elk populations were reduced by hunting and habitat losses until, by 1870, only 5-10 individuals remained on a single ranch.

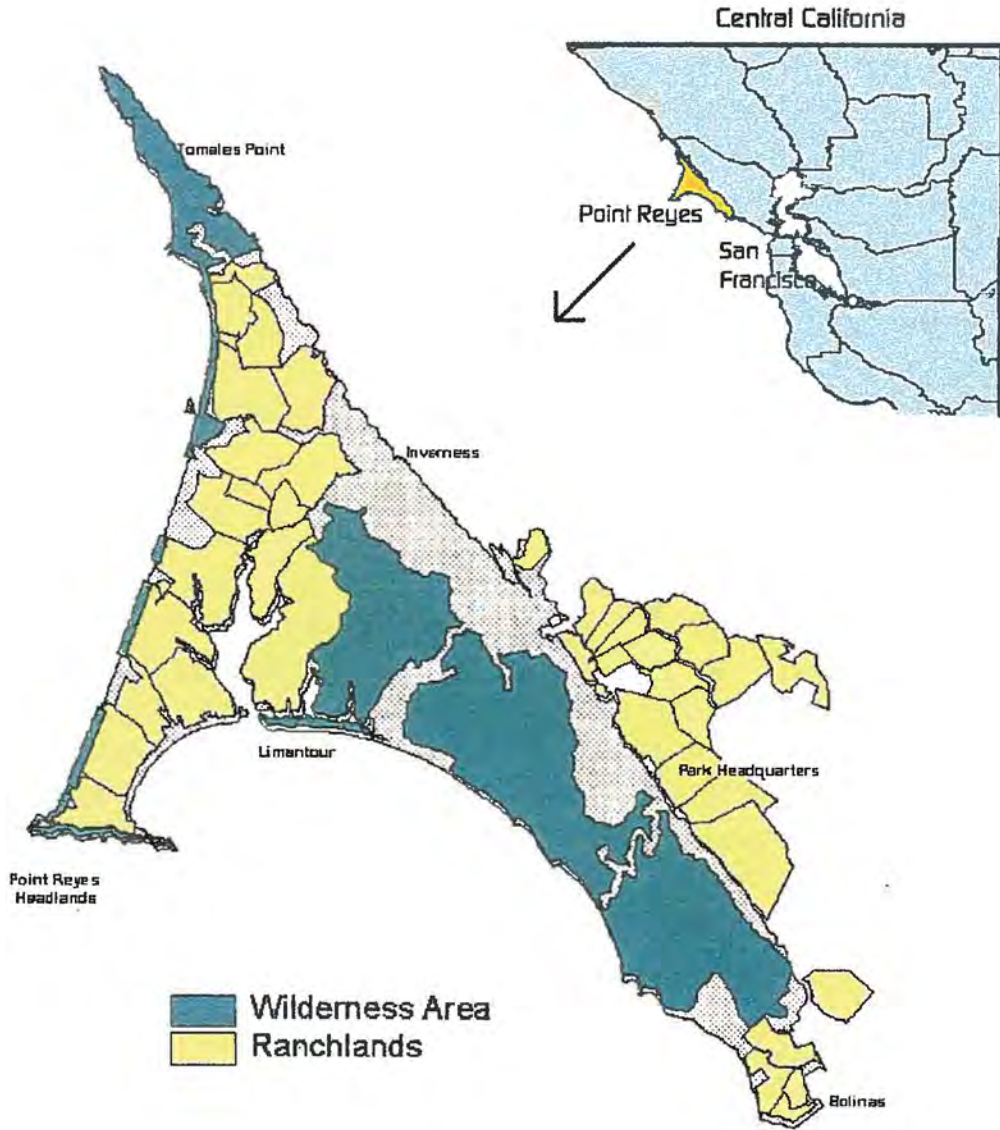


Figure 1. Map of Point Reyes National Seashore

After numerous attempts to establish new herds, two herds were created that thrived. These herds received protection, and by the 1940s increased to a few hundred animals (McCullough 1978).

The State of California began a conservation program in the 1970s for relocating and establishing new tule elk herds around the state with the expressed goal of reaching a population size of 2,000 statewide. An interagency task force was established and produced "A Management Plan for the Conservation of Tule Elk" (Tule Elk Interagency Task Force 1979). The plan set forth guidelines to be used in identifying new tule elk relocation sites, relocating herds, and public education. The National Park Service was a member of the task force and fully supported its objectives and guidelines. Today, the State of California contains some 3,200 tule elk in 23 locations, with Point Reyes National Seashore's population among the largest.

### **Elk Life History**

A general description of the biology of tule elk is useful for understanding many of the issues addressed in this plan, and is provided here for that purpose.

Tule elk females, or cows, give birth in the late spring and early summer from April through June usually to a single calf, and rarely twins. Weighing around 30 pounds at birth, the newborn calf was conceived some eight months earlier during the last summer's rutting season. The ratio of male to female calves at birth is 50:50, but this changes over their adult life, usually with females living longer than males. Tule elk young grow rapidly, reach sexual maturity at 18 months of age, and eventually grow to some 300-500 pounds, with males being 50-100 pounds heavier on average than females.

Males at 1.5 years of age develop short (about one foot), straight antlers and are known as "spike bulls." As they age, the antlers rapidly become larger with four or five points that may weight up to 40 pounds. The antlers begin growing in the late winter shortly after being cast off. Covered with tissue or "velvet" during the growth period, the velvet covering dries out and is shed to reveal the completed antler. This nutritionally demanding annual accomplishment compounds the biological cost of reproduction for the male.

Tule elk breed in a polygamous mating system where males compete during the rut or breeding season for dominance. The result is that the dominant bull mates with many females, accomplished through forming harems. Thus, only 15-25% of males breed compared with 90% of females. At Point Reyes the rutting season is usually in the late summer in July through September. Bulls establish a dominance hierarchy through rutting behavior that includes vocalizations such as "bugling," various body postures and threats, and the dramatic fights that can result from head butting and antler charging. While most of these behaviors result in no harm to competing males, injuries can sometimes occur. Most dominant bulls are in the range of 4-8 years old, but this varies a great deal depending upon the age structure of the herd. The dominant bulls herd and defend females, which form a reproductive herd or "harem." The lead bull will go a month with little food to keep out competitors and breed with the females when they enter reproductive readiness or "estrus."

Tule elk are considered mixed grazers and browsers, meaning they feed on both ground-level herbs and grasses and on woody shrubs and trees. At Point Reyes elk eat a wide variety of plants including various grasses, coyote bush, willow, bush lupine, plantain, and miner's lettuce. As ruminants, their multi-chambered stomach is ideal for breaking down plant cellulose through bacterial action. Each animal consumes some 2 to 3½ pounds of vegetation per 100 pounds body weight each day depending on nutritional content of the food. Thus, a 450-pound bull might eat 10 to 15 pounds of forage daily. Tule elk require 3-10 acres of habitat per animal, but this figure is very inexact due to the differences in productivity of different soils, climates, vegetation communities, and numerous other factors.

Tule elk have few remaining predators at Point Reyes at this time. Originally black and grizzly bears, mountain lions, and coyotes would have taken their toll, especially on the newborn and young, along with the older infirm animals. Today, coyotes occur on the Tomales Point elk range and mountain lions have occasionally been spotted a few miles away. Should tule elk be allowed to expand their range in the Seashore, they will likely come into regular contact with these predators.

Life expectancy for tule elk is generally considered to be 8-12 years once they reach adulthood, but individuals can live much older than this. In 1998 one of the original animals introduced in 1978, known locally as "old cow," died at an age of at least 21 years.

## Point Reyes Elk History

Early historical accounts described more than 1,000 tule elk in Olema Valley (Evermann 1915). Tule elk were eliminated from the Point Reyes area by the middle 1800s as agriculture, logging, and hunting took their toll. When plans to conserve tule elk statewide were being made, Point Reyes was discussed as a possible reintroduction site (Phillips 1976). Absent for over 150 years, elk were reintroduced at Point Reyes in 1978 with the transfer of 10 individuals from San Luis National Wildlife Refuge to Tomales Point. The erection of a three-mile-long fence across the peninsula from the Pacific Ocean to Tomales Bay isolated the herd from adjacent dairy ranches. This created a 2,600-acre enclosure that constitutes the current elk range in the Seashore. The reintroduction was possible through the cooperation of the California Department of Fish and Game, which included the Point Reyes herd in its statewide objectives for increasing tule elk. In a memorandum on October 12, 1979, NPS Western Regional Director Howard Chapman stated the intended purpose as "reestablishing a relatively wild, free roaming tule elk herd on Tomales Point."

The Tomales Point herd has increased considerably in size, reaching a 1997 population of 465 animals, representing 15% of the entire tule elk population statewide (Figure 2). However, the population did not grow in the first few years after the reintroduction. During this time concerns existed for the survival and long-term health of the herd, due to numerous problems the elk were encountering (Gogan 1986, Gogan and Barrett 1986). Problems documented included nutritional copper deficiencies, Johne's disease, adult mortality and low reproductive rates. By 1980 the remaining cattle were removed from Tomales Point and range conditions improved. The tule elk herd increased, slowly at first, and then rapidly. By 1990, the tule elk herd had reached the carrying capacity (see glossary) estimated for the herd by Gogan (1986) of 140 animals. During this time, management concerns shifted from a concern over lack of growth to one of overpopulation and overgrazing, resulting in degradation of the vegetation leading to starvation and a population crash.

These early concerns for the success of the herd, and the more recent concern over population expansion, led the Seashore to conduct numerous resource management and research projects, including graduate student studies. These studies were complemented with repeated consultations with scientific and wildlife management experts. In 1982 the Seashore completed an *Interim Tule Elk Management Plan* that briefly outlined the approaches that would be followed.

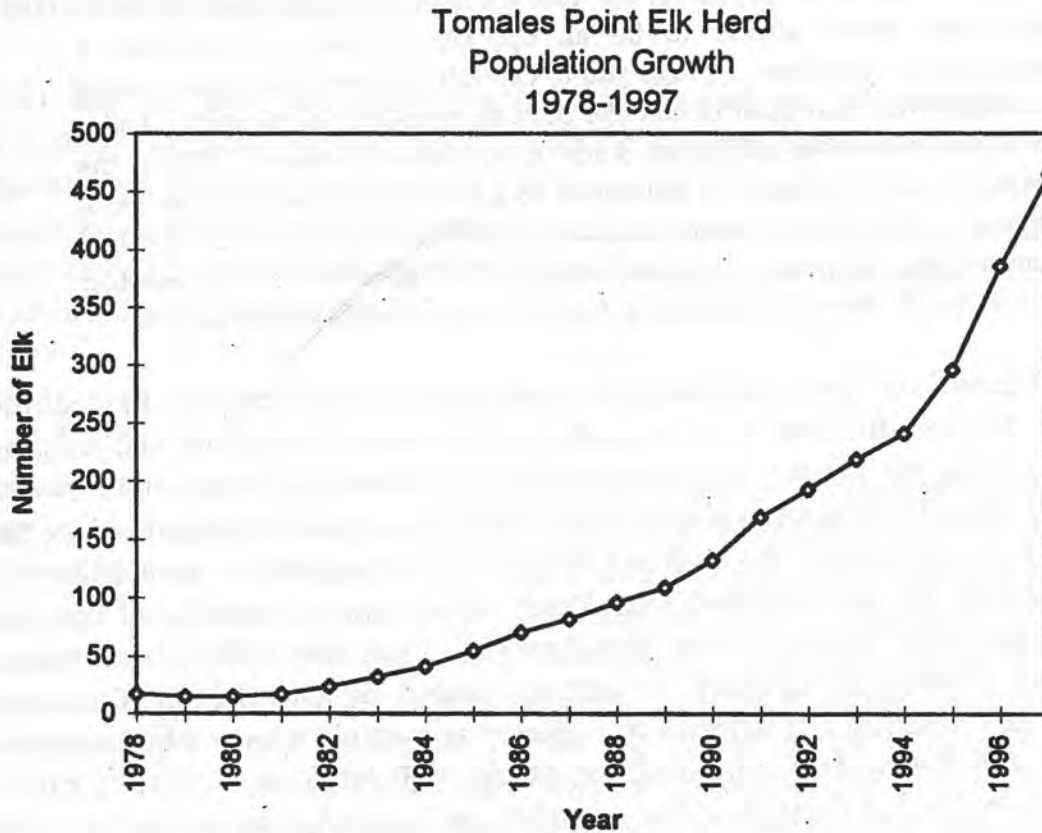


Figure 2. Growth of Tomales Point Elk Herd from 1978 to 1997

With the growth of the herd to 140 animals by 1990, the Seashore recognized the need to deal with the overpopulation of elk. This led to an environmental assessment in 1992 that addressed the need to control the growth of the elk herd and described eight alternatives (listed in appendix B). The preferred alternative was to remove excess elk on a yearly basis by having Seashore rangers shoot animals and donate the recovered meat to charity. This approach has not been utilized. Public review and comments on the draft environmental assessment raised a variety of concerns about the preferred alternative of culling, and the draft was withdrawn because of lack of public agreement with the preferred alternative. The response to the environmental assessment by U.S. Senator Alan Cranston of California was typical of many:

In your environmental assessment you recommend against a public hunt of elk. I totally agree and I am in full support of your recommendation. Sport hunting is counter to both the mission and character of the Pt. Reyes

National Seashore... in view of the concern about carrying capacity of the land, this would appear to be an opportune time to implement a contraceptive program.... I urge you to carefully explore this option before preceding with any plan to cull the herd by shooting the animals. I also urge you to devote additional study to relocation options. Killing the animals must be seen as a last resort to be considered only if the herd, beyond a shadow of a doubt, is nearing carrying capacity of the land; if contraception has been tried and has failed; if relocation is not possible; and if the elk face a demonstrable danger to their health or habitat.

The withdrawal of the environmental assessment (see appendix B) led the Seashore to obtain funding for an evaluation of the habitat condition and carrying capacity of the elk range. Bartolome (1993) conducted a range analysis and concluded using the scorecard method that 330 animals could be supported by the Tomales Point elk range. He analyzed changes in the vegetation since 1974 and concluded that the few statistically significant changes had occurred and that the general range trend was improving (see figure 3). That year, 1993, the Seashore established a scientific advisory committee headed by Dr. Dale McCullough, Professor at University of California at Berkeley and an elk expert who had been involved with the original reintroduction of elk at Point Reyes. A total of six experts served on the committee and provided recommendations to the Seashore (See appendix C).

With the progress of the scientific advisory committee's 1993 recommendations and additional research and monitoring projects on Tomales Point, the Seashore prepared an environmental assessment in 1995 entitled "Live Capture and Population Dynamics Study of Tule Elk at Point Reyes National Seashore" (see appendix D). A *Finding of No Significant Impact* was recorded for the environmental assessment's proposed action (alternative 2) which involved "implementation of a comprehensive, scientifically sound program of ecological monitoring for Tomales Point and the Tomales Point tule elk herd." The proposed action involved aerial capture and release of elk, after taking biological samples and fitting them with radio collars. This action was accomplished and 34 radio-collared animals were tracked and their movements analyzed.

## Issues and Concerns

The issues and concerns identified in this section have been collected from a variety of sources including public meetings and correspondence, advisory committee reports, and meetings with scientific and public agencies. These concerns, when combined with the Seashore's mandates and management recommendations, assist with the development of alternatives and the selection of impact topics for analysis of environmental consequences.

### Wilderness

Tomales Point and other areas in Point Reyes National Seashore totaling 32,000 acres are designated as wilderness under the Wilderness Act (PL 88-577). Wilderness areas are intended to remain undeveloped and exclude mechanized equipment and vehicles, except for emergencies such as threats to life. Park superintendents have the authority to establish the "administratively determined minimum tool" to manage wilderness areas. The management of tule elk has resulted in the use of helicopters for the capture of elk to be designated as a minimum tool. It is considered that brief and infrequent use of helicopters will have less of a long-term effect than the more extensive use of cars and trucks would have. Helicopters are faster, reducing time needed to capture elk, and do not travel across the ground like motor vehicles leaving permanent tracks and affecting vegetation. Still, helicopters are more noticeable by the public than are motor vehicles and this fact may cause some criticism or concern, but none has been expressed to date.

### Natural Resources

Non-native axis and fallow deer compete with elk for some food resources, although there are differences in their diets (Elliott 1973, Elliott 1983). Removal or reduction of the non-native deer would benefit the elk by increasing forage availability (Wehausen 1972, Wehausen and Elliott 1982, Gogan 1986).

The prescribed fire program at Point Reyes National Seashore seeks to return the pre-settlement fire regime to the Seashore's habitats while protecting against property or resource damage. Fire is seen as an important component for maintaining vegetative productivity and allowing for a more natural equilibrium of vegetation types. Elk assist in reducing fuel loads in grassland and shrub areas where they feed, decreasing the area's susceptibility to fire effects. Thus, elk



grazing reduces impacts from fires on forage species. Fire also works towards enhancing productivity through increased nutrient cycling, improving the quality of habitat for tule elk.

Non-native plants do not appear to have a major impact on the elk at this time. Some species such as purple velvet grass (*Holcus lanatus*) and harding grass (*Phalaris aquatica*) provide forage in early spring while they are small and green, while others such as german ivy (*Delaria odorata* formerly *Senecio mikanioides*), eucalyptus (*Eucalyptus globulus*), and poison hemlock (*Conium maculatum*), have caused a reduction of available forage. The Seashore is actively working to eliminate german ivy, wild radish (*Raphanus sativas*), ox-eye daisy (*Leucanthemum vulgare*), and pampas grass (*Cortadera jubata*) from Tomales Point. Some non-natives such as italian thistle (*Carduus pycnocephalus*) and milk thistle (*Silybum marianum*) increase in the presence of grazing. These alien thistles are not being removed at this time, as they are known to be nectar sources for the endangered adult Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*). It is the overall objective of the National Park Service to reduce or eliminate non-natives where possible, and this policy is followed in the management of Point Reyes National Seashore.

The peninsula of Tomales Point ranges from a narrow tip to over a mile and a half wide at the fence line enclosing the elk range. There are no natural year-round streams. The natural streams have significant flows only during the rainy winter months. From late spring to late autumn, only spring-fed seeps would provide water for elk if not for the existence of eight water impoundments originally built for cattle. Elk regularly use these impoundments, but it is unknown to what extent they may supply the population with an artificially high water source. The elk range does receive significant moisture in the form of summer fog and condensation during the dry season. The impoundments are considered as a possible means to manage tule elk under this plan. The water impoundments are a factor in determining the ability of the elk range to support its population. While clearly an artificial construction, caution should be taken to ensure that any alteration of artificial water sources does not impact other species of special concern. Otherwise, a return of the elk range to its native condition of seep-fed springs is considered desirable to maintaining viable populations.

## Threatened, Endangered and Rare Species

Although the tule elk as a subspecies has received special attention in PL 94-389 (see 16 USC 673g and Tule Elk Interagency Task Force 1979), it is not threatened by inadequate numbers or lack of suitable habitats. However, federal and state listed threatened and endangered species occur on Tomales Point and elsewhere in the Seashore that could be potentially affected by tule elk management. Two such species are the California red-legged frog (*Rana aurora draytoni*) and Myrtle's silverspot butterfly. So far, no direct impacts on these species by tule elk have been recorded, but the potential exists for greater numbers of elk to affect these species in the future. Some of the water impoundments, discussed above, contain the threatened California red-legged frog. These impoundments will not be altered unless an analysis, consultation, and full compliance related to the frog are completed.

Careful monitoring of both elk and threatened and endangered species is important to ensure that the Seashore's management of elk is not harming T&E species (Wilson et al. 1996). Proposed management actions will be assessed for the potential to adversely effect these species.

## Adjacent Landowners

The Park Service has a responsibility to be a good neighbor to adjacent and nearby landowners. Anticipating the effects of tule elk management strategies on the property or perceptions of neighbors is an important consideration. Any depredations by elk on fences, crops, or other property would require mitigation actions to correct or avoid problems. Experience with elk elsewhere in the State in situations similar to Point Reyes, such as Redwood National Park, has shown that elk can usually be managed to reduce conflicts with neighboring properties.

## Johne's Disease

Johne's Disease, caused by the bacterium *Mycobacterium paratuberculosis*, is a chronic debilitating infection of both domestic and wild ruminants. Tule elk at Point Reyes were infected with Johne's disease through contact with other infected animals or contaminated soil, probably from cattle, black-tailed or non-native deer (Riemann et al. 1979, Jessup et al. 1981). Studies of the prevalence of the disease in cattle and non-native deer within Point Reyes National Seashore found that 50% of ten dairy herds, 10% of axis deer, and 8% of fallow deer tested positive for the disease (Riemann et al. 1979). Found in many areas of the state, M.

*paratuberculosis* was isolated from cattle in 201 herds in 23 of the 58 counties of California from 1950 to 1975 (Riemann et al. 1979).

Johne's disease is monitored by the California Department of Food and Agriculture (CDFA) and is listed as a class B reportable disease. Veterinarians and diagnostic laboratories must report this disease to CDFA within three days of its diagnosis. The CDFA has no control or eradication program in place and does not restrict movement of domestic animals infected with *M. paratuberculosis* within the state of California.

Adult tule elk infected with Johne's disease may exhibit few or no visible effects. Young elk are most susceptible to infection and experience a high rate of mortality up to three years of age. Johne's disease is considered a disease of confinement. Animals in confined, crowded conditions will repeatedly be exposed to infected feces thereby increasing the likelihood of infection. On open ranges where animals utilize different areas on a daily or seasonal basis, opportunities for repeated exposure are significantly reduced.

The California Department of Fish and Game as the trustee agency for the fish and wildlife resources of the State has concerns about Johne's disease and the management of tule elk at Point Reyes National Seashore. The possible relocation of animals to areas outside the Seashore raises concerns about the possible spread of Johne's disease. It is the policy of the Tule Elk Interagency Task Force not to relocate infected animals. Because of the prevalence of Johne's disease on the Seashore, elimination of the herd was at one time suggested. This approach is no longer feasible and would not receive public support. Other management strategies such as reducing tule elk densities or terminating cattle leases may provide for a disease-free herd on the Seashore. Whether or not Johne's disease can be eliminated from Tomales Point, only animals deemed Johne's-free will be relocated outside the Seashore. This will be accomplished through a Johne's disease testing protocol that identifies disease-free animals, a risk assessment analysis, and the culling of animals testing positive for Johne's disease.

## **Ranching**

Point Reyes National Seashore has undergone significant changes in dairy ranching since its establishment. Originally, all ranches in Point Reyes were owned as private inholdings in the Seashore. During the 1970s and 80s, ranch lands inside the Seashore were purchased by the National Park Service and reservations, leases, or permits were given to former owners. The ranches will likely exist well into the

future with the full support and cooperation of the National Park Service. Upcoming revisions to the General Management Plan will address the management of the Seashore's pastoral zone.

Ranches may close operations over time due to economic reasons, the discretion of the leasee, or at the direction of the National Park Service. If and when ranches close, fencing and other restrictions could be removed, but this plan makes no effort to hasten this change.

### Carrying Capacity

Carrying capacity can be defined as the equilibrium population size reached in a given habitat by a species over time, or the long-term ability of a certain amount of acreage and vegetation types to support a certain number of tule elk (see also glossary). Various definitions have been given, as described in this plan's glossary, and some confusion exists over the concept's use. Lyon and Christensen (1992) define it as the "maximum rate of animal stocking without damaging vegetation or related resources." They note that it "is a well-established biological concept, but it is too imprecise for any useful application in elk management terminology." Their recommendation is to avoid using this term in relation to elk management. This plan avoids using it as a decision-making tool. It is used here because of the important role it plays in understanding the past management of tule elk at Point Reyes.

The quality of forage on the range is affected in part by the number of elk occupying the range. However, elk do not have a strictly negative effect on vegetation. Herbivores can improve the growth of vegetation through releasing nitrogen back into the soil and creating patches of diverse vegetation types (Elliott and Wehausen 1974, Hobbs 1996, Singer 1996). Additional factors influencing elk food resources include the presence of native and non-native deer, fire, alien plants, the existence of artificial water sources, weather, and global climate cycles.

The Tomales Point tule elk range comprises 2,600 acres on a fenced peninsula bordered by the Pacific Ocean and Tomales Bay. Large mammalian herbivores in a restricted reserve may grow to a number that exceeds the ability of the habitat to sustain them (McShea et al. 1997b). Population size, or the number of animals in a herd, represents a key controlling influence in the success of managing the current tule elk herd at Point Reyes. At a population size above 100-200, the herd is relatively protected against population declines that could result in extirpation (loss of the local population at Point Reyes). If tule elk numbers were to continue to

increase at Tomales Point and a population size of 1,000 or more is reached, the elk range will probably be unable to produce the amount of forage necessary to maintain the elk population.

The estimated carrying capacity of elk on Tomales Point has increased over time. Gogan (1986) estimated the carrying capacity as 350 animals with an optimum carrying capacity at 140, which would help ensure that overgrazing would be avoided. However, at that time the effects of cattle grazing present on Tomales Point up until 1980 were still evident. Later it was recognized that the forage had improved with the removal of the cattle. By 1993 it was estimated that Tomales Point had a carrying capacity of 330 tule elk in a poor year and 900 tule elk in a good year (Bartolome 1993). Because at least one poor year is likely to occur over a span of many years, the lower value of 330 animals was considered by the Seashore as the desired target of sustainable numbers of elk.

The Environmental Assessment begun in 1992 addressed the need to reduce the elk herd to prevent damaging the habitat and impacts considered imminent with the expanding population (see appendix B and NPS 1992a). The controversy over the methodology used led to a plan to collect further information about the dynamics of the population, as described in the approved 1995 Environmental Assessment (see appendix D and NPS 1995).

Scientists have not settled the issue of determining carrying capacity and the need for intervention to prevent overpopulation (Porter 1992, Wagner et al. 1992, McShea et al. 1997b). It is known that population growth cannot continue forever, but it is uncertain whether population swings can be moderate or if large die-offs will occur. The concept of population "self regulation" postulates that finite food resources and the effects of crowding will eventually lower reproductive rates, increase mortality, and lead to a reduction in the rate of population growth. Such considerations shift the objectives away from a fixed number carrying capacity and towards a dynamic view of elk population biology and environmental interactions, along with political considerations (Porter 1992).

Because of the uncertainty of the various interpretations of carrying capacity and the inability to accurately calculate its values, this plan does not set a carrying capacity as a targeted goal. Instead, an approach is used to define adaptive management objectives (see glossary) for elk populations that take into account the Seashore's ability to provide for the sustainable protection of the ecosystem over time. The primary public concern about tule elk populations has focused on the methodology used for reducing the herd when considered necessary.

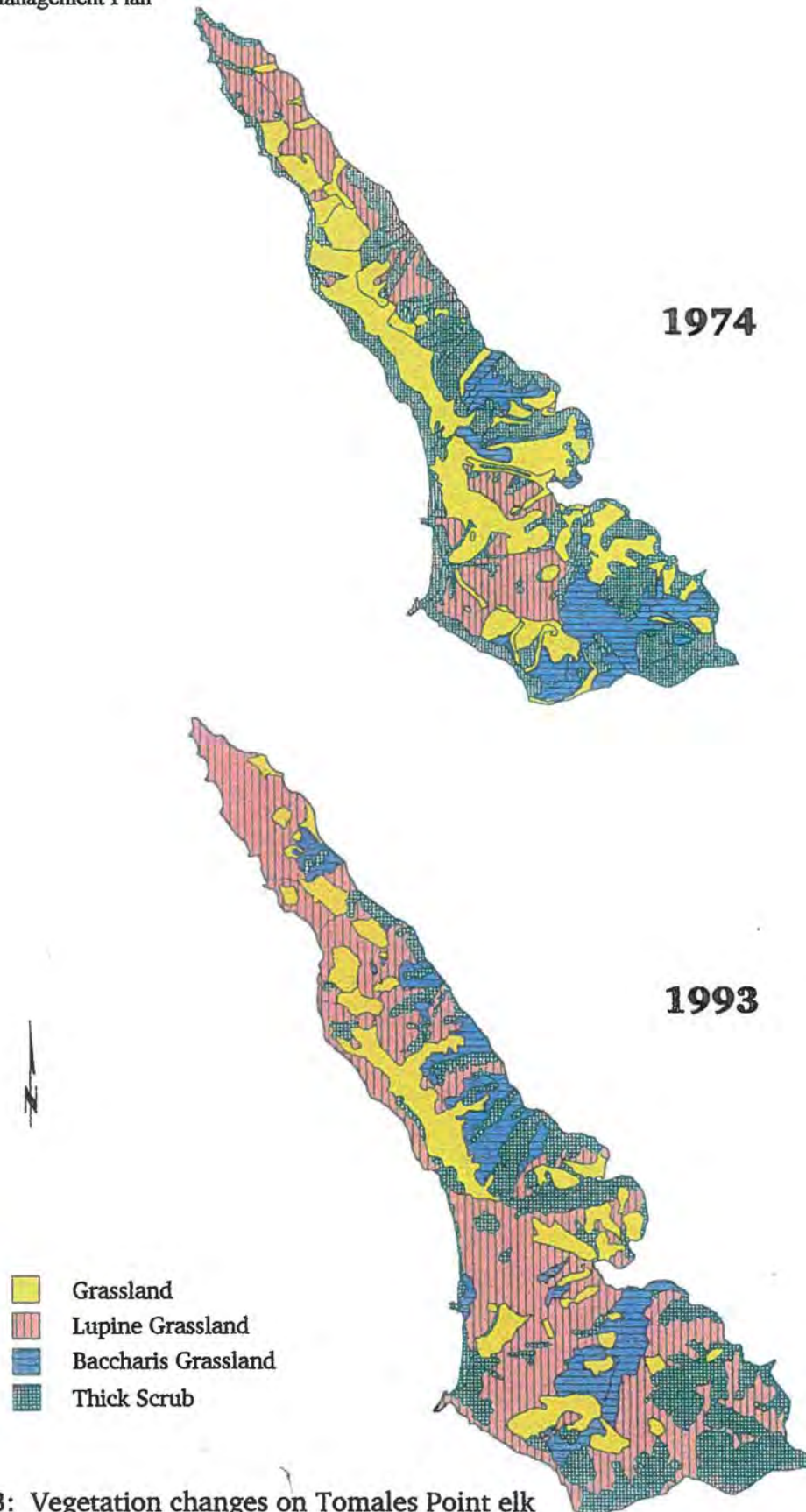


Figure 3: Vegetation changes on Tomales Point elk range from 1974 to 1993, from Bartolome 1993.

## Population Control

Point Reyes National Seashore's enabling legislation authorized the Secretary of the Interior to permit hunting. Nonetheless, since the Seashore began operation in 1961, public hunting has not been allowed. The State of California uses public hunting to manage other elk herds throughout the state (California Dept. Fish Game 1997). Even so, strong opposition exists to public hunting on Point Reyes and has been expressed whenever public opinion has been sought. Culling involves the shooting of animals by trained law enforcement employees under carefully controlled conditions. While less opposition to culling than to public hunting has been expressed, it still continues to generate controversy. Nonetheless, it remains a method of last resort to reduce herd size. Public correspondence on this subject is received by the Seashore on an ongoing basis.

Sterilization is another method that can be used to control population size by decreasing reproduction. However, it may alter behavior and has other deleterious effects that make it less than ideal. Contraception may be a possibility for limiting population growth, and research is being conducted to assess its effectiveness and safety (McShea et al. 1997a, Heilmann et al. 1998).

## Affected Environment

Point Reyes National Seashore is on the coast of central California 30 miles north of San Francisco, a large metropolitan area of six million people. Within Marin County most residents live in the eastern half along the major transportation corridors. The western half of the county is mostly agricultural grazing lands and public lands. The Seashore encompasses 100 square miles and is the county's western edge including much of Tomales Bay. Its neighbors include ranches, small towns, and scattered houses.

Point Reyes National Seashore is accessible by passenger vehicles through a few roads crossing the coastal mountain range that runs north and south down the center of Marin County. These two-lane roads, with their frequent curves and hills, result in a travel time to the Seashore averaging 45 minutes. The Seashore receives 2.2 million visitors annually with most coming in the warmer and drier months of spring and summer, and also for winter whale watching. Public transportation to the Seashore is very limited.

## Natural Environment

### Climate

The climate of the central coast of California is characterized as Mediterranean with cool wet winters and warm dry summers, often affected by low-lying fog and strong sea breezes. A major feature of the climate is the lack of extreme temperatures that rarely exceed a high of 90° or a low of 40° F. Thick local fogs are common. The temperatures change rapidly with proximity to the ocean and with topography. The ocean temperature averages 55° year-round, and the cold water and low fog mitigate the summer heat of eastern Marin County which frequently approaches 95°. Thus, as one moves away from the coast the climate often becomes warmer and sunnier, especially in the summer.

Rainfall occurs almost entirely during the winter from October through March averaging some 25 inches. However, a small but significant amount of moisture for vegetation is received along the coast in summer in the form of dense fog and mist. The majority of winds come from the northwest and often is strong and steady at 10 to 20 knots.

The Tomales Point elk range is located on a five-mile long peninsula bordered by the Pacific Ocean on the west and Tomales Bay on the east. The peninsula contains several microclimates influenced by topography. The western coastal bluffs are often 10-15° cooler than the sheltered sunny canyons along the eastern side. Strong winter storms may bring large amounts of precipitation along the coast while depositing only light rain at other spots, sometimes only miles away.

Total rainfall averages about 25 inches a year, with annual variations making wetter and drier years. Years of drought occur, where rainfall may be 50% or less of normal averages. A seven-year drought in the 1980s and a shorter drought in the 1990s strongly affected the both natural and human water sources in the area. The natural communities, while not immune from the effects of droughts, are at least adapted for their occurrence as part of the normal climate in central California.



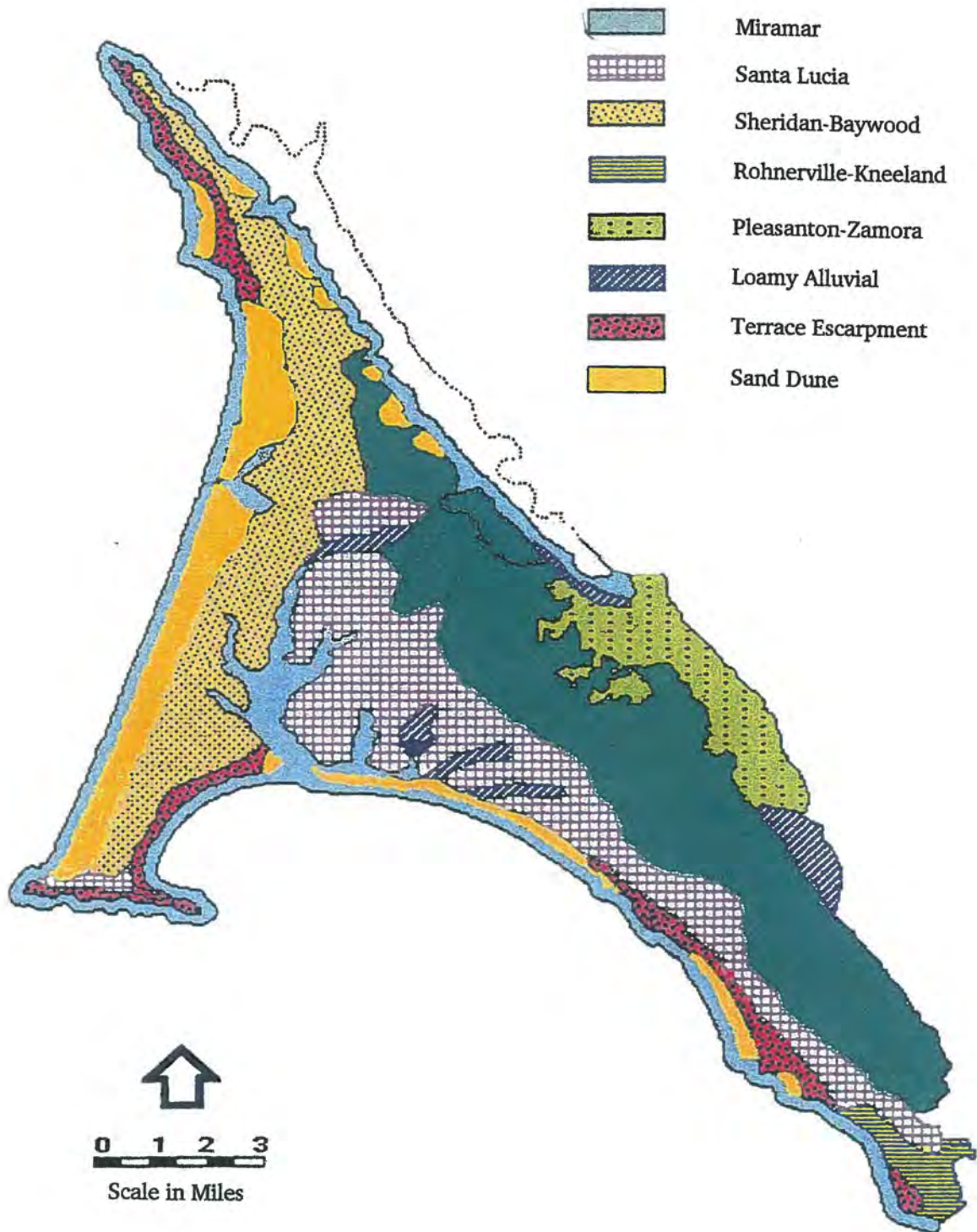


Figure 4. Soil Types of Point Reyes National Seashore

## Geology and Topography

Point Reyes is a peninsula that is almost a "geologic island" attached to the mainland. With the Pacific Ocean on its west and Tomales Bay on its east, the San Andreas fault runs down the center of the bay and along the eastern border of the Seashore. The peninsula rests upon a tectonic plate separate from the adjacent mainland, and is moving 12 to 50 millimeters northward each year in relation to the mainland. Granite bedrock forms the base of the peninsula and is overlaid with marine sedimentary rocks. Faults occur throughout the peninsula, and it was the epicenter of the great San Francisco earthquake of 1906.

The topography of the area is dominated by Inverness Ridge, which runs southwest to northeast and reaches 1,407 feet at Mount Wittenberg. The ridge drops sharply to Tomales Bay on the east and descends to rolling slopes leading to rocky cliffs over the Pacific to the west.

## Soils

Twelve soil types occur in Point Reyes and are associated with underlying rock and mineral types, vegetation, topography and climate. Soils have been subject to human influences including cultivation of crops, cattle grazing, changes in fire regimes, and alteration of watercourses. The soils of Point Reyes are relatively intact from their original native state, perhaps because the limited drainages that occur in the watersheds restrict erosive high-volume flows and also from the lack of major ground disturbances such as mining and quarrying. The pattern of soil distribution is shown in figure 4.

From Drakes Estero out to Tomales Point the Sheridan-Baywood soil type is generally deep and well drained. If these soils are left unprotected by vegetation removal they are susceptible to both wind and water erosion.

The Miramar soil type occurs along the Inverness Ridge and eastward towards the Seashore boundary. Developed from quartz diorite mixed with marine sandstone and shale, these soils occur on broad rolling ridge tops and steep hillsides. The erosion hazard is rated high for this soil type, especially where trees have been cleared and the soil plowed.

The Santa Lucia soil type runs southeast from Drakes Estero down from Inverness Ridge to the sea. These soils are generated from light-colored shales and sandstone. The erosion hazard for these soils is considered very high, and much of

the acreage in this soil type has been plowed at some time. Pastures in this area are commonly sown with perennial rye grass.

Sand dunes border the ocean around much of the Seashore. In some areas the dunes may extend inland for up to a mile. This soil type is highly susceptible to wind and water erosion, although these processes are part of the natural environmental forces. In the last few decades effort was put into planting European dunegrass in an attempt to control the expansion of dunes into grasslands used for grazing.

### Vegetation

The vegetative communities of Point Reyes include six vegetation types (figure 5). Coastal dunes surround the Seashore on the seaward side to the south and west. In from the ocean's edge, wide areas of coastal prairie grassland are mixed with coastal scrub. This mix makes up most of the Tomales Point elk range. On the lower slopes of Inverness Ridge the broadleaf forest abounds, and on the upper areas of the ridgeline douglas-fir and bishop pine forest predominates. Douglas-fir is most prevalent in the southern portion of the Seashore. Bishop pine is found in dense stands in the central portion. The Seashore lists some 828 known plant species, some of which are found nowhere else.

The vegetation of Point Reyes has been influenced by over 150 years of beef and dairy ranching, logging, farming, and alterations of natural fire regimes. Introduction of non-native herbivores such as cows, axis and fallow deer, and sheep have put grazing pressures on many native species. Non-native plants have also had a significant impact by displacing native plants. Despite this long and intensive level of land use many natural communities survive in the Seashore and some rare plants are able to find areas of refuge.

Point Reyes has 44 plant species that are covered by some form of special protective status, including threatened and endangered species, candidate species, and species of special concern. On Tomales Point, the Point Reyes blennosperma (*Blennosperma nanum* var. *robustum*) is the most widespread species of special concern, a former federal Candidate 2 species. Also present but less abundant are North Coast bird's beak (*Cordylanthus maritimus*) and San Francisco owl's clover (*Tryphysaria floribundus*). Another plant species of importance, *Viola adunca*, is not threatened itself but is the probable host species for the larvae of the endangered Myrtle's silverspot butterfly. Important plants for the silverspot

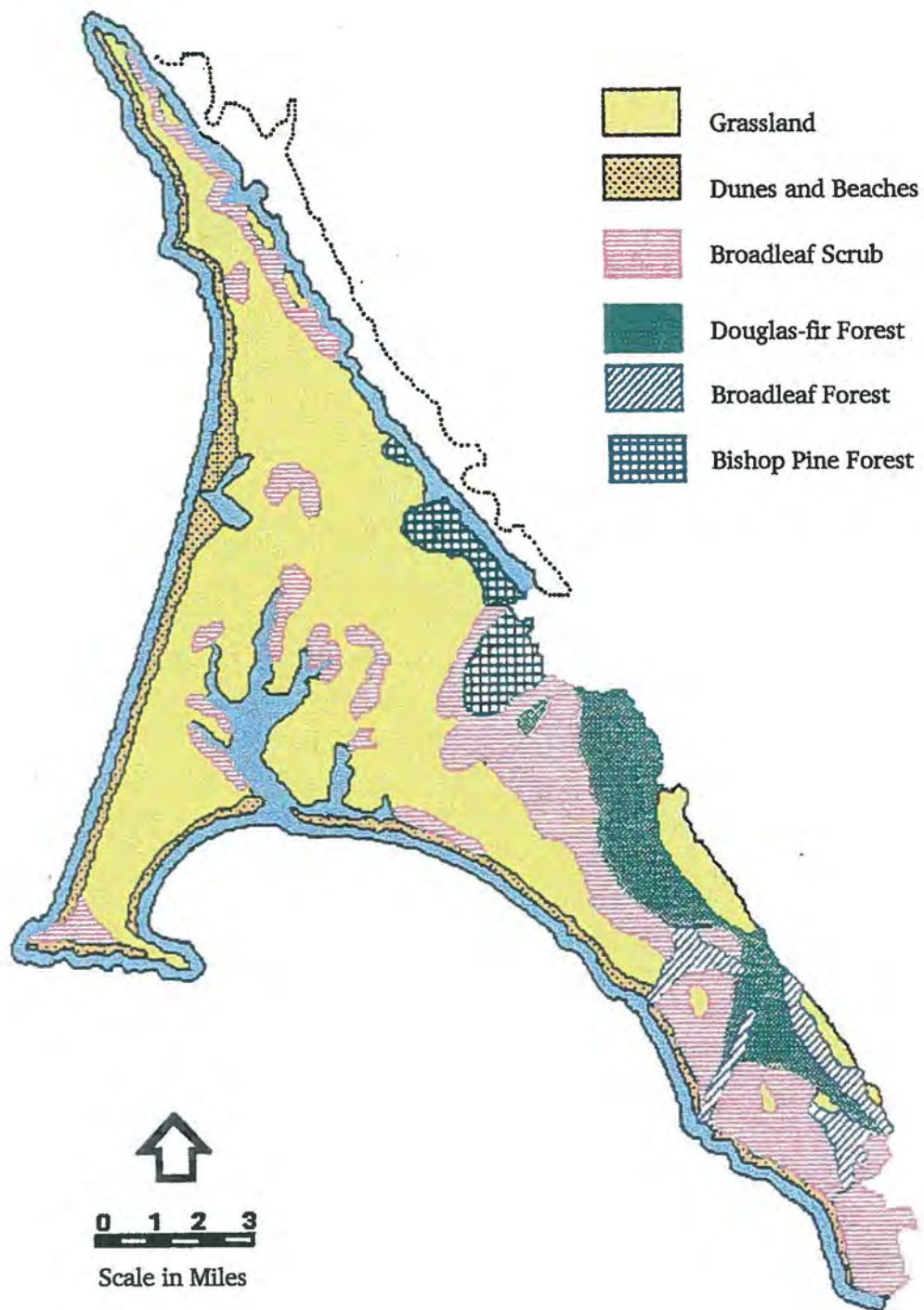


Figure 5. Vegetation Types of Point Reyes National Seashore

include nectar sources for the adults, such as bull thistle (*Cirsium vulgare*), milk thistle (*Silybum marianum*), and italian thistle. Gogan (1986) characterized the native vegetation of Tomales Bay as composed of four vegetation types: open, lupine, and baccharis grasslands and thick scrub, as shown in figure 5.

Non-native or exotic plant species also occur in abundance, with 44 species managed by the Seashore. Species of concern include german ivy (*Delaria odorata* formerly *Senecio mikanioides*), eucalyptus (*Eucalyptus globulus*), poison hemlock (*Conium maculatum*), wild radish (*Raphanus sativas*), ox-eye daisy (*Leucanthemum vulgare*) and pampas grass (*Cortadera jubata*). Some exotics such as italian thistle and milk thistle may be used as food sources by the adult threatened Myrtle's silverspot butterfly and are not being removed at this time.

### Wildlife

The fauna of Point Reyes exhibits a fairly rich diversity of animals that occupy its many habitats. Mammals include mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), black-tailed deer (*Odocoileus hemionus columbianus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*), and mountain beaver (*Aplodontia rufa phaea*). Some large mammals have been extirpated including the grizzly bear (*Urus horribilis*) and wolf (*Canis lupus*), while others such as the coyote (*Canis latrans*) are beginning to reappear. While native tule elk have been deliberately reintroduced, accidental reintroductions include a number of non-native mammals such as pigs, domestic cats, axis deer, fallow deer, and red fox (*Vulpes vulpes*). The marine environment plays a vital role in supporting significant populations of marine mammals, including southern sea otter (*Enhydra lutris nereis*), stellar sea lion (*Eumetopais jubatus*), harbor seal (*Phoca vitulina*) and California grey whale (*Eschrichtius robustus*). Northern elephant seals (*Mirounga angustirostris*) have established and increased breeding colonies in the Seashore since the 1980s.

Over 438 bird species have been recorded in Point Reyes, including 246 species characterized as rare by the *Field Checklist for Birds of Point Reyes National Seashore* (NPS 1992b). The Seashore contains the Point Reyes Bird Observatory, a preeminent non-profit bird research center. The peregrine falcon (*Falco peregrinus anatum*) is present and has been augmented through a reintroduction program.

Threatened and endangered animals in the Seashore include some eight mammals, 10 birds, five reptiles and amphibians, three fish, and 10 invertebrate species. Specific species include the mountain beaver, peregrine falcon, and Myrtle's silverspot butterfly, as well as the northern spotted owl (*Strix occidentalis courina*), Point Reyes jumping mouse (*Zapus trinotatus orarius*), California red-legged frog (*Rana aurora draytoni*), and coho salmon (*Oncorhynchus kisutch*). On Tomales Point the T&E species of concern are the Myrtle's silverspot butterfly and the California red-legged frog.

## Cultural Resources

The history of human occupation of Point Reyes goes back 11,000 years to the first known occurrence of Native Americans, although their presence may go back some thousands of years before this date. When Europeans first came to Point Reyes, the tribal group living here came to be known as the Coastal Miwok. One hundred and thirteen village sites have been recorded in the Seashore, and while they may not have been all occupied simultaneously, they show that Native Americans played a prominent role over most of the area.

Treganza (1962) has estimated some 1,500 Indians lived at Point Reyes in Miwok times. A number of observations since 1579 showed the Coastal Miwok used fire as a means of maintaining coastal prairie for the collection of grain and to enhance the habitat for grazing animals (NPS 1993). Today the Coastal Miwok still live in the area and are active partners with the Seashore and the Miwok Archeological Preserve of Marin. A replicated Coastal Miwok village, Kule Loklo, is used for both ceremonial and public events.

Spanish and English explorers were the first Europeans to visit Point Reyes. The Seashore is thought to contain the site of the first known landing by Sir Francis Drake where in 1579 he careened his ship for repairs on the beach. Since then, many ships and travelers visited Point Reyes, but it was not until 1834 that the first known settler, William Smith, built a house on the peninsula. That year two large Mexican ranchos were started at Point Reyes. The rancho period that first introduced cattle to Point Reyes lasted almost 25 years and by the end of the gold rush most of the land was under the ownership of a single American family. Beginning in 1858, the Shafter brothers established over 30 tenant-operated dairy ranches that gained national fame for their production and quality. These ranches were sold to many of the immigrant tenants between 1919 and 1939.

Today, seven dairies and six beef ranches remain in operation in the Seashore in addition to 15 beef ranches in Golden Gate National Recreation Area's Olema Valley area. The ranches have been determined eligible for the National Register of Historic Places (NRHP), State significance for Point Reyes and local significance for Olema Valley. Pierce Point Ranch, not originally owned by the Shafers, is listed on the NRHP (Livingston 1993).

In response to difficult maritime hazards and many shipwrecks, lighthouses and lifesaving stations were built in the late 1800s and early 1900s. The historic Point Reyes lighthouse, operated from 1870 to 1975, is on the NRHP. A lifesaving station was established at Point Reyes in 1890, and its 1927 successor is listed as a National Historic Landmark.

Point Reyes maintains a museum collection that plays an important role in preserving, documenting, and interpreting the cultural and natural resources of the Seashore. The collection contains approximately 9,000 cataloged items consisting of archeological artifacts, photographs, historic objects, and natural history specimens. These materials are housed in the Bear Valley Visitor Center in a storage room within the building. A new storage facility with increased space for expansion is currently being planned.

## Recreational Resources

Point Reyes National Seashore offers a variety of recreational resources for public enjoyment by over two million visitors every year. Offering scenic beauty and solitude, it provides facilities for individuals, families, and groups. Activities include hiking, water sports, horseback riding, fishing, camping, scenic and wildlife viewing, and other interpretive opportunities.

Hiking is primarily a day-use activity by visitors on the 147 miles of hiking trails in the Seashore. Some 48 trails are designated throughout the Seashore encompassing the majority of habitat types from wooded mountains to sandy beaches. On the Tomales Point elk range one trail extends the length of the five-mile peninsula and offers abundant opportunities for visitors to observe tule elk. Another short 2/3 mile trail leads to McClures Beach and also affords occasional glimpses of elk.

Overnight stays are available through hike-in campgrounds or local hotels and inns. The hike-in campgrounds permit multi-day hiking and an extended look at the wilderness for visitors.

Water sports involve kayaking, canoeing, boating, and swimming. The year-round cold Pacific waters require caution as exposure times in the water are limited by health and safety. The majority of paddle crafts use Tomales Bay as it provides protection from the Pacific waves and surf, while power boaters more freely use the ocean. Surfers have been known to use the waters off the Seashore, but most surf south of the Seashore closer to population centers with better beach access.

Dozens of visitors daily bring horses in trailers to ride on designated horse trails, and hundreds rent horses every week from commercial stables. The Seashore is widely known for enjoyable riding trails and the local area is rich in horses, with an estimated 5,000 kept in Marin County alone. The Seashore contains the working Morgan horse ranch in Bear Valley with interpretive displays and personal interpretation provided on the horses and ranch operation.

Nature study and wildlife viewing are important activities at Point Reyes. Winter whale migrations off the coast bring many visitors and commercial whale watch boating operations into the area. The whales receive wide media coverage as do those that watch them. Sea lions, tule elk, shore birds, spring wildflowers, all attract their share of eager observers. For the many environmentally educated local residents and national and international visitors, Point Reyes is famous for its plant and animal viewing opportunities.

Scenic views are also a very large part of the reason visitors appreciate and are endeared to Point Reyes. High hills and mountainous topography combined with shrub grassland open vistas and a dramatic ocean cliff - beach shorelines create spectacular perspectives. These scenic views can be enhanced with dense variable fog, windy sea breezes, and exciting sunsets.

## Specific Resources

Point Reyes preserves a rich heritage related to its human history. In this section the resource of ranching is covered which has been ongoing at Point Reyes for almost 150 years.



## **Ranching**

The enabling legislation of Point Reyes National Seashore authorized a pastoral zone where historical ranching and dairy farming could continue. In 1970, Public Law 91-223 provided authorization and additional funding for the National Park Service to purchase ranch inholdings with the provision that ranching and dairying were to continue to be allowed. In 1980 Public Law 96-199, nevertheless, gave the Secretary of the Interior authority to disallow ranching land use when deemed necessary for resource management or other Seashore activities.

Reservations were created that expire between 1991 and 2005. At this time, only two reservations are still in effect, with the rest now operating under either permit or lease. Currently some 18 ranchers are operating under permit at Point Reyes National Seashore.

## **Public Safety**

The National Park Service works towards maintaining an environment that is safe for visitors and provides adequate law enforcement staff for police services. Law enforcement helps enforce traffic laws and provides for visitor security. It also protects the natural and cultural resources from vandalism, theft, poaching, and other depredations. The Seashore's law enforcement staff is supplemented by nearby police and sheriff departments.

Safety includes the maintenance of traffic signs and roadways, trails and markers, walkways and sidewalks to the standards set forth for all National Park units. Safety warnings and brochures are provided to the visiting public to help increase awareness and respect for safety concerns.

An area of special concern is the ocean beach that presents features unfamiliar to many visitors from other parts of the country. These include rip tides, large waves, cold water, and rocky cliffs that catch some visitors unprepared.

Wildland and structural fire fighting capabilities are also an important public safety factor. The Seashore maintains a firefighting capability and many of its employees are certified for wildland fires. Additional help is available from nearby municipal fire departments and nationwide from the interagency wildland firefighting center. A large fire in 1995 called the Vision fire utilized local, state, and federal assistance in a highly coordinated incident that lasted six weeks.

## Ongoing Actions

Activities involved with the management of tule elk are currently ongoing or scheduled to occur. These actions will affect the elk population and provide information on their ecology and management.

A Memorandum of Agreement with California Department of Fish and Game has been drafted that describes the activities that each agency will undertake to improve the management of tule elk in Point Reyes National Seashore. Utilizing the authority each agency has, including Public Law 94-389, "Preservation of Tule Elk Population—California," the agreement helps coordinate the efforts of the two agencies. The Seashore and the State have cooperated in the past as described in agreements signed in 1969, 1974, and 1978.

Since its erection in 1980, the fence isolating elk at Tomales Point has been maintained through repair and replacement, as necessary. While during some period of years the fence has not required any repairs, its annual cost is estimated at \$800. In 1989 a cyclic maintenance rehabilitation of the fence cost \$33,000, and is expected to last 15 years.

Dr. Judd Howell, Dr. Katherine McEachern, George Brooks, and Marcia Semenoff-Irving of the Biological Resource Division of the U.S. Geological Survey are conducting a program to monitor and study the Tomales Point elk population and produce annual population estimates (Howell and Brooks 1997). It is funded through federal sources and private donations. Recent efforts involve radio tracking of individuals to better understand elk population dynamics (Howell 1996). This work, started in 1995, has produced an analysis of the movement patterns and home ranges of elk (see figure 6). A high degree of fidelity to a limited home range was exhibited by many of the animals tracked, as indicated by the circular projections of home ranges.

Dr. McEachern has placed small fenced exclosures within the Tomales Point elk range to study the vegetation growth in the absence of grazing by tule elk. These experimental plots will provide additional information about the ecology of elk and their interaction with the vegetation.

Johne's disease in black-tailed deer is being studied by a graduate student under the supervision of Dr. Ian Gardiner, School of Veterinarian Medicine at the University of California at Davis.

Contraception research began in the summer of 1997 involving trial inoculations of 29 tule elk with porcine zona pellucida (PZP) immunocontraceptives (see glossary) under the supervision of Dr. Susan Shideler and Dr. Bill Lasley of the University of California at Davis. These tule elk are being tracked to ascertain whether the contraceptive is effective in preventing pregnancies, document any behavioral changes, and note any other health or population effects. This work is expected to provide an essential tool for regulating population growth in portions of the population. There are limits, however, to its application to large numbers of individuals, in both cost and feasibility.

Myrtle's silverspot butterfly monitoring is ongoing by Dr. Alan Launer, Stanford University, that includes counts of adults, mapping of sightings, and attempts to identify the larval host plants. The area under study includes the Tomales Point elk range. The California red-legged frog is being monitored throughout the Seashore, including the populations living at Tomales Point. Terrestrial birds are monitored at many locations throughout the Seashore, including Tomales Point. Rare plants have been mapped and monitored at Tomales Point by the California Native Plant Society.



Figure 6. Tule elk home ranges on Tomales Point. Dots show locations of radio collared animals. Red circles indicate projected home ranges. Data from Judd Howell, USGS/BRD.



## Seashore Resource Management Objectives

The pursuit of effective and sound management objectives entails a review of existing management plans. National Parks operate under plans set forth in regulations and guidelines developed with the intent to insure consistency and effective use of resources. The following plans are currently operable at Point Reyes and provide the context for management actions.

### General Management Plan (1980)

Point Reyes National Seashore operates under the guidance of its General Management Plan (GMP), which was the result of a planning process that received extensive public review. The plan's overview of the Seashore provides a summary of the values the Seashore encompasses:

The rare juxtaposition of an outstanding natural area with a major metropolitan population presents a special opportunity and responsibility—to convey an environmental message to millions of people by facilitating and interpreting a unique outdoor experience. With perceptive management and sensitive development, the national seashore will continue to sustain a relatively high volume of use. However, the primary objectives for the park must continue to relate to the natural integrity of the seashore, upon which the quality of a Point Reyes experience totally depends.

Natural resource management objectives in the GMP include:

- To protect marine mammals, threatened and endangered species, and other sensitive natural resources;
- To enhance knowledge and expertise of ecological management through research and experimental programs;
- To preserve and manage as wilderness those lands so designated;
- To retain research natural area status;
- To manage seashore activities in pastoral and estuarine areas in a manner compatible with resource carrying capacity; and
- To monitor activities occurring on non-federal properties.

The GMP points out that much of the Seashore is either a natural wilderness area or under grazing permits, and that “within the legal and administrative constraints

imposed by these two designations, the unusual variety of scenic qualities and biotic communities that make the seashore attractive will be aggressively maintained." The Seashore should pursue "management strategies for perpetuating the biotic diversity and scenic quality of the park."

Elk are specifically discussed, including the mention of "Wildlife is abundant and includes... reintroduced native tule elk..." More important is the statement, "Restoration of historic natural conditions (such as reestablishment of tule elk) will continue to be implemented when such actions will not seriously diminish scenic and recreational values."

### Statement for Management (1993)

The 1993 *Statement for Management* (SFM) sets out objectives for Seashore operations. Tule elk issues are part of SFM sections on public hunting and tule elk.

Discussed in the SFM section on public hunting, while the Secretary of the Interior may permit hunting, Seashore policy has prohibited hunting since beginning operations in 1963 for visitor safety and protection of farm resources. Hunting was discussed again recently as a possible method for controlling exotic deer. After numerous public meetings and responses from individuals and groups, opposition to hunting led to a continuation of the "no hunting" policy. Then, the SFM notes...

As we approach the carrying capacity of the tule elk range, the need to control the tule elk population will once again revisit the controversy about public hunting and animal culling practices.

Under the SFM section on tule elk, it again mentions the need for controlling the herd size that led to a consideration and rejection of public hunting as a possible solution, and supported using contraception as a control method. It delineated a course of action, which recommended obtaining and allocating resources for:

- public meetings and meetings with special interest groups in an attempt to resolve concerns;
- undertaking studies of possible contraceptive methods which can be used to control the elk population;
- developing a method of control which is reasonably acceptable and feasible so that public relations are not unduly damaged;
- obtaining information to determine the appropriate target population level; and
- undertaking the actual physical control effort necessary.

## Resource Management Plan (1994)

The Resource Management Plan (RMP) outlines the goals and objectives for managing the Seashore's natural and cultural resources and is updated on an annual basis. First approved in 1976, the latest major revision was approved in 1994 and contains some 62 natural and 29 cultural resource project statements.

Management of tule elk is addressed in the RMP's first project statement:

N-01            Manage Tule Elk Populations (Overall project statement)

Additional subproject statements that describe actions in greater detail are:

- N-01.01        Monitor Tule Elk Habitat
- N-01.02        Monitor Tule Elk Populations
- N-01.03        Manage Tule Elk
- N-01.04        Relocate Elk
- N-01.05        Immunocontraception Trial

The tule elk project statement is given as the Seashore's highest priority. The alternative actions discussed include No Action, Monitor Elk Herd Population and Manage Elk Herd Population. The RMP notes that the first two alternatives are essentially the same, that is, allow the herd to expand or shrink without intervention. The last alternative includes active population control through habitat management and possible use of contraceptives.

## Interim Tule Elk Management Plan (1982)

After tule elk were reintroduced into Point Reyes it was recognized that a management plan was needed to guide the actions of the Seashore. An *Interim Tule Elk Management Plan* was written and approved on September 9, 1982. The 17 page document, of which 11 pages were appendices, set forth the objectives of managing tule elk until such time as a more thorough plan could be developed.

The plan states that the success of management practices would be measured by the ability to:

- Re-establish a healthy tule elk population on a range which has returned to a natural successional regime as if elk were always present.
- Determine a carrying capacity for the elk range and maintain those numbers in dynamic equilibrium with other organisms in the ecosystem.
- Create and maintain safe visitor observations of wild tule elk by recognizing and minimizing human/elk conflicts.

The plan called for monitoring the elk herd by monthly observations and roadside spotlighting, annual photopoint and watersource monitoring, and deer transect censuses. The plan laid out management actions as follows:

1. In accordance with the 1974 Memorandum of Understanding between the National Park Service and the California Department of Fish and Game, and the report to Congress which was prepared by the Bureau of Land Management, the herd will be maintained at a maximum of 300 animals until additional research is completed. While the herd is not expected to reach a size greater than 300 animals, prior to additional research, if removal of any excess animals is required such action will be accomplished as specified in the Memorandum of Understanding of 1974.
2. A fire research program will be initiated on the range to determine if fire could be used to restore pre-human conditions. A fire history of the range area will be established.
3. Visitor/elk interactions— Pets are excluded from the range; this regulation is strictly enforced. Increased patrols will be conducted during calving and rutting seasons to prevent conflicts between visitors and elk. Interpretive and warning signs are now in place on the range. A special warning sign is installed during rutting season to the entrance to the range.
4. John's Disease— Any elk exhibiting symptoms of the disease will be checked plus a fecal sample obtained. The sample will be forwarded to the California Department of Fish and Game laboratory for analysis. Any animals determined to have the disease will be removed from the range by California Department of Fish and Game personnel.
5. Elk fence— The fence will be checked semi-annually and repairs made as needed.
6. Remaining stock ponds will be left in place at least until carrying capacity is established.



7. Pending completion of the final report by the University of California, Berkeley, the National Park Service and the California Department of Fish and Game will develop a management plan for the tule elk herd at Point Reyes National Seashore. The plan will address such matters as removal of surplus animals and restrictions on population growth in a manner compatible with both State law and National Park Service guidelines for management of wildlife in wilderness areas.
8. Replace stock ponds on the range with natural flowing water sources in sufficient quantity to support the carrying capacity of the range.

The *Interim Tule Elk Management Plan* has been implemented over the last 15 years to a large degree. Monitoring techniques have been improved from those described in 1982. The plan's first six management actions have been implemented and followed for the most part. This document represents the completion of a tule elk management plan for the Seashore as stated in management action number seven. Action number eight, replacing the stock ponds with natural flowing water sources, is discussed as a possibility in this plan. While not explicitly stated in the 1982 plan, the technique intended for removal of surplus animals as called for in management action number one was culling through shooting by CDFG personnel. This method has not been used for reasons described herein.

The interim plan fulfilled its purpose, and guided the Seashore's actions during the 1980s. By the early 1990s, however, new developments in the herds growth and scientific advancements began to outpace the interim plan which was becoming increasing out-of-date.



## Tule Elk Management

The purpose of this plan is to guide the management and research of tule elk, *Cervus elaphus nannodes*, at Point Reyes National Seashore. It is intended that all available scientific information, legal considerations, and public opinions related to the management of tule elk at Point Reyes be utilized in this effort. The plan will comply with the National Environmental Policy Act.

### Mission

Defining the mission of managing tule elk at Point Reyes requires a broad, long-term view of what the Seashore wants to accomplish. The stewardship role defined by mission statements attempt to be consistent with the management goals for other species in the Seashore. Mission statements are adopted here for tule elk to provide the framework for developing and assessing specific management goals.

Three mission statements are set forth as follows:

**Mission 1. Adaptively manage elk as a natural component of the dynamic ecosystem of Point Reyes.**

The intent of this plan is to ensure the integration of tule elk management with all of the ecological components of the Seashore. This plan focuses on the adaptive management (see glossary) of a single species that if considered in isolation could suggest actions to be implemented irrespective of their effect on other Seashore resources or biota. Tule elk play an important role in the function of the Seashore's ecosystem. This plan views the tule elk at Point Reyes as a dynamic resource whose attributes will change over time as part of the natural processes that species undergo in relation to other resources. This management plan will change over time to adapt to new information and changing conditions. The needs of the animals and of the Seashore will be periodically reevaluated and incorporated into updates. No static management scenario can survive long enough to create a successful strategy.

**Mission 2. Assist in the preservation of tule elk as a subspecies and the genetic diversity it contains.**

The tule elk herd at Point Reyes is one of 22 herds in California that preserve this subspecies. The Seashore assists the State of California in meeting its objective of maintaining adequate numbers and populations of tule elk, as set forth in California law.

Tule elk contain genetic attributes that assist in adaptations to local environments. Tule elk have been through a series of reductions to very small population sizes (resulting in genetic bottlenecks) over the last 130 years, although the biological effect of this has not been determined (McCullough et al. 1996). Maintenance of the remaining genetic diversity has been identified by the Seashore's Scientific Advisory panel as an important objective for elk preservation (See appendix C).

**Mission 3. Manage tule elk consistent with other management objectives, including agriculture, public visitation, and the protection of natural, cultural, and recreational resources.**

Planning for tule elk has been placed within the context of natural ecosystem management as stated in mission statement #1. Mission statement #3 recognizes that Point Reyes National Seashore does not represent a self-contained ecosystem. No park or reserve, irrespective of size, contains enough space and resources to preserve its flora and fauna independently of other habitats. Living organisms travel and interact across large areas, even continents, and human influences such as pollutants and land use have far ranging effects. Thus all natural reserves must be seen in the context of landscapes where both ecological and human societal influences exert control. The management of tule elk must consider the history of elk and land practices in the Seashore, and human influences through such factors as fire, water, vegetation, and loss of predators. Thus, while the ultimate objective is to restore natural ecosystem functions, it is recognized that human-caused alterations will influence the tule elk population for the foreseeable future and must be taken into account in developing management strategies.

Point Reyes National Seashore also operates under other management, legal and administrative goals and constraints. The operation of historic ranches and public visitation must be considered. The protection of other natural, cultural, and recreational resources are also important management objectives that need to be considered. These management objectives are not considered mutually exclusive.

## Management Goals

Management goals are outlined to achieve the plan's missions and to be implemented within a reasonable time frame. While mission statements can involve decisions and actions taking decades to achieve, management goals are implemented over shorter time periods and are modified as changes occur and new information warrants. The five goals of managing tule elk at Point Reyes are:

### **Goal 1. Maintain viable populations of tule elk at Point Reyes.**

To ensure long-term success of the herd requires a population size, health, and genetic fitness to maintain a viable population. A viable population is used by ecologists to define the conditions of a population that help guarantee that it does not suffer short-term extirpations (local extinction) or become predisposed to a continual threat of extirpation (Soule 1987).

The Point Reyes elk herd relies on its genetic makeup and diversity to cope with the challenges of its environment. Tule elk in California have been through a series of genetic bottlenecks with undetermined effects. The population of tule elk at Point Reyes has been estimated to contain the lowest level of genetic variation (or heterozygosity) of all the herds in the state, based upon an analysis of translocations and bottlenecks (McCullough et al. 1996). Dr. Katherine Ralls (Appendix B) and McCullough et al. (1996) have recommended the regular translocation of female tule elk from other locations into the Point Reyes herd to maintain genetic diversity by increasing gene flow. This would help reduce founder effects and the loss of genetic diversity that occurs in isolated herds of elk.

The maintenance of the herd's health does not imply an artificial condition where no animals would be unhealthy as might be attempted in a domestic or captive herd. Natural ecosystem processes will result in disease, predation, loss of fitness, and eventual mortality. In this context, a healthy herd is one that does not suffer disease or mortality due to artificially induced or human caused impacts. While such conditions cannot always be controlled, some may be mitigated or at least taken into account. At Point Reyes, human caused influences include the fencing of elk on the peninsula of Tomales Point, the introduction of Johne's disease, the introduction of non-native plants and animals, elimination of predators, construction of roads and ponds, and prior land use patterns. These factors require that management strategies account for the effect of human altered environments influencing the survival of elk on Tomales Point. A diagram outlining this goal is given in appendix E.

**Goal 2. Manage tule elk using minimal intrusion to regulate population size, where possible, as part of natural ecosystem processes.**

The growth of large herbivore populations in the absence of predators and with limits on dispersal has been a controversy throughout this century in the science of wildlife biology. One issue is whether herbivore populations in the absence of predators will inevitably grow too large and cause long-term damage to the vegetation, causing a severe population decline as animals experience large die-offs due to starvation. An alternate outcome is that declining food resources will slow elk reproduction, combined with a moderate increase in elk mortality, which will allow the vegetation to recover. This process would lead to a series of modulated swings of population growth and decline, a process that has been called 'natural or self regulation' as it does not involve the limitation of elk numbers by active reduction on the part of wildlife managers (Wagner et al. 1992, Yellowstone National Park 1997). There is no indication at this time of any reduction of growth rate of elk on Tomales Point (see figure 2). Concern for the welfare of the tule elk has prompted intervention to reduce reproduction through PZP immunocontraception research (see glossary).

It is not certain, given the characteristics of the Tomales Point tule elk range, which scenario will likely occur. These outcomes are not mutually exclusive, and may overlap with one another. While scientists are not in total agreement, the Point Reyes Tule Elk Advisory Committee has recommended that the Seashore pursue a policy of allowing the elk to "self regulate" population size within certain limits (appendix C). These limits would be established through research as a series of 'thresholds' defining the conditions of the elk and their environment that constitute an acceptable range to management. When thresholds are exceeded based upon field monitoring, an assessment would be made of the severity and longevity of population and habitat trends and whether management intervention is needed. A diagram of this goal is given in appendix F.

**Goal 3. Provide for a free-ranging tule elk herd in Point Reyes by 2005.**

Wildlife in National Seashores is managed as part of ecosystem processes that are not actively constrained or manipulated, except where necessitated by law, policy, or valid need (*NPS Management Policies* 1988). Tule elk at Point Reyes are a component of the original native fauna and do not pose an immediate threat to life or property. Their limitation to Tomales Point is an historical artifact of their reintroduction onto an area bounded by historic ranches and the intent to restrict their movements to a protected preserve. If they are to remain as part of the

Seashore's fauna and ecological processes, they should eventually become free-ranging throughout most of the Seashore's natural zones where conditions allow. Even when free-ranging, population regulation may still be necessary (Wagner et al. 1992). A diagram of this goal is given in appendix G.

**Goal 4. Research and monitor the habitat and elk population over time.**

Research involves the development of new information on the biology and ecology of elk at Point Reyes. Understanding cause and effect, interpreting trends, and appraising different possible approaches require a scientific methodology and analysis. Monitoring involves regularly collecting information on the status of the elk herd and the environment. This information allows for the evaluation of environmental factors and the analysis of trends. Without this information, the lack of knowledge will prevent an assessment of the current conditions and possibly allow for deleterious changes to go undetected.

Monitoring and research provide the tools to make objective assessments of the effectiveness of management actions, and create the foundation for success through adaptive management.

**Goal 5. Provide the public with interpretation and information on tule elk conservation biology and management.**

The mission of managing elk at Point Reyes is undertaken as part of the stewardship of our nation's resources. Appreciation and support by the public is essential for a successful program, including public health and safety issues. The Seashore intends to develop interpretive media such as brochures, videos, and other distributed information to increase the public understanding.

Some of the issues involved with this plan have been the subject of public controversy in the past. The Seashore intends to work proactively with the public media, including newspapers and television, to inform the public on issues involving the management of tule elk, especially dealing with potentially controversial issues. This goal can also be met by presenting public programs, tours, and first-person interpretive programs on tule elk.



## Alternatives including the Proposed Action

### Overview of Alternatives

**F**our alternatives describe a range of reasonable approaches to the management of tule elk at Point Reyes National Seashore:

**Alternative A:** (Proposed Action) Manage Elk using Relocations and Scientific Techniques

**Alternative B:** Eliminate Restricted Range through Management Decisions

**Alternative C:** Reduce and Maintain Elk at Small Remnant Population Size

**Alternative D:** No Action / Minimum Requirements

The alternatives address the mission and goals established in this plan for tule elk at Point Reyes, the topics described under the section Issues and Concerns, and the other Seashore management plans such as the General Management Plan, the Statement for Management, and the Resource Management Plan. The alternatives vary in the number and size of elk herds projected, the amount of effort required in their management, and the number of years required to achieve their goals. Some alternatives meet some of the goals better than other alternatives, and such alignments will be discussed where applicable.

Alternatives B and D propose to manage elk populations sizes with minimal intrusion, within certain constraints. Alternative C places the tightest restraints on the upper limit of elk population size with a concurrent need to eliminate animals and/or reduce fertility. Alternatives A and B emphasize relocating elk to establish free-ranging herds. Alternatives C and D represent the lowest cost approaches over a long time period. While Alternative B may be low cost initially, future costs appear higher with this approach. Alternative C will be initially costly, but then costs will be lower. Alternatives A and C pose the least threat to other Seashore operations such as visitation or ranching; Alternatives B and D offers the highest level of potential impacts on these other resources. Alternatives A and B contribute the most towards managing tule elk as part of a natural ecosystem dynamic.

Alternatives may use a variety of methods to reduce elk populations when necessary, including contraception, sterilization, relocation, and lethal removal. The justification and decision process for making such reductions vary significantly between the alternatives.

## Alternative A (Proposed Action): Manage Elk using Relocations and Scientific Techniques

This alternative describes an approach that uses the latest technology and scientific understanding of the dynamics of tule elk populations. It sets an interim management limit on the Point Reyes tule elk herd of 600-800 until such time as thresholds can be established. Thresholds will then be used to assess the effects of tule elk on other species and their environment. Thresholds will be used to evaluate and set limits on population size. Moving towards establishing a free-ranging herd at Point Reyes, elk will be relocated to Limantour as a trial introduction. This new trial herd will be carefully monitored for signs of successful adaptation to their environment and tracked using radio telemetry. They will be tested for Johne's disease and animals testing positive will be removed. Immunocontraception may be used as a means of slowing initial reproductive rates until the trial is considered a success. The Seashore will continue testing PZP immunocontraception as a growth limiting control. Through monitoring and research, improved understanding of elk population dynamics may lead to the revision of this plan.

A summary of the proposed actions under Alternative A:

### Interim or short-term actions:

1. Maintain elk fence on Tomales Point range.
2. Continue monitoring tule elk and their environment.
3. Continue PZP immunocontraception tests on elk.
4. Continue research efforts into tule elk ecology, including methods to alter elk population size where necessary.
5. Set interim management limit for Point Reyes tule elk population at 600-800 animals, with Tomales Point set at 350-450 and Limantour set at 250-350.
6. Establish thresholds for tule elk, vegetation, and other resource indicators to replace interim management limits.
7. Conduct a Risk Assessment Analysis to address Johne's disease transmission.
8. Establish a free-ranging herd within 18,000 acres by relocating 35-70 animals to the Limantour area. Work to ensure only Johne's free animals are relocated.
9. Work to ensure public safety; reduce consequences to neighbors of free-ranging elk.
10. Work with other agencies to relocate 35-70 animals elsewhere in the State in the historic tule elk range in cooperation with the State of California.

### Long-term actions:

1. Manage free-ranging herds using minimal intrusion to achieve viable management limits as part of dynamic ecosystem processes.
2. Adaptively manage the herd, revising this plan as necessary to best fit new situations and information.



Under alternative A the Seashore will maintain the elk fence on Tomales Point and continue to separate tule elk from cattle. The Seashore will continue monitoring tule elk and their environment to analyze trends and better understand tule elk population dynamics and ecology at Point Reyes. The control of the Tomales Point elk population will be attempted through management techniques of contraception and relocation. No effort will be made to cultivate food crops specifically to improve the range's ability to support elk. Such strategies are known to be self-defeating as artificially provided food leads to ever increasing herd sizes that overwhelm the ability of the range to support them. A history of failed elk management approaches can be seen at Yellowstone National Park, where elk were fed supplementary winter food that resulted in chronic overpopulation problems (U.S. Senate 1967, Houston 1982). It would also run counter to ecosystem management objectives of managing for diverse and natural systems.

The Seashore will continue porcine zona pellucida (PZP) immunocontraception tests on tule elk as a possible means of effecting population control through a reduction of pregnancies. This technique has been successfully used for contraception of other mammals including horses, elephants, and deer (Kirkpatrick et al. 1996). Twenty-nine female tule elk were captured during the summer of 1997 and treated with PZP immunocontraceptive and radio collared for tracking purposes. Another 30 animals were captured and treated in June 1998. If this trial is successful, the Seashore intends to continue using PZP where applicable for controlling tule elk herds. As the technique is labor and cost intensive, it is not being pursued as the only means of control. It is not considered feasible for large numbers of animals.

The Seashore will continue research efforts into tule elk population dynamics and ecology. These studies will explore methods to alter elk population size where necessary, looking at food and water resources, predation, disease, and population control techniques.

### **Management Limits**

The Seashore intends to manage the tule elk population over time with as little population manipulation as possible. This may require occasional intervention to dampen the potential for negative impacts. In order to provide adequate response time and detect negative effects through monitoring, the Seashore intends to manage the number of elk by establishing a range of acceptable limits. This range is being called the interim "management limit" for Point Reyes tule elk. The management limit for Point Reyes National Seashore is set at this time as 600-800

animals. Included in this value is the limit set for Tomales Point of 350-450 animals and for Limantour of 250-350 animals. The management limit is an estimate of the number of animals that can be successfully maintained, monitored, studied, and as necessary, controlled. It provides an interim objective for elk management that is the best estimate of sustainable herd size. As the herd size exceeds this limit, efforts will most likely be undertaken to reduce the herd size. Under this alternative, this level would probably be reached by the year 2001. It should be noted that it is not the intention of the Seashore to maintain the herd at this upper limit for a sustained period of time. The interim management limit will be used until thresholds are developed.

### Thresholds

Under Alternative A, the Seashore will develop thresholds for tule elk, vegetation, and other resource indicators, and use these thresholds as indicators of the need for management actions. The limits of elk population size allowed under thresholds would be an acceptable population size range, not a fixed number. A number of thresholds, established through research, would define conditions of the elk and their environment that constitute an acceptable range. An example of a threshold under development would be that no more than 5% of the tule elk range would have a residual dry matter (a measure of vegetation) of less than 1,400 pounds per acre. Another threshold might be that no more than 50% of San Francisco owl's clover is lost due to trampling. A threshold could account for increased safety risks such as elk leaving the Tomales Point range. These examples are given only as interim estimates of what the final thresholds may be. When thresholds are not surpassed tule elk population management is "hands off." When established thresholds are exceeded, an assessment would be made of the severity and longevity of population and habitat trends and whether active intervention is needed (see appendix F).

A determination that thresholds have been exceeded could result in a decision that no management actions are necessary. This may occur when the number of thresholds exceeded are few, the extent of surpassing the limits is small, or the trend is recent and is not exacerbated by other problems. In the event a decision is made not to intervene, the condition of the herd would continue to be monitored. Indirect methods of population control may be utilized through such means as controlled burns or altering artificial water sources. Alternatively, a determination that thresholds were exceeded may result in a decision that direct intervention is necessary.

Severe erosion and depletion of vegetation, large numbers of starving elk, dispersal of elk outside the Seashore, and public safety hazards are some of the unacceptable situations that would require the Seashore to intervene. Different methods of population control could be used, contraception and relocation being preferred. Controlled shooting or lethal removal of animals would only be used where immediate harm is known to be occurring and all other methods have failed.

Immunocontraception is intended to slow the birth rate to balance births with deaths. This is undertaken to reduce eventual population levels and their deleterious effects on the environment, and reduce the need for further intervention. The herd is quite young at the present time, with some 40% age two years or younger. It will take a while for mortality due to old age to increase. Proper management should reduce the need for intervention and as techniques are refined the Point Reyes herd may be managed using only occasional contraception and relocation with most losses due to natural mortality.

Once resource indicators have returned to below threshold levels the population would again be managed using threshold assessment. Additional research and experience over time would further refine the ability to analyze and predict the responses and interactions between tule elk and their environment.

### **Relocation to Limantour**

To establish a free-ranging herd and reduce population pressures on the Tomales point elk range, animals will be relocated to Limantour. Some 35-70 animals would be relocated initially, with the potential for additional animals to be moved if the trial is determined to be successful. The desired condition of the herd would be free-ranging over some 18,000 acres as a long-term goal (see figure 7). The Seashore will not attempt to establish new herds that require permanently fenced, restricted ranges.

The area chosen for the Limantour herd has characteristics that will encourage free-ranging elk to establish and maintain home ranges within the Seashore. These characteristics include large acreage in natural zones with buffers from major highways, ranches, and lands outside the Seashore (see figure 7). The primary geographic feature expected to slow the spread of tule elk is Inverness Ridge with its heavily forested slopes, a habitat type that tule elk tend to avoid. Tule elk will be allowed to roam outside the area as long as new home ranges are not established where conflicts with traffic corridors or neighbors are likely. Animals found east of the ridge will be monitored to determine whether they have

established new herds in the area and, if so, what the effects would be. Concerns have been raised over tule elk crossing Highway 1 and ultimately establishing herds outside the Seashore. The Seashore proposes to capture and move any animals that cross Olema Creek along Highway 1. Captured animals will be tagged, radio collared, and returned to designated tule elk ranges within the Seashore. It is the long-term management goal to keep tule elk within federal lands, currently west of Highway 1. An overview of meeting the goal for free-ranging elk has been diagrammed in appendix G.

Some animals in the trial herd will be radio collared to gather information and, if necessary, assist in recapturing any individuals that might wander outside the Seashore. Contraception will provide for a period of two or three years to assess the success of the new herd before it increases in size. The preferred technique to limit growth is immunocontraception, which allows treated individuals to breed after contraception is stopped. This could be important if survival rates drop and the herd is threatened with extirpation. Immunocontraceptive techniques now under research offer the best method if they prove successful. Sterilization through surgical techniques is also a possible method of limiting growth but is more invasive.

All tule elk captured for relocation will be tested for Johne's disease according to the protocols developed for this purpose. To maximize the probability that only disease-free animals are relocated, a series of tests will be conducted on adult elk over a three to six month period. All animals testing positive for Johne's disease will be lethally removed from the herd. The disease testing coupled with a formal risk assessment will be used to determine the feasibility of relocation outside the Seashore.

Ideally, as many elk as possible should make up the founding herd to preserve genetic diversity within the new herd. A reasonable number of animals to accomplish this is 35 to 70 animals. Deleterious genetic effects may be reduced by the introduction of new animals from other herds or the possible merging of herds across the Seashore (McCullough et al. 1993).

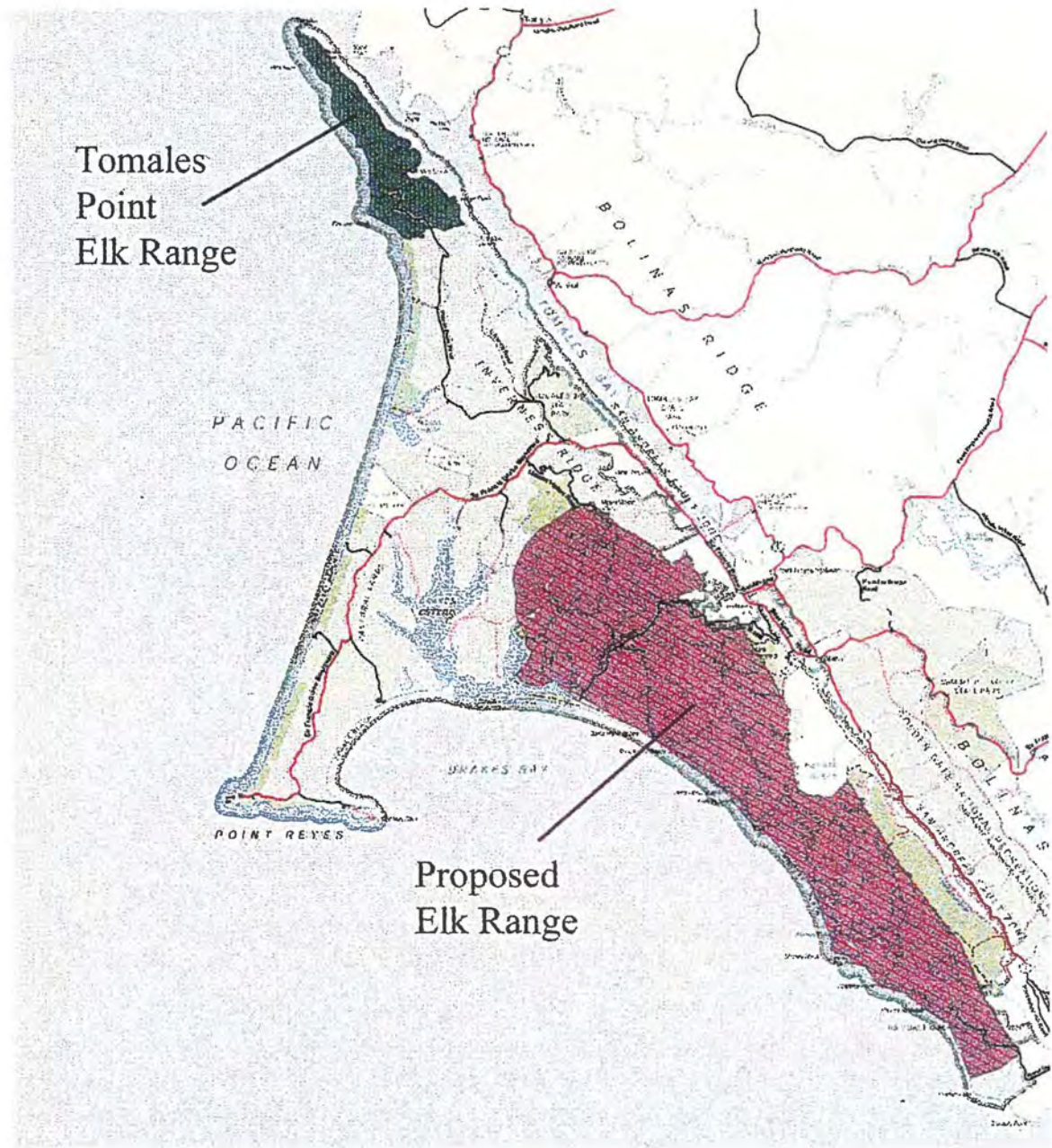


Figure 7. Map of Tomales Point Elk Range and Proposed Elk Range for relocated population.

### **Free-ranging Safety Considerations**

As the Seashore establishes free-ranging elk at Point Reyes, public safety and the protection of private property will be maintained. Threats to public safety from elk are rare in national parks. The greatest threat is from automobile collisions and accidents. Signs placed at key crossings and entrances to the Seashore and enforcement of speed limits will be used to reduce the potential for this problem. During certain times of the year, such as rutting season, occasional temporary road closures may be necessary if large numbers of elk occupy a road. This should be rare as elk are known to avoid humans and roads during most of the year (Millsbaugh 1995). Late summer rutting, when bulls are contesting each other over females, appears to represent the greatest potential for hostile interactions with visitors on foot. Providing interpretive information has proven successful in educating the public on these hazards.

Damage to property could occur if elk move outside the Seashore onto private lands and consume crops or damage fences or other property. The Seashore will be ready to recapture or destroy problem animals should these situations arise, or establish partnerships with state and county agencies with the necessary skills and personnel to assist with the recapture. The Seashore should be prepared to provide funding for compensating property damage if necessary. It may be possible for the Seashore to modify parts of the habitat to help prevent such occurrences, or construct barriers to dispersal.

Removing the fence at Tomales Point will be considered if and when ranching ceases on the adjacent lands. To open the Tomales Point elk range with adjacent lands under ranching could negatively impact both ranching and the elk habitat.

### **Relocation Outside the Seashore**

Before any animals are relocated off the Seashore an analysis of the risks associated with Johne's disease being transmitted to deer, cattle, or other elk will be completed. The California Department of Fish and Game will not relocate animals that are likely to infect other animals with diseases or have a low probability of survival. Johne's disease may not pose as significant a threat to other animals as was once believed. A relocation of tule elk from Point Reyes to other parts of the state may be possible, given a thorough evaluation of the risks involved and the testing of individual animals to ensure their Johne's disease-free condition.

The Seashore proposes to work with other agencies to relocate animals from the Seashore to other areas within the historic tule elk range. A site will be selected by the California Department of Fish and Game who will ensure that suitable habitat is present and adjacent landowners agree to the introduction. It is hoped that as many as 35 to 70 animals in one transfer could be relocated elsewhere within the state using this method.

The completion of a risk assessment evaluation, conducted by qualified epidemiologists and veterinarians, will evaluate the potential for transmitting Johne's disease to deer, cattle, or other elk. Based upon the findings of the risk assessment the planned methodologies and strategies for selecting disease-free animals to be relocated will be evaluated. Tule elk will only be relocated outside the Seashore if there is a very small probability that Johne's disease might be spread.

#### **Long-term actions**

The Seashore will attempt to manage free-ranging herds using minimal interventions to achieve viable populations as part of dynamic ecosystem processes. It intends to achieve a balance between reproductive replacement and natural mortality over time, resulting in limited requirements for intervention and active management.

The Seashore will adaptively manage the herd, revising this plan as necessary to best fit new situations and information. Most revisions to this plan will be minor corrections and adjustments to the actions described herein. When and if major changes are considered necessary, a supplemental revision may be issued. As this plan becomes obsolete, a new planning effort will be required.

Disadvantages of this alternative are the cost of its implementation to conduct the necessary relocations, monitoring and research. This alternative is expected to take at least six years to implement.

## **Alternative B: Eliminate Restricted Range through Management Decisions**

This alternative describes a process whereby the National Park Service would pursue its tule elk management mission and goals through elimination or reduction of ranching permits using existing authorities. Tule elk at Tomales Point would be allowed to move outside the current elk range to former ranch units within the Seashore. No initial limits would be set on the tule elk population size within the Seashore. When tule elk appear to have reached the limit of an area's ability to support them, and resource impacts appear unacceptable, either relocation, fence alterations, immunocontraception, or lethal removal would be used to mitigate adverse impacts.

A summary of the actions under Alternative B:

1. Eliminate or reduce agricultural leases, permits, and reservations.
2. Modify restricted Tomales Point elk range by:
  - removing fence from Tomales Point, or
  - installing elk gates in several places, or
  - relocating the fence to expand the fenced area.
3. Allow elk to free-range as their habitat area expands.
4. Monitor elk and habitat condition.
5. Limit elk numbers based upon impacts that are within acceptable range.

These changes would be effected without full knowledge of the potential for success. The higher risk assumed by such a strategy would be offset in part by the short time frame. Impacts to Seashore resources and activities such as ranching would likely be the highest under this scenario.

While this alternative may represent a low cost, successful short-term strategy, it will probably result in producing problems with conflicting land uses and agriculture. If population control becomes a problem, it will occur on a much larger scale than at present. Though the passage of time may produce unexpected scientific and/or management solutions to such problems, it will be necessary for the Seashore and public to place the priorities of elk management above many other concerns.



### **Breach Fence at Tomales Point**

Removing or opening the fence at Tomales Point would allow the existing elk herd to disperse. At the current time, this would create conflicts with ongoing agricultural interests. Anticipated conflicts include elk feeding on cultivated crops and food supplied by ranchers for cattle and damage to ranch property. Removing the fence would also allow cattle to move onto the elk range at Tomales Point, thereby reducing the quality of the range for elk and risk exposing cattle and elk to each other's diseases. This could be avoided by installing elk gates or fence openings designed to allow the passage of elk but not cattle.

Agricultural land uses in the Seashore are approved for a period of years with lease and permit renewals occurring over the next 20 years. Removing the fence or installing elk gates could be easily implemented only after ranching activities terminate. The National Park Service, under this alternative, would have to eliminate some or all of the permits, leases, or reservations on an accelerated schedule to eliminate the fenced area without conflicts with ranching.

### **Expand the Fenced Area**

The geographic restrictions on the size of the Tomales Point elk range include its location on a peninsula surrounded by water. To expand the available contiguous habitat would require the existing fence to be relocated further southeast, or away from the present range. Expanding the fenced area entails shifting adjacent land use from its current status as dairy ranching to a natural zone within the Seashore. The high cost of relocating the fence, approximately \$150,000, implies that this action would be undertaken only if the new range boundary added substantial acreage to the existing elk range. It would suggest that the new fence line boundary should last decades in order to justify the expense.

This alternative includes monitoring to measure the effect of management strategies on the elk and their habitat. Though less research would be involved than in alternative A, it could still be undertaken to better understand the ecology of elk at Point Reyes. Disadvantages of this strategy are its conflict with and impact on ranching operations at Point Reyes, a land use that is supported by enabling legislation and existing management plans. The expanded fence would initially include habitat in poor condition and expose elk to cattle-borne diseases.

## Alternative C: Reduce and Maintain Elk at Small Remnant Population

Maintaining population and reproductive restrictions on large herds of elk can be expensive and difficult to achieve, given the best means available. This alternative seeks to reduce the present tule elk population in the Seashore to a small remnant herd of 40 to 60 breeding animals that could be more easily and cost effectively limited in size over many years. Initially, this alternative would require a large investment. However, eventually, a small remnant elk herd would require only occasional, relatively inexpensive contraception or sterilization, on the order of reducing growth by some 5 to 10 animals every few years. Under this strategy, no new herds would be established, as new herds would increase costs and run counter to the intent of limiting tule elk to a small number of animals.

A summary of the actions under Alternative C:

1. Maintain existing fence on Tomales Point.
2. Eliminate, relocate, sterilize, or contracept all but 40 to 60 animals on Tomales Point elk range.
3. Maintain a balance between births and deaths over three-year spans by relocation, contraception, sterilization, or culling.
4. Maintain total tule elk population size to keep impacts within acceptable range.
5. When and if ranching ceases, remove fence and allow herd to expand.

### Reduce Existing Herd

The existing herd of 465 animals would be reduced under this alternative to a breeding population of 40 to 60 animals. This range has been selected as the best compromise between maintaining a small herd with low growth rates and protecting the herd from extirpation. The herd could be physically reduced through relocating the elk, but there are no known locations that could accept this many elk. Another method would be to shoot the surplus animals, but this would be unacceptable to many in the public. The preferred method would be to contracept or sterilize the surplus 400 to 450 animals, leaving the remaining 40 to 60 animals to freely reproduce. Eventually, these non-reproductive animals would die of old age. It is estimated given the life span of tule elk that this method would take 10 to 20 years to achieve.

### Maintain Small Herd Size

Creating a balance between births and deaths with 40 to 60 reproductive animals will maintain a no growth herd. Over periods of greater than average rainfall with high vegetation growth and higher calf survival, recruitment in the herd may exceed mortality and the herd will grow larger than 60 animals. When this occurs the surplus animals could be relocated if the State of California has appropriate sites, or animals will be contracepted or sterilized to bring the population size back down.

This alternative represents a costly strategy to achieve a low growth herd and maintain the elk herd until such time as restrictions on their range can be removed. If this takes many decades, this alternative would be the lowest cost once the small herd is achieved. Range restrictions would be removed if and when the pastoral zones of the Seashore are converted to natural zones after the cessation of ranching activities. Under this strategy little monitoring or research of elk and their environment would be necessary, except to prepare for the removal of restrictions or to study the impact of elk on the range and threatened and endangered species. At such a small population size, any impacts would be expected to be minimal.

There are numerous disadvantages of this strategy. Elk would not be managed using ecosystem concepts, and their contribution to the ecology of the Seashore would be minimal. The herd would be at risk of local extinction in the case of a severe drought, disease outbreak, or other concurrent stresses. The genetic diversity of the herd would be reduced and inbreeding would increase as animals become more genetically related. The initial reduction of the herd would be costly if done through contraception, or controversial if culling is used. Overall, this alternative runs counter to the NPS policy of not maintaining captive herds for the enjoyment of visitors but instead to maintain wild populations within natural habitats.

## Alternative D: No Action / Minimum Requirements

Under Alternative D the National Park Service would undertake the minimal requirements to manage tule elk. It would continue to be responsible for the overall management of tule elk as outlined in planning documents and approved actions would be continued. Point Reyes National Seashore would continue to meet its legal and policy mandates necessary to manage tule elk at Point Reyes National Seashore. No new efforts would be initiated except where necessitated by adverse effects on other resources, the public, or legal mandates.

A summary of the actions under Alternative D:

1. Maintain existing fence.
2. Monitor the general condition of elk and their habitat, annually survey elk.
3. Monitor threatened and endangered species.
4. Undertake action only in the case of imminent threat to elk or other affected species.
5. Undertake no population controls except where impacts are not within acceptable range.
6. If and when ranching ceases in Point Reyes, remove fence and allow herd to expand.

Management of the tule elk would be limited primarily to ensuring against impacts to threatened and endangered species. No manipulation of tule elk population numbers or vegetation resources would be attempted. Existing fences would be maintained, and no new herds would be created or allowed.

As with other alternatives, future changes in land use where ranching is discontinued would affect the management of elk at Point Reyes. Removal of restrictions on the elk range could result in the eventual removal of the fence at Tomales Point.

Disadvantages of this alternative are that impacts from overpopulation of elk on their present range are a current management concern that this alternative does little to address. The lack of any new research decreases knowledge and increases reaction time to correct any problems.



## Environmental Consequences

Topics selected for inclusion in the assessment of impacts of the different alternatives were chosen on the basis of the significance of the resource and the potential for adverse or beneficial impacts on them. Considerations also included Federal and State laws, NPS policies, and information provided by public responses and interested parties.

Some of the resources described under the section "Affected Environment" were dropped from inclusion as the alternatives would have little or no direct or indirect effect upon them. They include climate, geology and topography.

The analysis for each alternative is addressed separately in tables on the following pages.

## Alternative A

The environmental consequences of the proposed action, "Manage Elk using Relocations and Scientific Techniques," are outlined in the following matrix:

| Affected Resource                 | Positive Consequences  | Negative Consequences   |
|-----------------------------------|--|---|
| Wilderness                        | Expansion of elk range would further recreate original wilderness scene.   | Minor helicopter access may be required for capture and relocation of elk. Erection or removal of temporary fences may require one-time vehicle access and have temporary visual effects on the visitor wilderness experience.                        |
| Soils                             | Maintaining population of tule elk within management limits would be beneficial to soil conservation by avoiding concentrated effects on soils of larger numbers of elk.   | Potential exists for soil erosion to accelerate at times of higher numbers at peak population cycles. At anticipated peaks this effect would be short-term and very localized, with no expectation of worsening spread of erosion.                    |
| Water Resources                   | Understanding of water requirements by wildlife on altered water sources will permit assessment of restoration needs for returning Seashore wilderness to natural state. Eventual removal of artificial water sources will restore native habitat conditions.  | Numbers of elk at population peaks may over utilize water resources affecting other wildlife and water quality. Effect would be short lived and impacts to water quality minor. Possibility of effecting T&E aquatic species such as red-legged frog. |
| Vegetation                        | Elk are important in nutrient cycling of nitrogen and improving vegetation growth. Grazing creates mosaic of distribution for plants, increasing diversity, and potentially reducing impacts of fire by reducing fuel buildup in grasslands. Potential benefit to native perennial grasses and indirectly to endangered butterfly. | Patches of vegetation may be overgrazed and some trampling will occur. Unknown effect on rare plant species, which could be affected if highly palatable.   |
| T&E Species                       | Proposed action will benefit T&E species through restoration of ecosystem and improved monitoring and research leading to better understanding of ecology.   | It is not anticipated that any T&E species will be impacted. Ongoing study and monitoring of Myrtle's silverspot butterfly and California red-legged frog will detect adverse impacts at earliest stage if applicable.                                |
| Wildlife                          | Management of tule elk will be least intrusive and utilize best scientific technology available. Other wildlife benefit from restored ecosystem through nutrient cycling and presence of large herbivores.   | Possibility of unchecked growth by elk which may cause large die-off. Monitoring will detect trend but a large increase may require culling as only effective control method, a technique that has received public criticism.                         |
| Table continued on next page..... |  |   |

## Alternative A: Matrix of Environmental Consequences continued....

| Affected Resource      | Positive Consequences  | Negative Consequences   |
|------------------------|--|---|
| Recreational Resources | There should be very little effect on recreational resources. Increased distribution of elk herds in Seashore will increase viewing opportunities for visitors. Interpretation will provide educational and enjoyment possibilities. Additional elk distribution will disperse visitors. | Possible closure of areas on temporary basis for a few days to conduct operations may inconvenience some recreationists, but no more likely in this alternative than others.  |
| Public Safety          | There should be little effect on public safety under the proposed action. Avoidance of need to lethally remove animals should reduce need for addressing the public safety issues involved.  | Free-ranging elk may have potential for wandering onto roads and pose traffic hazard. Expanded distribution may increase visitor contact with elk during rutting season, a time of increased safety risk due to aggressive male behavior. |
| Cultural Resources     | Elk will assist with maintaining open grassland landscape similar to that achieved through cattle ranching. No effect expected on historic structures. Will recreate prehistoric landscape element.  | Some limited erosion of archeological sites may occur. Large herds of elk will constitute visual intrusion on cultural landscape as they would not have been present during ranching period.  |
| Adjacent Landowners    | Action should have little effect on adjacent landowners or land planning in area. Improved restoration should encourage additional visitors with positive effect on local economies.   | Permitting free-ranging elk may generate dispersal of individual elk out of the Seashore boundaries onto private lands. Potential if this occurs for damage to private property to occur.   |
| Ranching               | Creation of new herds will remove pressure to expand Tomales Point elk range. Alternative compatible with ranching activities encourages continued support of permits and leases.  | Free-ranging herds may expand into territory adjacent to agricultural lands and possibly come into conflict with cattle. Some use of cultivated crops may occur and cattle may affect health of elk herd through cattle borne diseases.   |
| Non-native Deer        | Native herbivores can replace non-native fallow and axis deer accelerating trend for restoration of ecosystem.   | Conflicts between elk and non-native deer may increase need to reduce, remove, or eliminate non-native deer, increasing costs.  |

### Mitigation Measures

The following actions can be implemented along with Alternative A, the Proposed Action, to mitigate all or part of the negative consequences described above:

- Monitor elk populations and their environment annually and analyze data to detect negative trends.
- Act in a timely fashion to control elk population size as necessary to ensure conditions of herd and environment remain within acceptable range.
- Conduct research to improve basis for decision making and better understand the ecosystem and interactions between elk and park resources.
- Close areas when necessary, conduct capture or helicopter operations during periods of low visitation such as weekdays.
- Maintain capability to take corrective actions as necessary including revegetation and soil stabilization, and capture and/or culling of elk.
- Work to establish partnerships with organizations interested in the protection and interpretation of tule elk. Investigate the feasibility of funding any potential depredations to private property with private contributions.
- Develop capability through partnerships to restabilize any damaged archeological sites or potentially excavate those in danger of being lost.
- Prepare educational materials on tule elk to increase public awareness and provide safety information.
- Monitor threatened and endangered species in contact with tule elk with potential for effects.
- Conduct assessment of impacts before altering existing water impoundments on Tomales Point.



## Alternative B

The environmental consequences of Alternative B: "Eliminate Restricted Range through Management Decisions," are outlined in the following matrix:

| Affected Resource               | Positive Consequences   | Negative Consequences  |
|---------------------------------|---|--|
| Wilderness                      | This action would have little effect on wilderness. Benefit would accrue due to decreased impacts on restricted range in wilderness.  | No known negative effects on wilderness status.  |
| Soils                           | Would decrease potential for impacts to soil due to overpopulation of elk. Increased area of grazing and nutrient cycling would benefit soil fertility.   | If population does not disperse, could cause local concentrations that increase soil erosion.  |
| Water Resources                 | This action would have little effect on water resources. Action would provide some justification for removal of artificial impoundments on Tomales Point.   | No known negative effects on water resources.  |
| Vegetation                      | Removal of restrictions on Tomales Point would have potential for relieving grazing pressure as population expands over greater area.   | No known negative consequences for vegetation, unless population expands greatly.  |
| T&E Species                     | Removal of restricted range could reduce impacts on T&E species due to overcrowding of elk.   | Increased distribution would cause elk to come into contact with more T&E species with undetermined effect.  |
| Wildlife                        | Potential as elk range expands for predators such as coyote or mountain lion to come into contact with elk. Restored habitats would increase amount of natural areas supporting wildlife including native deer. | No known negative effects on wildlife.   |
| Recreational Resources          | Increased opportunity for viewing elk over wider area. Possibility for expanded trail systems for hikers.   | Dispersal of elk into different habitats will make them harder for visitors to see until numbers are increased. Rutting, if in visitor areas, may cause short-term disruption of some recreational activities. |
| Public Safety                   | Decreased overcrowding of elk in Tomales Point range would reduce safety concerns.  | Elk would occupy more Seashore areas with potential for increased road hazards. Rutting may increase potential for hostile encounters in visitor areas.  |
| Table continued on next page... |   |  |

Alternative B: Matrix of Environmental Consequences continued....

| Affected Resource   | Positive Consequences   | Negative Consequences  |
|---------------------|---|--|
| Cultural Resources  | Grazing by elk maintains open pastoral appearance of cultural landscape in absence of cattle.   | Expanded range will put elk in contact with larger number of archeological sites and historic structures, with potential for impacts. Visual impact of elk on historic landscapes where they would not have occurred during ranching period. |
| Adjacent Landowners | Action could provide knowledge of movements and behavior of elk before population comes into contact with Point Reyes boundary. Potential for slight increase in visitation to Seashore with economic benefits. Possibility that elk may be legally hunted on adjacent lands. | Elk could migrate outside Seashore and cause concerns and/or damage private property.  |
| Ranching            | No known benefits to ranching.  | Action would either reduce number and extent of ranches in Seashore, or increase potential for effect of elk grazing on ranch areas.   |
| Non-native Deer     | Increased need to reduce or eliminate non-native deer.  | Increased overlap of elk range with non-native deer could increase competition between native and non-native deer.   |

## Alternative C

The environmental consequences of Alternative C: "Reduce and Maintain Elk at Small Remnant Population Size," are outlined in the following matrix:

| Affected Resource      | Positive Consequences  | Negative Consequences  |
|------------------------|--|--|
| Wilderness             | Reduces overpopulation potential that could require regular use of motorized vehicles in wilderness. Reduces need for culling large numbers of elk over long period. | Reduces natural ecosystem restoration in wilderness. Creates tightly controlled herd that requires regular intervention on small scale. Initial use of helicopters and/or motor vehicles high.               |
| Soils                  | Greatly reduces potential for soil erosion through reducing number of elk.   | Eliminates positive effect of elk on nutrient recycling and soil fertility. Lack of grazing can cause build-up of biomass and fuels that can cause very intense fires and damage or expose soils to erosion. |
| Water Resources        | Less use of limited water resources by tule elk.   | No known negative effects on water resources, unless large amounts of chemical sterilizers are used which may effect water quality.  |
| Vegetation             | Reduces potential for overgrazing. Lessens potential for spread of non-native plants that benefit from grazing.  | Decreases mosaic pattern that encourages plant community diversity. Reduces nitrogen cycling by elk. Reduces grazing pressure that can enhance native perennial grasses.                                     |
| T&E Species            | Reduces potential for negative impacts through decreased contact.  | Decreased restoration of habitat reduces long-term benefit to T&E species.   |
| Wildlife               | Could potentially benefit other herbivores such as black-tailed deer.  | Decreased elk numbers more vulnerable to local extinction. Less potential food for predators and scavengers.   |
| Recreational Resources | Less potential for closing area because of large numbers of elk or extensive management efforts.   | Fewer elk will be harder for visitors to see or encounter.   |
| Public Safety          | Reduces potential for elk problems on highways. Rutting by smaller herd will pose less potential for hazards. Problems that develop are easier to correct.           | No known negative effects on public safety.  |
| Cultural Resources     | Eliminates potential for visual intrusion on cultural landscape. Reduces potential impacts on sites or structures.   | Reduced grazing may permit grasslands and shrub areas to grow into dense stands reducing the historic pastoral appearance of landscape.  |
|                        | Table continued on next page...  |  |

Alternative C: Matrix of Environmental Consequences continued....

| Affected Resource   | Positive Consequences  | Negative Consequences  |
|---------------------|--|--|
| Adjacent Landowners | Greatest reduction of potential for elk to stray onto private lands.   | Reduced elk sightings by visitors may eliminate some visitation and reduce economic benefit to area.   |
| Ranching            | Small elk herd would pose lowest threat to ranching operations. Eliminates need for reduction of ranching on Seashore. | Could increase perception that ranching and restored habitats cannot coexist as neighbors, putting increased pressure on Seashore to reconcile by reducing ranching. |
| Non-native Deer     | Lessens potential for conflict with non-native deer.   | Reduces short term justification for non-native deer removal with potential for larger conflict in future if non-native deer herd grows larger.                      |

## Alternative D

The environmental consequences of Alternative D: "No Action / Minimum Requirements," are outlined in the following matrix:

| Affected Resource               | Positive Consequences   | Negative Consequences  |
|---------------------------------|---|--|
| Wilderness                      | Reduces intrusions into wilderness by vehicles, helicopters, or temporary fences.   | Lack of effort to ensure restoration success could cause large effect on wilderness if large future corrective efforts become necessary.                                       |
| Soils                           | Soils would benefit through elk contributing to soil nutrients and fertility. Grazing will decrease biomass and fuels to reduce harmful fire effects. | Increasing large numbers of elk could expose large soil patches to erosion.  |
| Water Resources                 | No known positive effects on water resources.   | No anticipated effects, but lack of monitoring may not detect impacts. Larger herd sizes may impact water sources by reducing water quality and quantity.                      |
| Vegetation                      | Elk will contribute to nutrient cycling beneficial to plants, and grazing will benefit native perennial grasses.                                      | Large uncontrolled elk population will degrade vegetation resources.   |
| T&E Species                     | Elk will contribute to restoration of ecosystem.  | Large numbers of elk may impact T&E species or their habitats. Lack of knowledge may contribute to size of impact over time.   |
| Wildlife                        | Elk will contribute to wildlife communities and increase food resources for predators and scavengers.   | Large numbers of elk may degrade habitat for small rodents and other herbivores, also impacting their predators.   |
| Recreational Resources          | Visitors can more easily see larger numbers of elk.   | Larger numbers of elk may require more area closures.  |
| Public Safety                   | The confinement of elk to their present range limits the exposure of the public and the amount of road accessibility to elk.                          | Larger numbers of elk may increase human conflicts. If range deteriorates, elk in poor condition may exhibit more aggressiveness.  |
| Cultural Resources              | Elk would be restricted to fewer cultural landscapes and ranching would be unaffected, thus maintaining pastoral zones.                               | Large population buildup in elk range may impact sites or structures on range.   |
| Adjacent Landowners             | Restricted range reduces potential for elk to move outside Seashore.  | Increased numbers of elk may create pressures on individual elk to breach fence or swim bay to escape poor habitat condition, increasing chance of impact to private property. |
| Table Continued on next page... |   |  |

Alternative D: Matrix of Environmental Consequences continued....

| Affected Resource | Positive Consequences   | Negative Consequences   |
|-------------------|---|---|
| Ranching          | Maintenance of range outside ranching areas reduces potential for conflicts between elk and cattle. | Development of crisis of elk overcrowding could put pressure on Seashore to reduce ranching, or elk could escape confinement.   |
| Non-native Deer   | Maintenance of elk on restricted range would reduce contact with non-native deer.                   | If non-native deer are allowed to increase over short term as a result of lack of need to reduce contact with elk, then eventual problem could be much larger in future and more costly to correct. |



## Compliance Status

Compliance with federal law and regulations is summarized in this section.

### **National Environmental Policy Act of 1969**

This *Tule Elk Management Plan and Environmental Assessment* provides public disclosure of the planning and decision making process and describes the potential environmental consequences of the proposed actions and alternatives are required by the National Environmental Policy Act. The document was made available to agencies and the public for comment for a period of 45 days from October 25<sup>th</sup> to December 12<sup>th</sup>, 1997. Comments received were considered, and the draft plan and environmental assessment was reviewed and revised in light of those comments.

### **Endangered Species Act of 1973**

The Endangered Species Act, Section 7, directs federal agencies to further the purposes of the act. The National Park Service is required to consult with the U.S. Fish and Wildlife Service (USFWS) to ensure that any action taken by the agency does not jeopardize listed species or their critical habitat. Informal consultation on threatened and endangered species has been ongoing at Point Reyes National Seashore, including a meeting with, and site visit by, USFWS personnel during 1997. The National Park Service will continue to consult with USFWS prior to implementing actions that could adversely affect listed species.

### **Section 106 of the National Historic Preservation Act of 1966**

Section 106 activities for planning are set forth by the Programmatic Agreement between the National Park Service, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers. Point Reyes National Seashore has conducted historic studies and evaluations, and recently updated its List of Classified Structures that describe historic properties within the Seashore. No activity described within this plan is expected to adversely impact historic properties under this act. The Seashore will continue to consult with the State Historic Preservation Officer on any actions potentially affecting historic properties.

## **Archeological Resources Protection Act of 1979**

The National Park Service will meet all its obligations under the Archeological Resources Protection Act at Point Reyes National Seashore. No archeological sites will be disturbed or excavated without appropriate permits. Unauthorized digging or damage to archeological resources will be prosecuted, and archeological site information will remain confidential.

## **Coastal Zone Management Act of 1972**

Under the Coastal Zone Management Act, federal projects must meet a consistency review and the Act requires that federal activities affecting the coastal zone must adhere to the state Coastal Zone Management Plans. All actions proposed by this plan are consistent with this act and the coastal zone plan for the Point Reyes area.





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## Consultation and Coordination

**P**oint Reyes National Seashore seeks to operate and conduct its management in full consultation and coordination with other federal, state, and local agencies, private organizations, and the interested public. Development of this plan and environmental assessment was conducted over a period of six months with as wide a distribution as possible to elicit cooperation and consultation. List of agencies and organizations consulted in preparation of this document included:

### Federal Agencies

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### State Agencies

California Department of Fish and Game, Sacramento, CA  
California Department of Agriculture, Sacramento, CA

### Advisory Commission

Point Reyes National Seashore Committee, Golden Gate/Point Reyes Citizens  
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### Interested Organizations

In Defense of Animals, San Rafael, CA  
Committee for the Preservation of Tule Elk, San Francisco, CA  
Rocky Mountain Elk Foundation, Colorado  
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## **Public**

Scoping was conducted during May and June 1997 and a total of 13 letters were received. Ten letters were generally supportive and three letters stated special concerns to be addressed.



## Glossary

The following descriptions of terms used in this plan were compiled from the scientific literature for additional explanation of complex concepts.

### **Adaptive Management**

- “States that rules and management criteria must be flexible enough to changing biophysical events and changing human goals. Because a continual change in ecosystem processes is accepted, it is important to realize that no one single management practice is adequate. Adaptive management does explicitly accept the fact that variation is embedded in ecosystems. Adaptive management means establishing measurable objectives, both in ecosystem function and social desires, increasing current levels of data gathering by managing scientifically (with controls), monitoring, and adjusting management practices to meet changes in ecosystem capacity or social demands. The demands being placed on many systems may result in environmental changes occurring at a rate that exceeds the adaptive capacity of many species so that management has to be flexible to deal with new information as it becomes available and adjust accordingly. It is extremely important that feedback loops are integrated into the ecosystem management structure and are kept flexible... It will help stabilize natural resource management by allowing incremental changes that are easier to work with, instead of major adjustments in practices every 30 years or so.” (From Vogt et al.1997)
- “This approach uses management itself as the experimental manipulation, but the essential requirement is that the manipulation is varied over a wide a range as possible. A variation of this approach is to use natural disturbances, particularly local extinctions and recoveries, as a way to understand the ecological influences of the herbivore.” (From Sinclair 1997)

### **Carrying Capacity**

- “‘Carrying capacity’ is the name we give to an equilibrium between animals and vegetation, and we index the position of that equilibrium by its characteristic density of animals... The system is interactive: rate of increase of herbivores is influenced by the density of edible vegetation, and the rate of increase of those plants is determined largely by the density of animals eating them. An equilibrium is finally achieved because the plants and the herbivores are pulling in opposite directions.” (From Caughley 1979)
- “Any definition of carrying capacity must imply a long-term stability of herbivore numbers, vegetation biomass, and community species composition; that is, biodiversity must be stable... Most definitions of carrying capacity are arbitrary rather than biological.... My intention is to show that a wide range of [definitions] exist... They include ecological carrying capacity... predator limitation... predator regulation... maximum sustained yield... rare species carrying capacity... timber harvest carrying capacity... cultural carrying capacity... and hunter opportunity carrying capacity.” (From Sinclair 1997)

### **Immunocontraceptive**

- “A contraceptive designed to raise antibodies in the target animal. These antibodies may prevent reproduction by inhibiting one of several reproductive hormones, or one of the proteins regulating sperm-ova binding.” (From McIvor and Schmidt 1996)

### **Porcine Zona Pellucida**

- “Zona pellucida material derived from the macerated ovaries of pigs. Zona pellucida is an extracellular layer surrounding mammalian eggs which remains around the embryo until it hatches in the uterus. The zp has receptor sites that regulate sperm penetration of the egg.” (From McIvor and Schmidt 1996)

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## Appendix A

This appendix contains the Memorandum of Agreement between state and federal agencies on Point Reyes tule elk approved in February 1998.

**MEMORANDUM OF AGREEMENT  
BETWEEN THE CALIFORNIA DEPARTMENT OF FISH AND GAME  
AND  
NATIONAL PARK SERVICE  
POINT REYES NATIONAL SEASHORE  
RELATING TO THE MANAGEMENT OF TULE ELK**

**ARTICLE 1—BACKGROUND AND OBJECTIVES**

WHEREAS, National Park Service (NPS) and the California Department of Fish and Game (Department) have entered into previous agreements concerning the management of tule elk at Point Reyes National Seashore; and

WHEREAS, A Congressional Joint Resolution (P.L. 94-38, 90 Stat.1189, 16 United States Code section 673e) authorizes the Secretary of the Interior to cooperate with the State of California in making their lands under their respective jurisdictions of Interior Agencies reasonably available for the preservation and grazing of tule elk in such manner and to such extent as may be consistent with Federal law and develop a plan for tule elk restoration and conservation that is integrated with the Department's Statewide Tule Elk Management Plan; and

WHEREAS, 16 United States Code section 1 provides the NPS with its purpose which "is to conserve the scenery and the natural and historic objects and the wildlife therein" and the National Park Service Management Policies (NPS 1988) provide overall guidance on the management of wildlife populations on National Park Service lands; and

WHEREAS, 16 United States Code section 1131 provides the NPS with overall direction for management of wilderness areas such as Tomales Point; and

WHEREAS, the NPS with the cooperation of the Department under a previous agreement, reintroduced tule elk within the wilderness area of Tomales Point; and

WHEREAS, the NPS and the Department have recognized the desirability of restoring tule elk to suitable former ranges of this species within central California; and

WHEREAS, the Department, under the laws of California, has legal responsibilities for the management of wildlife and its habitats within the State of California; and

WHEREAS, each of the agencies involved have developed recognized skills, expertise, and experience in tule elk and wildlife management; and

NOW, THEREFORE, both parties agree as follows:

**ARTICLE II--STATEMENT OF WORK**

A: The NPS agrees to:

1. Complete the environmental and historical compliance, including public meetings, necessary for the implementation of the tule elk management plan.
2. Protect and preserve the tule elk population at Tomales Point consistent with NPS policies which state: "The National Park Service will seek to perpetuate the native animal life as part of the natural ecosystem of parks."
3. Conduct research to determine population dynamics, impacts on special status species, carrying capacity, regulation methods, threshold levels, range utilization and monitor the extent of Johnes disease in the Point Reyes elk herd and overall population size. Research will be identified in and prioritized through the development of the long-term management plan and adaptive management strategies.
4. Maintain, as necessary, the tule elk enclosure of approximately 2,600 acres on Tomales Point.
5. Convene scientific panels, as needed, to provide advice and guidance with management of the tule elk.

B. The Department agrees to:

1. Supplement the initial reintroduction of two bulls and eight cows at Tomales Point with animals of appropriate age and sex, if deemed desirable by both parties.
2. Provide technical services, including veterinary service, if necessary as determined by the Department, in the management of the tule elk herd.
3. Assist NPS in removing from Tomales Point all tule elk determined to be in excess of the established maximum carrying capacity for the enclosure, if deemed desirable by both parties.

4. Assist NPS in live-capture of elk for research and removal by direct and other means of reducing the elk population to an acceptable level below maximum carrying capacity at such suitable intervals as may be determined in the management plan.
5. Assist, if deemed desirable by both parties, with research related to tule elk management at Point Reyes.
6. Assist in overall annual surveys of the elk population.

**C. Both agencies agree to:**

1. Assist in the development of the long-term management plan for tule elk at Point Reyes National Seashore.
2. Evaluate the feasibility of reintroductions of tule elk to other locations using criteria for relocations as established by the Interagency Tule Elk Task Force. It is furthered agreed the sites will be compatible with the long-term goal of having free-ranging tule elk.
3. Make available to the other party any documents, reports, and information related to the management of tule elk.
4. Provide an overall liaison authorized to exchange information, assist with the development of study techniques, and attend joint meetings regarding tule elk management and research at Point Reyes National Seashore.

**ARTICLE III--TERM OF AGREEMENT**

- A. Unless earlier terminated pursuant to Article VIII, this Agreement shall become effective on the date of final signature, and shall continue in effect for a period not to exceed five years.
- B. This Agreement may be modified only by the written agreement of both parties.

**ARTICLE IV--KEY OFFICIALS**

**For the NPS:**

**Don L. Neubacher**  
Superintendent  
Point Reyes National Seashore  
Point Reyes, CA 94956

**Frank Dean**  
Assistant Superintendent  
Point Reyes National Seashore  
Point Reyes, CA 94956

**Bill Shook**  
Chief of Resource Management  
Point Reyes National Seashore  
Point Reyes, CA 94956

**For the Department:**

**Terry M. Mansfield, Chief**  
Wildlife Management Division  
Department of Fish and Game  
1416 Ninth Street  
Sacramento, CA 95814

**Brian Hunter, Regional Manager**  
Department of Fish and Game  
Post Office Box 47  
Yountville, CA 994599

No changes in key officials shall be made by either the NPS or the Department without written notification. The notification shall include an explanation in sufficient detail to permit evaluation of the impacts of such a change on the STATEMENT OF WORK as contained in ARTICLE II. Specific project coordinators shall be designated by the NPS and Department for each activity and project issued under this Agreement.

**ARTICLE V--PROPERTY UTILIZATION**

Not applicable.

**ARTICLE VI--PRIOR APPROVAL**

Not applicable.

**ARTICLE VII--REPORTS AND DELIVERABLES**

Delivery of all reports and documents required by Article II above shall be made as follows:

Place of delivery for the NPS:

Don Neubacher  
Superintendent  
Point Reyes National Seashore  
Point Reyes, CA 94956

Place of delivery for the Department:

Brian Hunter, Regional Manager  
Department of Fish and Game  
Post Office Box 47  
Yountville, CA 994599

**ARTICLE VIII--TERMINATION**

This Agreement can be terminated at any time and by any party. Any party desiring to terminate this Agreement must provide thirty days written notice to all other parties.

**ARTICLE IX--GENERAL AND SPECIAL PROVISIONS**

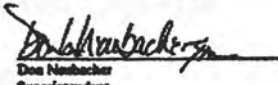
- A. During the performance of this agreement, the participants agree to abide by the terms of USDI-Civil Rights Assurance Certification, non-discrimination and will not discriminate against any person because of race, color, religion, sex or national origin.
- B. No member for delegate to Congress, or resident Commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this Agreement if made with a corporation for its general benefit.



**ARTICLE X—AUTHORIZING SIGNATURES**

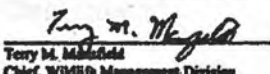
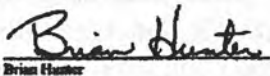
IN WITNESS WHEREOF, the parties hereto have signed their names and executed this Memorandum of Agreement.

**National Park Service**

|  |                       |
|--|-----------------------|
| <br>Don Neubacher<br>Superintendent | <u>2/4/98</u><br>Date |
|--|-----------------------|

\_\_\_\_\_  
(signed) \_\_\_\_\_ 2/4/98  
Don Neubacher Date  
Superintendent

**Department of Fish and Game**

|  |                        |
|--|------------------------|
| <br>Terry M. Mansfield<br>Chief, Wildlife Management Division | <u>2/20/98</u><br>Date |
| <br>Brian Hunter<br>Regional Manager                          | <u>2-13-98</u><br>Date |

\_\_\_\_\_  
(signed) \_\_\_\_\_ 2/20/98  
Terry M. Mansfield Date  
Chief, Wildlife Management Division

\_\_\_\_\_  
(signed) \_\_\_\_\_ 2/13/98  
Brian Hunter Date  
Regional Manager

## Appendix B

The following alternatives were developed as part of the public scoping document for the 1992 environmental assessment *Control of Tule Elk Population at Point Reyes National Seashore*. While it was withdrawn from the approval process, the draft assessment and the response by the public helped formulate policy and direct strategies for tule elk at Point Reyes National Seashore.

### **Control of Tule Elk Population at Point Reyes National Seashore (1992)**

#### **Alternatives**

##### **1. No Action**

No effort is made to control the population of the elk herd at Tomales Point. Using the population model developed by Gogan, the herd will continue to increase at a near exponential rate. The elk population would temporarily exceed the carrying capacity of the range, perhaps by a considerable amount.

##### **2. Remove Fence and allow elk to disperse.**

With the Tomales Point fence removed, elk would initially disperse to the south. Eventually elk may migrate beyond the boundaries of the Seashore.

##### **3. Create additional fenced reserves within the Seashore.**

Additional acreage elsewhere within the Seashore could be fenced off and a number of elk could be transplanted to the new range. This would require the construction of additional elk fences.

##### **4. Relocate excess elk to areas outside the Seashore.**

As called for in the April 27, 1974 Memorandum of Understanding (this MOU has expired), California Department of Fish and Game (DFG) would remove any elk determined to be in excess of the maximum carrying capacity.

##### **5. Allow Public Hunting to reduce the number of elk.**

A public hunt, regulated by DFG, would harvest elk on a yearly basis so that the carrying capacity of the elk range is not exceeded.

**6. Remove excess elk on a yearly basis.**

After the fall census is conducted, the number of elk to be removed is determined. Rangers or individuals under cooperative agreement or contract, reduce the number of elk necessary to bring the population down to carrying capacity.

Option A: Elk shot near roads will be removed and delivered to non-profit charity for use as food resource.

Option B: All elk carcasses would be recovered and donated to charity.

Option C: Contract recovery of elk carcasses, and donated to charities.

Option D: Cooperate with Native Americans to recover elk carcasses. The Native Americans may keep a portion of the meat recovered and the remainder of the meat is donated to charities.

**7. Reduce the reproductive rate of the elk currently within the Seashore.**

Reduction of reproductive rates of the elk herd may be accomplished by one of two methods. Sterilization would require intensive surgical procedures, involving capture, anesthesia and field surgery. A second method to reducing the reproductive rates would involve the remote delivery of chemical-contraceptives.

**8. Introduce additional predators.**

Wolves (non-natives) could be introduced and/or additional mountain lions (native) could be relocated in order to control the elk population.

## Appendix C

This appendix extracts the "Concluding Remarks" and "Recommendations" sections from the *Report of the Scientific Advisory Panel on Control of Tule Elk at Point Reyes National Seashore*, dated October 18, 1993.

### CONCLUDING REMARKS

We recognize that this report leaves many issues unresolved. This is because the current status of the elk population is uncertain, and the future trends not entirely predictable. Only better information and time will address the fundamental issue: will the tule elk herd on Tomales Point naturally regulate or is active management required? We cannot give a prescription at the present time. The best we can do is to lay out the alternatives and recommend a course of action that will address alternate outcomes of this experiment in population growth. The crisis stage has not yet been reached, but the time to act is now. There are no perfect solutions and good information and hard work are necessary to establish the best program, taking into account NPS policies and public acceptance.

The NPS faces some difficult problems. How can elk impacts on critical areas be measured, and what threshold (that if exceeded, active intervention is indicated) should be adopted? Only careful study of specific impacts can address these issues. And, should active intervention prove to be required, is it preferable to maintain a large population near carrying capacity, or a smaller population well below carrying capacity? Clearly the method of control will strongly influence the choice.

## **RECOMMENDATIONS:**

1. We recommend that the elk herd be permitted to self-regulate with regard to population size unless some predefined threshold of impact upon habitat has been exceeded. We strongly recommend that the NPS establish the habitat impact threshold as soon as possible. Threshold criteria could be based upon:

- a) a reduction in residual dry matter in critical areas below the levels that would protect the soil,
- b) excessive localized impacts such as trailing in localized critical areas, and
- c) excessive impact on threatened and endangered flora and fauna.

Without this standard, there is no basis for determining whether active management (e.g. culling or contraception) or passive management (e.g. natural population regulation) is appropriate.

The consequences of not establishing a threshold are possible excessive damage to the habitat and natural systems that are incompatible with the NPS goals for management of Tomales Point.

2. We view the integrity of the ecosystem as the predominant goal of elk management. Therefore, we recommend that if necessary, agency culling be employed as the ultimate control method to hold elk numbers to the predefined habitat impact threshold. If alternative controls can be achieved, either by natural regulation, translocation or contraception, culling may not be necessary.

3. The only current management technique available for controlling the elk population is agency culling of animals assuming that public hunting is not an option. Translocation and reproductive control are both potential management techniques but cannot be implemented at present due to a lack of baseline information. Therefore, we recommend implementation of the following research initiatives to increase management options.

- a) Establish a pilot study to assess the feasibility of utilizing contraceptives as a means of population control.
- b) Initiate a program of fecal culture and necropsy to establish the current status of Johne's and other important livestock diseases in the population. This is required in order to evaluate the feasibility of translocation of animals outside of the National Sea Shore.

4. We recommend that the habitat and animal monitoring programs be expanded. This is essential to establish the validity of the current estimate of range carrying capacity of 350 animals and the feasibility of population control with contraceptives. The plant monitoring program needs to include critical areas, e.g. areas of high physical impacts, water sources and threatened and endangered plants. Better information on total size of the herd and the sex/age composition need to be obtained. For example, changing the survey date and implementing ground surveys to obtain sex/age composition would help achieve this goal.
5. We recommend the addition of 2-3 female elk every elk generation to maintain genetic variation within the population. The first addition of new elk should be made as soon as possible.
6. The long-range goal of elk management at PRNS should be the re-establishment of free-ranging elk throughout the seashore and associated public lands. This would involve elimination of exotic cervids and removal of the fence across Tomales Point. NPS and CDFG should develop a long-range management plan with the goal of achieving a large, healthy, free-ranging elk population subjected to a minimum of management intervention.

## Appendix D

In this appendix is extracted the alternatives given in the environmental assessment titled *Live Capture and Population Dynamics Study of Tule Elk at Point Reyes National Seashore* dated October 18, 1995.

### Alternatives

#### **A. Proposed Action - Implement a comprehensive, scientifically sound program of ecological monitoring for Tomales Point and the Tomales Point tule elk herd.**

The proposed action entails a minimum of four coordinated studies, with the potential for additional components. The main objective of the monitoring plan is to: 1) determine the population size, population and reproductive dynamics, age/sex structure and spatial utilization of the tule elk, 2) establish an ecological impact threshold for Tomales Point, 3) determine the impact upon the endangered Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) and 4) evaluate exotic disease and the reproductive biology of tule elk for possible hormonal contraceptive testing. The National Park Service (NPS) and the National Biological Service (NBS) will conduct item 1 over a five year period and item 2 over a two year period. Myrtle's silverspot ecology, item 3, will be implemented by the Center for Conservation Biology, Stanford University over two years. The fourth component, hormonal receptivity to immuno-contraception and exotic disease evaluation, will be accomplished by a group of researchers from University of California at Davis.

The first component of the elk monitoring program will be implemented in the fall of 1995 with the capture, marking and release of 20 female elk. A combination ground and aerial census will be conducted in the fall of the year to determine minimum population size (Beyer and Golightly 1994). Elk will be located by aerial search and immobilized by the use of a ballistic net (net-gun) deployed from a light helicopter. Helicopter net-gun capture has been used on a variety of ungulate species ranging from antelope to Rocky Mountain elk, and has been demonstrated to present the least risk of injury to animals in relation to other capture methods. In a study of desert bighorn sheep, net gunning was employed to capture 137 sheep with a loss of only 1 animal (0.7%) to capture myopathy and 2 animals (1.5%) to injury. (Jessup et al. 1988). In a similar capture operation for white-tailed deer, one animal (0.1%) died as a result of injury (Potvin and Laurier 1988). By comparison, in a Texas study of desert mule deer captured with projectile dart administered immobilizing drugs, 15% of all captured deer suffered mortality within 24 hours (Krausman et al 1987). Animal loss must be considered as a possibility in the capture and restraint of any wildlife. The method chosen statistically offers the shortest stress period on animals with the statistically demonstrated minimum mortality rate.

Captured elk will be fitted with breakaway radio collars to allow long-term monitoring of movement and habitat utilization. At the time of capture, biological samples will be taken to evaluate general health, genetics and presence/absence of livestock disease. Marked tule elk individuals will be monitored continually utilizing radio telemetry to determine habitat utilization, social grouping and reproductive status. Marked elk bearing offspring will be located and calves will be captured utilizing hand nets and fitted with radio-transmitter ear tags to facilitate tracking. Calves will be followed for the duration of the project to determine calf mortality and recruitment rate. In the fall an additional 20 female elk will be captured and tagged to increase the sample size and improve the statistical strength of the study

In years two and three of the monitoring program a study will be implemented to determine the ecological threshold beyond which impacts occur which could degrade the overall quality of habitat on Tomales Point. This ecological threshold would be one of the measures used to determine the point at which elk population size has exceeded the capacity of the habitat. Paralleling this study will be an evaluation of the population distribution and habitat usage of the Tomales Point elk reserve by the endangered silverspot butterfly. This monitoring program will aid in the evaluation of this species within Point Reyes National Seashore and in determining the affect of an increasing elk population upon silverspot viability.

**B. No Action**

A no action alternative would allow tule elk to follow population cycles within the Tomales Point elk reserve without manipulation or intervention. Monitoring activities would be limited to annual census. Habitat information beyond minimal species composition and forage utilization would not be acquired. The actual or potential impact upon the endangered Myrtle's silverspot butterfly would remain unknown.

**C. Capture and Release Tule Elk through Chemical Restraint**

This alternative is identical to alternative A. with the exception that 20 female elk would be captured, marked and released utilizing tranquilizer drugs administered by projectile dart.

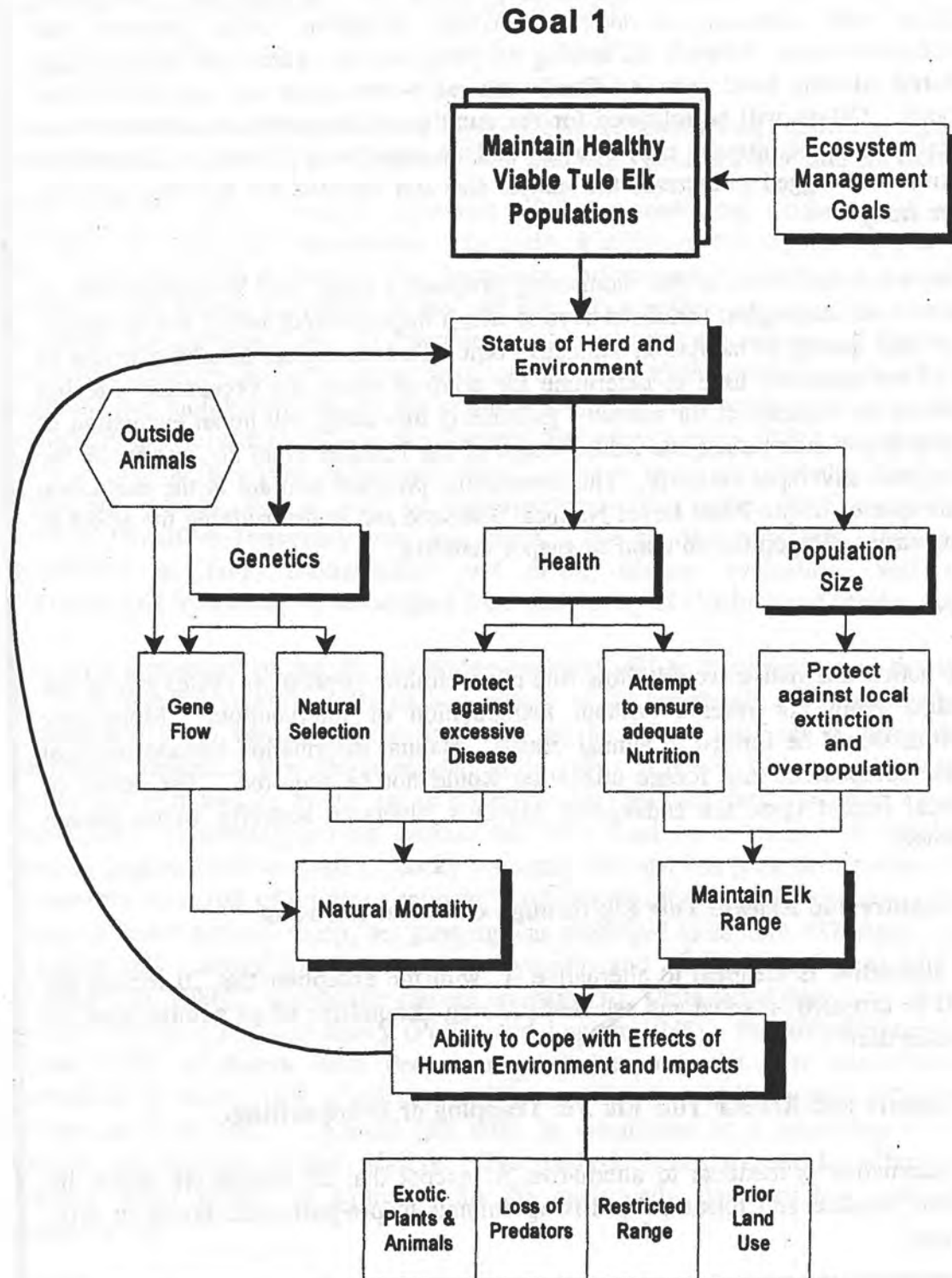
**D. Capture and Release Tule Elk Via Trapping or Drive-netting.**

This alternative is identical to alternative A. except that 20 female elk would be captured, marked and released by driving animals to pre-positioned corral or drop net traps.



# Appendix E

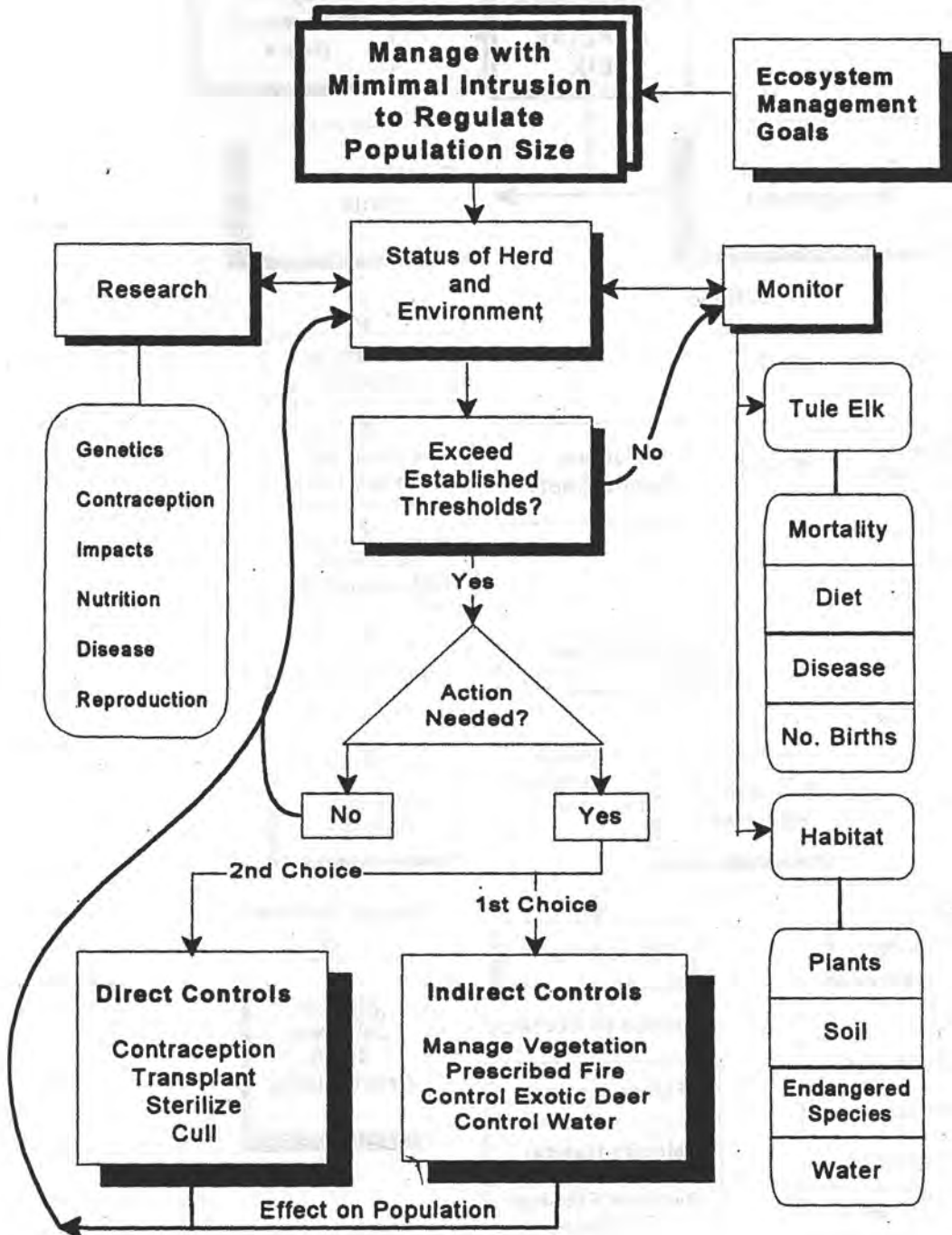
Flow chart of Goal 1: Maintain viable and healthy populations of tule elk at Point Reyes. See text starting on page 39.



# Appendix F

Flow chart summary of Goal 2: Manage tule elk using minimal intrusion to regulate population size, where possible, as part of natural ecosystem processes. See text starting on page 40.

## Goal 2



# Appendix G

Flow chart for Goal 3: Provide for a free-ranging herd in Point Reyes by 2005, over as large an area as is feasible. See text starting on page 40 for further explanation.

