
SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

CHAPTER FOUR ENVIRONMENTAL EFFECTS

Introduction

This chapter describes the environmental consequences of implementing each alternative described in Chapter Two. In addition this chapter will analyze whether the actions proposed in this analysis will impair park resources. Discussion on “Impairment of Park Resources or Values”, as required by National Park Service Management Policies (NPS, 2000b) and Director’s Order 12 (Conservation Planning, Environmental Impact Analysis and Decision –making), is provided as a separate section at the end of this Chapter.

The environmental consequences or environmental effects will be categorized in three broad areas. The three categories of effects are direct, indirect, and cumulative. These “effect” categories will form the basis of the effects analysis in this chapter.

Direct effects, as defined by the Council on Environmental Quality, are those that are caused by the action and occur at the same time and place. Indirect effects are those that are caused by the action and are later in time or farther removed in distance. Cumulative effects are

those that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative impacts analysis will consider effects of past ranching on the ecosystem, spread of non-native weedy plants, restoration of endemic island fox, and protection of archeological sites.

For this section the duration and intensity of an effect (impact) will generally be described by using the following terms:

- Negligible – When an impact is localized and not measurable or at the lowest level of detection.
- Minor – When an impact is localized and slight but detectable.
- Moderate – When the impact is readily apparent and appreciable.
- Major – When the impact is severely adverse and highly noticeable.

Connected Actions

It has been determined that fennel control or manipulation is a connected action to the proposed pig eradication actions. NEPA describes connected actions as those that “cannot or will not proceed unless other actions are taken previously or simultaneously”. Because of the density and extent of the fennel on the isthmus of SCI, substantial reduction of the fennel would likely be necessary to successfully eradicate pigs from this area. Without the reduction of fennel in this area, successful islandwide pig eradication would be compromised. Because fennel control or manipulations are likely necessary actions they have been included as part of all action alternatives (Alternatives Two-Four).

As connected actions, the analysis of effects will be evaluated for each separate action (fennel control and pig eradication) as well as the combined effects of implementing both actions. In addition, the Park has identified other “past, present, and reasonably foreseeable future” activities that are considered in the cumulative impact analysis.

Past, Present, and Reasonably Foreseeable Future Activities

NEPA requires that cumulative effects be considered as part of the environmental effects analysis. CEQ (40CFR1508.7) defines cumulative effects as: “*the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions*”. Described below are past, present and reasonably foreseeable future activities that have been or will take place on Santa Cruz Island.

Past Activities

Human occupation of Santa Cruz Island began approximately 9,000 years ago. European exploration began in the mid 1500’s with actual European occupation occurring in the mid 1800’s. It is during this period that much of the decline in the native plant communities began due to the sheep and cattle ranching that was introduced at that time. At their peaks there were at some point in time during this era an estimated 50,000 sheep and between 1,000-7,000 cattle on Santa Cruz Island (Brenton and Klinger 1994). It was also during this period that pigs were introduced to the island. During this era significant vegetation type conversion from native woodland and shrubland to non-native grasslands occurred. The rapid removal of cattle and sheep are also thought to have played an important role in the large fennel expansion that occurred on Santa Cruz Island. Between 1981-1988 The Nature Conservancy removed 36,000 sheep and 1,500 cattle, the latter were removed in a 6 month period in 1988 (Benton and Klinger 1994). The NPS removed 9,270 sheep from the east-end between 1997 and 1999.

The Nature Conservancy was also active since 1990 to find the best way to treat fennel on the island. Two large studies (Dash and Gliessman 1994; Erskine unpublished data) were initiated by TNC during this decade and were used as the basis for the fennel control protocols proposed in this analysis. Erskine’s study was initiated in 1997 and treated most of the fennel in the east portion of the Central Valley. Present Activities

Present Activities

Current management of the island is divided between the National Park Service who own the east end of the island (24%), and The Nature Conservancy who owns the central and western ends of the island.

NPS

Present NPS management (1997-present) of Santa Cruz Island has implemented five major projects. These project include: 1) temporary administrative housing construction within Scorpion drainage; 2) Scorpion Ranch restoration due to the Scorpion Flood (1997); 3) Scorpion Pier reconstruction; 4) sewage disposal system in Scorpion Valley; and 5) Prisoners Pier reconstruction (ongoing). Each of these projects had or will have limited resource impacts other than those impacts within the local vicinity of the project. Indirect impacts of rebuilding the Prisoner's Pier may increase visitor use to the NPS-owned isthmus. The Park has also opened a trail system that goes from Prisoners Harbor to Scorpion Anchorage. Along this trail is a backcountry campground near Del Norte Ranch. Increased visitor use will be incorporated into the cumulative effects discussion where appropriate.

The Nature Conservancy

Present activities associated with The Nature Conservancy include continued resource management, continued research and monitoring of island resources, and continued conservation work including removing fennel, and continued fund raising and teaching throughout its property.

In the Spring of 2002 The Nature Conservancy, at the request of the California Department of Fish and Game (CDF&G), permitted a limited sport hunt of pigs from the island. The hunt was one of several hunts offered by the CDF&G and is covered under the CDF&G's Wild Pig Plan. The limited sport hunt has no relation to the eradication activities proposed in this analysis. The short-term reduction of pigs that result from the pig hunt will have little effect on reducing long-term pig population or reducing the ongoing pig damage to resources on the island.

Future Activities

National Park Service

General Management Plan

The General Management Plan provides the basic guidance for the Park on how it will manage protection of Park resources, visitor use, and facility development. The current GMP (1980) provides the guidance for the activities proposed in this analysis, this GMP is out of date in many respects and is being revised. Revision of the 1980 GMP is currently underway as part of a multiyear process. For Channel Islands National Park this public process officially began in November 2001 with a series of public meetings held in Santa Barbara, Ventura, Oxnard and Los Angeles. Because it is not known which management policies might change as a result of the GMP revision process, this process will not factor into the cumulative effects analysis. Tiered from agency wide NPS policy, the revision of the GMP will likely include removal of exotic species as a management goal as it has in the past.

Golden Eagle Removal and Bald Eagle Re-establishment

The Park, in association with TNC, is collaborating their efforts to remove golden eagles from Santa Cruz Island. Park biologists have verified that the decline of the Island fox population on San Miguel, Santa Rosa, and Santa Cruz Island is due primarily to predation by golden eagles. The Park will be collaborating with other organizations to study the feasibility of restoring bald eagles to the northern Channel Islands. Study activities regarding bald eagles are expected to begin in 2002 and continue for five years, at which time an evaluation and determination will be done on whether to implement a reintroduction program. The bald eagle study on Santa Cruz Island is being funded

by settlement monies from the Montrose DDT lawsuit.

Fox Recovery

The island fox (*Urocyon littoralis*) occurs on Santa Cruz Island. In December, 2001, the U.S. Fish and Wildlife Service proposed for listing as endangered four subspecies of the island fox, including the Santa Cruz Island subspecies (*U. l. santacruzae*). A final rule listing those subspecies as endangered could become effective as early as December, 2002. A draft recovery plan has been prepared and will likely be adopted as part of a USFWS recovery plan for the species, should the species be listed.

The current status of foxes on Santa Cruz Island indicates that captive breeding is warranted for that island fox population. In 2001 eight radio collared island foxes died from golden eagle predation, and recent monitoring suggests there are only about 50-60 adult island foxes on the island. This population is too small to persist over time. Therefore in 2002 NPS and TNC will work to establish captive breeding for island foxes on Santa Cruz.

Control of pigs on NPS Property

Until the pigs are eradicated on NPS property, NPS will continue, as it has in the past, to control pigs in order to protect sensitive cultural and natural resources, visitor safety and enjoyment, and facilities.

The Nature Conservancy

The Nature Conservancy's future actions on Santa Cruz Island are focused primarily on collaborating with the Park to eradicate pigs from the island. As a matter of course, TNC will continue to conduct resource management activities, research and monitoring of island resources, and conservation work including removing fennel, and continued fund raising and teaching throughout its property.

Chapter Organization

This Chapter is organized so as to display environmental effects by Alternative. The four Alternatives appear as major headings (headings are within boxes with white font text). For each Alternative there is an "effects" discussion (effects analysis) for each environmental issue. Each alternative will include the following effects analysis:

- Effects of Implementing Fennel Control
- Effects of Implementing Pig Eradication

Following the discussion of direct and indirect effects of implementing fennel control and pig eradication, a separate section will discuss the cumulative impacts. The "cumulative impacts" section will take into consideration the cumulative effects of implementing fennel control, pig eradication, and other "reasonably foreseeable" activities. An outline of a typical Alternative section will be as follows:

The "effects" discussion will be limited to only the environmental issues that were raised during internal and external scoping. Issues dismissed from analysis can be found in Chapter Two. The scope and indices for measuring environmental impacts for each environmental issue can be found in the section titled, "Significant Environmental Issues", Chapter Two.

Alternative

Environmental Issue

- Effects of Implementing Fennel Control (direct and indirect)
 - Fire Effects
 - Herbicide Effects
- Effects of Implementing Pig Eradication (direct and indirect)
- Cumulative Effects

Alternative One: No Action

Issue 1: Likelihood of Achieving Success

Effects of Not Implementing Fennel Control

It has been determined that fennel control is a necessary component of the Santa Cruz Primary Restoration Plan. The fennel control strategy that is recommended for this project is the minimum set of actions that are needed to reduce fennel cover. Since Alternative One would not enact these minimum control activities, fennel cover would either be maintained or most likely increase because pigs would still be present to disturb soil and spread fennel seed.

NPS management of the fennel problem on NPS-owned lands would be evaluated in light of weed control priorities park-wide. NPS fennel control would occur within current funding and personnel constraints. This level of treatment would not meet the restoration goals set for this project. Furthermore, the largest fennel infestation is now on NPS-owned lands, and NPS would not be able to take full advantage of the extensive TNC sponsored fennel research to treat this large infestation.

TNC, as a private landowner, has invested considerable resources (Central Valley Fennel Control Project) researching the most effective way of controlling fennel on the island. As a result, TNC would likely continue their efforts to control fennel on owned lands (Aschehoug pers. comm). However, TNC would always have to be on guard to keep fennel in check because pigs would still be present islandwide and the large fennel infestation on NPS land would continually supply fennel seeds.

Effects of Not Implementing Pig Eradication

Under this alternative NPS would take no action to eradicate feral pigs from NPS-owned portions of Santa Cruz Island. Likewise, TNC would likely not take the extensive and expensive actions to eradicate pigs on their lands in the near future. TNC would likely implement a control program to protect sensitive resources. A control program would not meet the objectives set forth in this analysis.

Direct and Indirect - This alternative fails to meet the objective of pig eradication, the most destructive disturbance agent on the island. The goal of protecting island resources could not be met if pigs are not eradicated from the island. The effects of not eradicating pigs islandwide would have detrimental affect on cultural and natural resources. These effects are described throughout the rest of this chapter.

Issue 2: Vegetation Impacts

Native Communities

Effects of Not Implementing Fennel Control

It is estimated that fennel covers 10% of Santa Cruz Island (Klinger unpublished data). Fennel researchers have found that fennel expands best into areas that have been disturbed. The largest single fennel infestation is on the isthmus of Santa Cruz Island, an area that was heavily grazed by cattle. Fennel continues to expand into areas that have been disturbed by feral pigs. Fennel is more likely to expand into disturbed grassland habitats. Grassland habitats dominate the vegetation types on the east portion of Santa Cruz Island. As feral pigs continue to root in these areas fennel continues to expand. The existing 1,800 acres of fennel could double in acreage with unchecked feral pig disturbance in east-end grassland habitat. Fennel is less

likely to invade shrub communities (Beatty and Licari 1992).

Fennel is a highly invasive weed in disturbed areas. In the absence of disturbance the rate of spread of fennel is less than with disturbance. Alternative One would continue to allow disturbance by pigs. Pigs on Santa Cruz Island are the main vector for spread of fennel. Failure to control pigs would result in substantial spread of fennel across the island. Areas infested with fennel, when left untreated, and continually subjected to disturbance, would likely form dense fennel stands that are nearly void of native plants.

Fennel would continue to invade disturbed communities of Santa Cruz Island crowding out native forbs. Invasive forb species such as yellow star thistle (*Centaurea solstitialis*), tocalote (*Centaurea melitensis*), hoary cress (*Cardaria draba*) and a variety of other Brassicaceae and other species would also take advantage of pig rooting disturbance and spread throughout native plant communities.

Effects of Not Implementing Pig Eradication

Under this alternative, the park would not eradicate feral pigs from any portion of Santa Cruz Island. Their population numbers would continue to rise and fall with the seasonal and long-term availability of food sources. Feral pigs would continue to impact the native island vegetation including endemic and federally listed plant species.

Impacts to native plants and native plant communities by introduced alien herbivores have been well documented in the literature (Sauer 1988; Hochberg et al 1980; DeBenedetti 1987; Painter 1993; Fleischner 1994; and Orodho et al. 1990). Similar impacts have been noted with regards to feral pigs (Brumbaugh 1980; Chipping 1993; and Peart et al. 1994).

Feral pig numbers on Santa Cruz Island are known to oscillate widely between climatic episodes. During the drought years of the early

1990's in California, feral pig numbers on Santa Cruz Island were estimated to be less than 1,000. Under normal rainfall years and with sheep present only on the eastern portion of the island, feral pig numbers on Santa Cruz Island have been estimated to be as high as 5,000 (Aschehoug, personal communication). When The Nature Conservancy (TNC) removed feral sheep from the main portion of the island, the feral pig population increased and degradation of many of the island ecosystems continued (Peart et al. 1994). With the recent removal of the remaining sheep from east SCI, the average feral pig numbers could increase.

The feral pig population on Santa Cruz Island will even vary over the course of a year. Numbers normally rise in the spring and summer when food is widely available and then drop dramatically in the fall and winter when food becomes scarce and starvation becomes commonplace (Aschehoug, personal communication).

In California, from 1956 through 1991, approximately 750,000 feral pigs were harvested statewide (Peart et al. 1994). These numbers are not surprising given that feral pigs have an extremely high reproduction potential. Conservatively, with plentiful food, feral pigs can be expected to double their numbers at least twice a year (Peart et al 1994).

The amount of disturbance caused by feral pigs would vary by community depending on access, shelter, water sources, and food availability. Those communities providing adequate water, abundant food sources and shelter would probably incur the most use.

Monitoring of feral pig activities on Santa Cruz Island revealed that they preferred terrain close to cover and north-facing slopes, especially during the dry season. This may have to do more with thermoregulation rather than predator avoidance. Because pigs do not have sweat glands, they are more likely to seek moist, shaded areas during the warm summer and fall months (Sterner 1990). Feral pigs also preferred sites close to water regardless of the season, and

they avoided the highest and steepest slopes (Sterner 1990). Similar habitat use has been observed in other parts of the country. In Texas, feral pigs prefer moist habitats when available, with pig distribution limited primarily to bottomland areas (Synatzske in Hellgren 1993).

Although feral pigs on Santa Cruz Island appear to inhabit at least ten of the island communities (Baber 1982), chaparral and oak woodland seem to be the preferred habitats (Sterner 1990). Correspondingly, another study found that feral pigs on Santa Cruz Island preferred chaparral and oak woodland in the dry season and grassland in the wet season (Van Vuren 1984).

Pigs are omnivorous but, in the U.S., tend to have a definite pattern of diet staples throughout the course of a year. In the spring, feral pigs feed on grasses and forbs, followed by fruits and nuts in the summer and fall. Roots, tubers, and invertebrates are consumed throughout the year (Springer, Wood and Roark, Sweeny and Sweeny, Baber and Coblenz in Hellgren 1993). This pattern seems to solely depend on the availability of different food sources.

Direct Effects - Documented direct effects on plant communities by alien herbivores, including feral pigs, are reduction in native species cover, density, and biomass. Alien herbivores and feral pigs have also caused the elimination of the soil litter layer and loss of seed banks, increased soil disturbance, and soil compaction, and lowered or altered rates and patterns of nutrient cycling (Coonan et al. 1996).

On Santa Cruz Island, acorns and island cherries (*Prunus illicifolia ssp. lyonii*) are preferred diet staples (Schuyler 1988) during the time of year they are available. Feral pig consumption of acorns can reach nearly 100 % (Barrett 1990). This level of use has contributed to the almost complete annual reproductive failure for island oak species on SCI. Without adequate reproduction, as the mature older trees die out, entire stands of oaks could be lost. When comparing fenced exclosures versus unfenced study plots on Santa Cruz Island,

during normal rainfall years, oak seedling abundance was 85% in the fenced exclosures and only 15% in the open, unfenced plots (Peart et al 1994). There was no significant difference in seedling counts between the fenced and unfenced treatments on the island during drought years (Peart et al 1994). On Santa Cruz Island, only drought stress and feral pigs are known to inhibit oak and woody species regeneration (Peart et al 1994).

In Texas, Synatzske found that feral pigs would concentrate in areas of mast-producing trees (in Hellgren 1993). Although acorns and island cherries are a large part of the feral pig diet on Santa Cruz Island, they are also known to feed on manzanita berries, roots and tubers, and insects (Burhans in Peart 1994). Barrett (1978) found that brodiaea (*Brodiaea spp.*) bulbs are also a preferred food item for feral pigs. A similar species on Santa Cruz Island, wild hyacinth (*Dichlostemma capitatum*), found in grasslands, chaparral, and coastal sage scrub also appears to be actively consumed by feral pigs (Chaney, personal communication). In at least two 6-year old exclosures on SCI, mature plants of onions (*Allium spp.*) and wild hyacinth (*D. capitatum*) have increased exponentially since feral pigs were excluded (Wilken 2000).

When rooting for tubers, corms, or bulbs, feral pigs can till up the soil over a large area to a depth of 2-feet. In a study comparing fenced pig exclosures with unfenced areas on Santa Cruz Island, feral pigs disturbed up to 85 % of the surface area in an unfenced study site (Peart et al 1994). In Hawaii, with the loss of vegetative cover, areas of pig-caused disturbance lead to increased soil erosion and facilitated the spread of non-native, disturbance-adapted plant species (Spatz and Mueller-Dossbois in Hellgren 1993). Feral pigs can also facilitate the spread of invasive, non-native plant species by carrying the seeds on their fur and in their digestive tract. These seeds are then deposited in the freshly churned soil. Once established in an area, invasive non-native species can outcompete native plant species for available resources.

In searching for food and shelter, feral pigs create winding trails through all plant communities. These paths compact the soil and contribute to increased water run-off and erosion. These paths can also serve as routes for the spread of invasive, non-native plants species. Where they intersect maintained park trails, these extraneous pig trails can also lead visitors astray (Willy 1987).

Indirect Effects - Documented indirect effects of alien herbivores and feral pigs to plant communities include the increase of cover, frequency, and biomass of non-native plants species, increased water run-off and soil erosion, and degradation of soil structure. Feral pigs have also contributed to changes in the soil microflora and microfauna, and the potential loss of fire-induced successional communities due to inadequate fuels and lack of seed banks (Coonan et al. 1996). In Tennessee, indirect effects associated with feral pigs included setting back or speeding up plant succession, consumption of natural seed crops to the point of impeding reproduction, limiting species composition and quantity of vegetation, encouraging erosion and physical damage to trees (Hellgren 1993).

Disturbances caused by feral pig rooting and movement through island vegetation may facilitate the spread of non-native, invasive plant species. Once established these species have demonstrated the ability to expand at the expense of native plant species (Sauer 1988). Additionally, many of naturalized exotic plant species found on Santa Cruz Island have co-evolved with the grazing pressures exerted by large herbivores. They have adaptive mechanisms, which allow them to avoid being grazed or to better survive the impacts of grazing. These exotic plant species have expanded in the presence of feral sheep and cattle on Santa Cruz Island at the expense of the island's native flora. The presence of feral pigs would clearly benefit these species.

Continued pig disturbance would be the most prevalent vector for invasion by Mediterranean annual grasses. There is no

evidence either way that feral pigs have a positive or negative impact on native perennial grasses. If rooted extensively, native perennial bunch grasses would likely die, which would decrease the already depauperate native bunch grass communities.

With the constant disturbance by pig rooting, native shrub communities would continue to become invaded with these noxious weed species, and some native shrub communities would be out-competed (i.e. coastal sage scrub) and removed from the system.

Microbiotic flora or crusts are a critical component of many of the arid and semi-arid rangelands throughout the North American west (Johansen 1986). These crusts are found throughout the world and are known to occur on Santa Cruz Island. Cyanobacteria make up the majority of the microbiotic crusts but lichens, mosses, green algae, microfungi, and bacteria are present as well. These soil crusts significantly modify the surfaces on which they occur and can represent 70-80 percent of the living ground cover (Belnap 1994). Soil crusts are known to be important in nitrogen fixation, enhancing vascular seedling establishment, and reducing soil erosion (Snyder and Wullstein 1973, St. Clair et al. 1984, Bailey et al. 1973).

Several studies have shown that soil crusts are severely impacted by the trampling associated with grazing (Rogers and Lange 1971, Kleiner and Harper 1977, Brotherson et al. 1983, Johansen 1986, Anderson et al. 1982, Cole 1990). Researchers have noted that soil lichen cover is negatively correlated with livestock grazing and that soil mobility and erosion increased with reduced lichen cover (Rogers and Lang 1971). It is likely that feral pig rooting would be equally if not more damaging. Recovery of soil crusts following the cessation of grazing and trampling has also been noted (Johansen et al. 1986, Cole 1990). This recovery seems to follow a certain pattern in that the algae component of the soil crust is the most resistant to disturbance (Anderson et al. 1982) and is the quickest to recover (Johansen et al.

1984). The lichen and mosses component on the other hand recovers much more slowly.

Cumulative Effects

Historic

Past activities may have included the manipulation and use of plant communities by Native Americans prior to European arrival. Early Native Americans were hunter-gatherers who relied heavily on fishing and harvesting of marine resources (Junak et al 1995). By the early mission period, there were 11 Chumash villages on Santa Cruz Island with a total population of more than 1,100 (Glassow 1980). Native Americans probably locally affected the plants and plant communities of Santa Cruz Island by selectively harvesting plants for food or other uses. They may also have altered habitats near their villages, and they are known to have transported plant materials from the mainland and between islands (Juank et al 1995). The Chumash may also have deliberately set fires for vegetation management purposes (Carroll et al. 1993).

Impacts also occurred and were greatly accelerated with European settlement of Santa Cruz Island in the nineteenth century. Activities associated with settlement included the clearing and farming of certain areas on the island; the establishment of grapes, olive trees, and eucalyptus trees; and the introduction of sheep, pigs, cattle, and horses. By the late nineteenth century several ranches were established on Santa Cruz Island. The introduction of non-native plant species continued and included fruit trees, acacia trees, Italian stone pines, Monterey cypress, alfalfa, walnut, and cultivated vegetables (Junak et al. 1995). Of these activities, by far the one that would most impact the native vegetation was the introduction of sheep. By 1875, there were an estimated 60,000 sheep on the island. In 1939, following several short-term efforts, a systematic roundup of the sheep was begun. Around 1954, it was reported that approximately

35,000 sheep were caught and sold but that many more remained. Between 1955 and 1962, almost 30,000 more sheep were caught and sent to market and during the 1960's and 1970's an estimated 180,000 sheep were shot and killed (Junak et al. 1995). By 1980, after decades of overgrazing by sheep, all of the island's plant communities had been adversely affected. These effects included changes in population structure and species diversity. Species distribution had also been affected. Some native species such as giant coreopsis, Humboldt lily, and northern island hazardia had their ranges reduced; while other native species like dove weed (*Eremocarpus setigerus*) and opuntia (*Opuntia spp.*) increased their ranges (Junak et al 1995). These impacts are still very much evident. However, in 15 years significant recovery has already taken place on TNC's land, including a new generation of Bishop Pine trees. With removal of the last feral sheep in 1999 from east SCI, native vegetation is recovering markedly and rapidly.

Present – Present activities which could impact native plant communities include: public recreational activities, road maintenance, research and monitoring projects. Other activities beyond the ability of local control include, shifts in global weather patterns and human induced climatic shift.

Recreational activities include camping and hiking on land and kayaking on the surrounding waters. Hiking and camping are limited to identified camping areas and hiking trails, although some hiking off-trail likely occurs.

Hiking outside of trails can trample and crush native vegetation and is usually most noticeable around campgrounds and immediately adjacent to hiking trails. The use of these areas also compacts the soil, which locally increases water run-off and soil erosion. The constant disturbance of trails and campgrounds facilitates the spread and establishment of invasive non-native plant species. Similar effects are seen with road grading and maintenance. Russian thistle (*Salsoa tragus*) has been spread along the south

side of Santa Rosa Island due to grading activities (Chaney, personal observation). Yellow starthistle (*Centaurea solstitialis*) has likely been recently introduced and spread on Santa Rosa Island recently due to the activities of private sport hunters (Chaney, personal communication). There are so far no discernable impacts to the islands native flora associated with sea kayaking.

Research projects and monitoring activities are varied in nature and can occur throughout the year but usually take place in the spring and summer. Research projects on Santa Cruz Island are initiated or approved by NPS, TNC, and the University of California Natural Reserve - Santa Cruz Island. Most of the research projects taking place on Santa Cruz Island have limited physical disturbances associated with them and impacts to islands native plant communities are negligible. All proposed research projects that would occur on NPS property are subject to internal park review and are evaluated for potential impacts. Any research that may have significant impacts must undergo environmental analysis prior to approval. Vegetation monitoring projects usually require no additional environmental analysis because of the negligible impacts associated with this kind of work.

Specific impacts are associated with the Channel Islands Terrestrial Vegetation Monitoring program. These impacts include the trampling and crushing of native vegetation, the accidental uprooting of herbaceous plants, the accidental breakage of native tree and shrub branches, and the collecting of plant specimens for the Channel Islands National Park herbarium. These impacts are negligible and are usually confined to the areas where permanent transects have been set. On Santa Cruz Island, within the National Park Service boundary, there are 22 vegetation transects in place. Ten additional transects will be set up later this year. The protocol is to read these transects annually in the short-term to capture any initial changes in the vegetation following the removal of feral sheep and possibly feral pigs from the island.

There are approximately 75 similar transects set up by TNC on the main portion of the island. These transects are not currently being read but that may change in the future. Other impacts are also associated with the Park's island fox recovery program, golden eagle trapping, the seabird monitoring program and cultural or archaeological monitoring. Most of the impacts associated with these programs are negligible.

The California Department of Fish and Game hunt on the west end of the island, may incrementally effect native plant communities. Incremental impacts include increased trampling of vegetation, increased soil compaction and possible water run-off. There is also an increased risk of the introduction of non-native invasive plant species and the increased risk of an accidental fire. Because this activity is tightly regulated, limited in the number of hunters allowed, and widely dispersed geographically these incremental impacts would be negligible.

Future – Future cumulative impacts to native plant communities could be caused by recurring natural shifts in weather patterns. This has been evidenced most recently with the El Niño/ La Niña weather pattern. During El Niño events the easterly surface winds in the Pacific weaken causing the winds to shift to a westerly flow followed by stormy weather west of the International Dateline. Within several weeks, the Pacific Ocean reacts to the changes in wind speed and direction. In the past, sea levels have risen by up to one foot in the eastern Pacific to Ecuador, with a corresponding drop in the western Pacific. Sea temperatures have also risen along the whole expanse of the Pacific coastline stretching from Chile to British Columbia. These changes in wind direction and ocean temperatures are accompanied by changes in the global climate. In effect during an El Niño event, the rain area that is usually centered over Indonesia and the far western Pacific moves eastward in the Central Pacific, this causes unseasonable weather over many regions of the globe including California. Typically,

California experiences more intense storms and increased precipitation during El Niño years.

On the Galapagos Islands, most herbaceous species, both native and non-native responded well to the increase in rainfall, with increases in cover and frequency. This was usually followed however by decreases for both in the subsequent La Niña events. In the *Scalesia* genus, several species experienced increased die-off of adult individuals, possibly due to root rot or temporary flooding but this was followed by increased recruitment of seedling and saplings (Tye and Aldaz 1999). For trees and shrubs of Alcedo Volcano, Isabela Island, El Niño was a somewhat of a mixed blessing. While the regeneration of tree and shrub species in the lowland area increased following an El Niño event, there was increased die-off of adult shrubs and trees on the upland slopes. This latter result was caused by a combination of steep slopes and high rainfall, which caused many of the trees to fall and subsequently die (Aldaz and Tye 1999).

La Niña is another natural climatic shift, which can cause impacts to native, island vegetation. La Niña events are almost the direct opposite of El Niño events. Under a La Niña episode, the ocean temperature in the Pacific is colder than normal, which tends to bring climatic shifts that are opposite of those produced in El Niño years. For California, this usually means that winters are warmer and drier than in normal years bringing drought like conditions with attendant impacts to native, island flora. Water stress in individual plants can cause decreased vegetative and reproductive growth and reduced resistance to insects and disease. Many plant species experienced a contraction in frequency and cover during La Niña events on the Galapagos Islands (Tye and Aldaz 1999).

Global warming, caused by the accumulation of carbon dioxide in the atmosphere, is a man-caused condition which is expected to modify the world's environment to an as of yet unknown degree. Any climatic

changes associated with this phenomenon could have significant impacts to native, island flora. Changes from global warming are ongoing and are affecting us today. Currently there is some controversy about global warming but what is known is the earth's mean surface temperatures have increased 0.6-1.2 degrees F since the late 19th century. Globally sea levels have risen 4-10 inches and worldwide precipitation over land has increased by about one percent (US EPA 2000). The frequency of extreme rainfall events has also increased throughout much of the United States. A study looking at plant response to elevated carbon dioxide levels in an arid ecosystem showed increases in production for perennial native species and introduced annual grasses during high rainfall years but not during drought years (Smith et al. 2000). The study hypothesized that elevation carbon dioxide levels could enhance the long-term success and dominance of exotic annual grasses in the arid ecosystem. The resulting shift in species composition in favor of introduced annual grasses would then have the potential to accelerate fire frequency, reduce biodiversity, and alter ecosystem function.

Predictions about the future are uncertain but scientists expect that the average global surface temperature could rise 1.6-6.3 degrees F by 2100 with significant regional variation. As the climate warms, evaporation would likely increase which would increase global precipitation. Soil moisture is likely to decline in many regions with the increase in temperatures while intense rainstorms are likely to become more frequent. The sea level may rise up to two feet along the U.S. coast (U.S EPA 2000).

World wide climatic changes such as these are bound to impact vegetation on a local and regional level. The flora of the Channel Islands and on Santa Cruz Island would undoubtedly be impacted to some degree. Current native species composition and frequency which is already undergoing change and recovery from past land management activities and the introduction of non-native plant species would react to these

climatic changes. Some species may benefit from these predicted changes while others would be negatively impacted, either slightly or severely. Those species growing along the ocean-land interface could become submerged permanently under seawater. Long-term vegetation monitoring may capture some of these changes caused by climate and these changes may be more subtle versus the changes in vegetation that may occur as a result of removing a major perturbation such as feral pigs in the short-term.

Conclusion

The result of past activities has had a major impact on the current vegetation conditions on the island. Without implementing this project the current vegetation composition, especially those in a low seral condition - and those communities with a high weedy component, would continue to expand and effect the recovery of native communities. High seral communities would continue to be negatively impacted causing less desirable species to continually be introduced into these communities and thereby reducing their resource value.

Implementing present and future activities as described above would add only negligible impacts to the major negative feral pig impacts to native communities as a result of implementing this alternative. Cumulative negative impacts to native communities would result from not eradicating pigs or fennel control as described under this alternative.

Threatened and Endangered (T&E) Plant Species

Effects of Not Implementing Fennel Control

Invasive, non-native plant species like fennel outcompete native plant species for available nutrients, sunlight, and water. When

fennel invades native plant habitat replacing the native diversity associated with the site, the site may no longer provides suitable habitat for the already rare species. Limited habitat for T& E species can lead to the local extirpation of listed plant occurrences. Infestations of non-native invasive plant species like fennel can alter the micro-habitats of an area. This could render these sites unsuitable for those species

Table 8. Santa Cruz Island federally listed as threatened or endangered plant species

Scientific Name	Common Name
<i>Arabis hoffmanii</i>	Hoffman’s rock cress
<i>Berberis pinnata ssp. Insularis</i>	Island barberry
<i>Dudleya nesiotica</i>	Santa Cruz Island dudleya
<i>Galium buxifolium</i>	Island bedstraw
<i>Helianthemum greenei</i>	Island rush-rose
<i>Malacothamnus fasciculatus ssp. nesioticus</i>	Santa Cruz Island bushmallow
<i>Malacothrix indecora</i>	Island malacothrix
<i>Malacothrix squalida</i>	Santa Cruz Island malacothrix
<i>Thysanocarpus conchuliferus</i>	Santa Cruz Island fringedpod

occupying the site or it could prevent the expansion of listed plants into what otherwise would be favorable sites. Limiting the number of suitable habitats for rare plant species further exposes the present occurrences to extinction through random stochastic events such as landslides, pig trampling, local pollination failures, etc..

Effects of Not Implementing Pig Eradication

In the Final Recovery Plan for *Thirteen Plant Taxa from the Northern Channel Islands Draft Recovery Plan* (USFWS 2000), feral pigs were identified as a potential threat to each of the nine listed plant species found on Santa Cruz Island (see Table 8).

Under this alternative the threats to each of the listed species would remain. Fluctuations in the severity of impacts would occur seasonally and yearly as feral pig numbers changed. However, the potential for recovery of rare plant species would still be negligible even during those years when feral pig numbers are low. This is because the number of feral pigs on Santa Cruz Island is tied to food availability. Pig numbers are lower during drought years when little food is available but these periods of low rainfall would also likely inhibit overall plant growth and reproductive success in those plants that are rare. Therefore, the chance for extirpation of occurrences and species extinction would continue to be higher in all years with pigs, than in the absence of feral pigs.

Direct Effects - Direct impacts to listed plant species would include herbivory of T&E plant species by feral pigs and the trampling, crushing, and uprooting of listed plant species should feral pigs walk, root, or bed down within listed plant occurrences. Depending on the number of individual pigs within an area, one to many T&E plants may be grazed, trampled, or uprooted. Those occurrences that are found in areas of high pig use would likely incur the most damage. Because the rarity of these listed plant species is defined by their limited numbers or range, even relatively small impacts can have a large detrimental effect. Individual plants lost through predation, trampling, or uprooting cannot contribute off-spring to the succeeding generation. This results in a loss to the next generation in both absolute numbers and potential genetic diversity. A decrease in genetic diversity can lead to an overall decrease in evolutionary fitness for a species. Decreased

population numbers leads to increased potential for extinction from continued predation, or from large random disturbance events such as a fire, earthquake, or landslides.

Indirect Effects - Indirect effects include alterations in listed plant micro-habitats, soil erosion, and facilitation of the spreading of invasive, non-native plants into the habitats of rare plant species. Disturbances caused by feral pigs in and around rare plant occurrences can lead to increased erosion within those areas. This increased erosion can expose the roots of listed plant species inhibiting water and nutrient uptake or in severe cases completely up-root or bury individual plants. Disturbances caused by feral pig foraging and rooting can also facilitate the spread of invasive, non-native plant species within listed plant occurrences. Invasive, non-native plant species can out-compete native plant species, including T&E listed plants, for available nutrients and water. This can lead to the local extirpation of listed plant occurrences. Infestations of non-native invasive plant species can also alter the micro-habitats of an area. This could render occupied habitat unsuitable for those species occupying the site or it could prevent the expansion of listed plants into what otherwise would be favorable sites. Limiting the number of suitable habitats for rare plant species further exposes the present occurrences to extinction through random stochastic events.

Feral pigs, like all animals, excrete excess nutrients and waste in the form of urine and feces. Chemicals, primarily nitrogen, in urine can chemically burn individual plants and alter the micro-habitats around the point of urination (Williams and Haynes 1994). Pig feces can cover individual plants blocking their access to sunlight, reducing the plant's vigor and health (Williams and Haynes 1995). Adjacent plants may benefit from the extra nutrients available in urine and feces in ways similar to the effects seen with the application of chemical fertilizer. Increased nutrient availability may still be evident three years after deposition of dung (Williams and Haynes 1995). Typically though,

it is the weedy non-native species that benefit the most from increased nutrient availability.

Cumulative Effects

If the no action alternative is selected, the island's nine listed plant species would continue to be threatened by pig-related disturbances.

Cumulative effects are past, present, or future activities that have or may affect rare plant species. All species, especially those with small population sizes, face the threat of extinction. Threats to a species survival include competition from other species, disease, predation, habitat loss, long-term environmental trends, and catastrophic events. Species with small populations also face threats to their genetic diversity from inbreeding, loss of heterozygosity, and, for those species arising from colonization and subsequent adaptive radiation, possible founder effects.

Past, present, and future activities that can cumulatively impact T&E species are similar to those described under Alternative One – Native Species, the impacts of these activities would add negligible impacts to those described under this alternative. The impacts caused by pigs to T&E species have been far more severe than the T&E impacts that are associated with the implementation of this project. Total impacts to T&E species are important to evaluate because rare plant species are limited both in absolute numbers and number of occurrences. Impacts to a portion of a population can have severe consequences to their viability to survive. Common plant species are often extirpated in localized areas, either from natural disturbance events or human caused disturbances. These areas can sometimes be recolonized from seed stored in the soil or propagules from adjacent areas. Rare plants species on Santa Cruz Island may not be able to recover in these ways because either their seed bank has been severely disrupted from years of over-grazing, or distances between known occurrences are usually too great to allow for re-colonization.

Fennel

Effects of Not Implementing Fennel Control or Pig Eradication

Fennel control is a connected action to the eradication of pigs on Santa Cruz Island. Failure to treat the fennel to a condition where hunting can be successful in these stands would compromise the efficacy of pig eradication. Fennel would continue to spread on the island and this spread would greatly be enhanced by pig disturbance.

Fennel has the ability to grow and reproduce during hot and dry conditions, and thrive in disturbed landscapes. Fennel also has the greatest ability to expand into disturbed grassland and coastal sage habitats. Due to widespread pig disturbance, the conducive conditions that allowed the rapid expansion of fennel in the Central Valley and on the isthmus are still prevalent. The continued presence of pigs and their impacts continually create conditions in which fennel could expand.

Available suitable habitat for fennel expansion, just on the east-end of the island, could double the fennel infestation under the right environmental conditions. Failure to eradicate pigs and control fennel would allow the continued expansion of fennel.

The uncontrolled pig population on Santa Cruz Island has been linked to many islandwide resource impacts. Failure to eradicate pigs from the island would mean that those identified impacts would continue.

Specifically, the decline of the island fox population has been attributed to golden eagle predation on the fox. Golden eagles, in part, are present year round on the island; because piglets are an abundant food source for them. Impacts to the island fox would continue as pigs remain on the island.

In addition, pigs in their search for food cause much soil and vegetation disturbance. The soil disturbance affects watershed health,

sensitive cultural resources, and rare plant species. Without pig eradication these resource impacts would continue to occur.

Under Alternative One no pig eradication or fennel control action would be done. Continuation of the existing management efforts to control fennel and pigs would continue. Actions which merely control feral pig populations still allows undesirable resource impacts.

Fennel would continue to spread throughout the isthmus outcompeting native plant species and invading native plant communities where feral pigs cause disturbance. Feral pigs would continue to thrive in the fennel spreading the invasive species, breeding, and causing further degradation.

Cumulative Effects

The result of past activities has had a major effect on the existing condition of fennel on the island. Without implementing this project the existing footprint of fennel on Santa Cruz Island would continue to expand, affecting many natural resource values.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible impacts to the major negative effects that would result from implementing this no-action alternative. Cumulative negative impacts would occur to all the resources affected by fennel expansion under this alternative.

Other Weeds

Effects of Not Implementing Fennel Control

Fennel covers over 10% of Santa Cruz Island (Klinger unpublished data), and is currently spreading along roadsides into many coastal sage, grassland and bare/disturbed sites. With continued pig presence, disturbance would

continue creating suitable habitat for weed colonization.

Effects of Not Implementing Pig Eradication

Implementation of Alternative One would result in continuation of large and rapid increases in distributions and abundance of invasive alien plants on the island, and would produce heavy and long-term negative consequences to the success of NPS and TNC weed management programs. The current trends of increasing distributions and abundance of many alien species are likely to continue and accelerate. The largest numbers of these species are concentrated in the areas of highest pig population density. Some impacts and trends could have long-term negative implications.

Dispersal of weed seeds by pigs from infested to un-infested areas would continue. Prevalence of favorable weed seed germination conditions created by pig rooting and trailing would also increase.

Cumulative Effects

Past grazing and human disturbance have allowed the transport of weed seeds to Santa Cruz Island and has resulted in the current weed infestation on Santa Cruz Island. Without implementing this project the existing footprint of weeds on Santa Cruz Island would continue to expand, affecting many natural resource values.

Present and future activities as described in the beginning of this chapter could add additional negative effects to the weed problem on Santa Cruz Island. Human activities have the greatest chance of transporting weeds from mainland sources to Santa Cruz Island. Continued pig presence poses the largest threat for transport and establishment of weeds intra-island. This no-action alternative would result in major impacts due to the potential for weeds to be spread via pig disturbance. Introducing other weeds as a result of human activity would

only add minor cumulative impacts to the significant negative effects the spread of weeds would have with the implementation of this alternative.

Issue 3: Island Fauna Impacts

Native Island Fauna

Effects of Not Implementing Fennel Control

Fennel control consists of both burning and herbicide application. Both of these activities can have impacts to native fauna that utilize the fennel stands. Fires generally change the structure of the community making them more open. Keeping intact the dense fennel stands would benefit species that prefer a more relatively closed community, specifically the Southern Alligator lizard. Conversely, the open would not be good habitat for species, such as the side-blotched lizard, that prefer a more open vegetation structure.

Effects of Not Implementing Pig Eradication

The feral pig population would continue to fluctuate due to annual differences in weather. In years with favorable precipitation, greater plant productivity would allow pig populations to expand. Conversely, during periods of drought pig populations would decrease.

Pigs would have significant and adverse effects on island wildlife and fauna under this alternative. Pigs would continue to cause direct mortality of invertebrates during certain times of year, since invertebrates are a part of their diet. However, it is doubtful that pig foraging would have significant effects on invertebrates at the population level.

Under this alternative pigs would continue to adversely impact wildlife on Santa Cruz

Island, primarily by destruction of suitable habitat. Pig rooting in specific locales would destroy habitat for rodents, lizards, snakes, salamanders, foxes and skunks. Pigs would also continue to directly consume small vertebrates when encountered. Pig use of riparian areas would adversely impact frogs, salamanders, and aquatic invertebrates. Because feral pigs prefer mast crops, pig rooting for acorns in years of significant mast would impact those species, such as the Santa Cruz Island jay, which depend upon mast crops.

Pig carcasses would continue to be a food source for ravens, perhaps maintaining them at levels which allowed raven predation on other species (such as snowy plovers) to be significant.

Under this alternative pigs would continue to form the primary prey base for non-native golden eagles. Although 19 golden eagles were removed from Santa Cruz Island in 1999-2001 as part of island fox recovery actions, the continued presence of feral pigs could still attract and support a breeding population of golden eagles on Santa Cruz Island. In turn, a population of eagles supported by feral pigs could drive island fox populations on the northern Channel Islands to extinction. Because of their large territories, golden eagles breeding, wintering or roosting on Santa Cruz Island could easily prey on island foxes on Santa Rosa and San Miguel Islands. There are approximately five golden eagles remaining on Santa Cruz Island. Predator-prey modeling (Roemer et al. 2002) indicates that as few as two eagles could have been responsible for the observed decline of island foxes on San Miguel Island, and that if fewer pigs were not present, golden eagles would not be supported and foxes would not be in decline.

Cumulative Effects

Alternative One, the no action alternative, should have no additional effect on vertebrate species. Those birds foraging on invertebrates within the fennel would continue to forage.

Southern Alligator lizards would continue to be the dominant herpetofauna in the fennel, and the small mammals that seek cover in the dense fennel would continue to hide there.

With the continued spread of fennel, those vertebrates that use other plant communities encroached by fennel would be negatively effected by the spread of fennel and the continued rooting of feral pigs.

Alternative One, the no action alternative, should have no affect on invertebrate species located within the fennel monocultures. The spread of fennel and the continued rooting of feral pigs would negatively effect invertebrates that use plant communities less vertically diverse than fennel.

Past activities, such as introduction of non-native fauna to Santa Cruz Island has negatively affected native island fauna. This effect is best understood with the decline of the Island fox and its negative association with golden eagles. Year-round golden eagle presence would not be possible without feral pigs.

Present and future activities, as identified in the beginning of this chapter, would have effects on island fauna, particularly island foxes. Golden eagles are currently being relocated from Santa Cruz Island. Relocation of golden eagles from the island would increase survivorship of island foxes on Santa Cruz Island. The NPS is working with several other agencies to study the introduction of bald eagles to the northern Channel Islands. As part of the study release of juvenile eagles may occur on Santa Cruz as early as summer, 2002. If bald eagles eventually breed on the island, their territorial nature may discourage golden eagle use of the island, thus preventing golden eagle predation of island foxes. These positive effects on fox survivorship would continue until pigs are removed. Without eliminating the year-round feral pig prey source, golden eagles may still be attracted to Santa Cruz Island negatively affecting fox survivorship. The negative effects of not eradicating feral pigs outweigh the

positive effects of either golden eagle removal or bald eagle introduction.

The NPS and TNC began a captive breeding program for island foxes in April 2002. Combined with golden eagle removal, island fox captive breeding should help increase the wild fox population on Santa Cruz Island from the current 50-60 foxes to several hundred foxes, thus minimizing the chance of extinction for this subspecies. Without feral pig removal this program would be negatively affected.

Non-native Fauna (Pigs)

Effects of Not Implementing Fennel Eradication

The dense fennel on the isthmus is suitable and preferred habitat for feral pigs on Santa Cruz Island. Pigs continually root in this area to eat the roots of the fennel plant. This has caused significant disturbance in this area. Without treating fennel, pigs would continue to use this area as preferred habitat, maintaining or increasing their population in this area as the fennel continues to expand. Significant soil disturbance and resource damage would be incurred.

If fennel is not controlled the effect to pigs would be positive. Fennel on the isthmus provides both food and shelter for pigs. As suitable habitat for pigs it harbors a higher density of pigs than some other habitats on the island. Failure to control fennel would also result in fennel expansion. If fennel is expanded, more pigs may be able to be supported on the island.

Effects of Not Implementing Pig Eradication

Under this alternative, the feral pig population would continue to fluctuate due to annual differences in weather. In years with favorable precipitation, greater plant

productivity would allow pig populations to expand. Conversely, during periods of drought pig populations would decrease.

Annually many pigs die of starvation, this is especially evident during drought years.

Some piglets would die annually due to golden eagle predation.

Cumulative Effects

Past activities, such as the initial introduction pigs to Santa Cruz Island, has resulted in the current feral pig population.

Present and future activities, as identified in the beginning of this chapter, would have negligible effects to feral pigs on the island. It has been reported that people have provided food to feral pigs, and if visitation increases, more unauthorized feeding may continue to occur. This intermittent feeding has probably only had a negligible effect to the feral pig population.

Issue 4: Impacts to Physical Resources including Soils, Water and Air Quality

Effects of Not Implementing Fennel Control

Feral pigs extensively use fennel stands and create disturbed soil conditions. Feral pigs are also responsible for the spread of fennel, fennel stands would likely increase in size. As fennel continues to grow in size the soil disturbance would expand accordingly. Soil erosion results in loss of soil from the site but can result in loss of nutrient availability and the creation of gullies.

The prescribed burn to treat fennel would not occur; therefore no fire emissions would occur that would adversely affect air quality.

Effects of Not Implementing Pig Eradication

Because sheep have been removed from Santa Cruz Island, direct impacts from overgrazing from sheep have ceased. However, soil disturbance from pig activities continues. This alternative would not implement any significant reductions in the pig population. Pigs would continue to root for food causing continued soil disturbance. This soil disturbance eventually results in soil erosion.

Slopes whose vegetation and soils have been upturned and tilled as a result of pig rooting are susceptible to having rapid runoff during storm events. This rapid runoff would continue to deepen existing gullies, and possibly create new gullies. Rapid runoff causes high sedimentation to occur in low gradient valleybottom reaches.

Water quality would continue to decline because of the high sedimentation rates in watersheds that have been previously disturbed by past grazing.

Cumulative Effects

Under Alternative One, fennel would continue to spread on the isthmus, releasing potentially allelopathic secondary compounds into the soil. These compounds may suppress possible regeneration of native species within the vicinity of *Foeniculum vulgare* (Colvin 1996). Pigs would continue rooting along the isthmus causing more soil erosion and more potential patches for fennel and other invasive species invasions.

The result of past activities, mainly domestic and feral livestock grazing, has had a major effect on the soil conditions on Santa Cruz Island. However, removal of cattle and sheep over the last 15 years has halted overgrazing and has prompted recovery in many areas. Pig disturbance continues to degrade soil resources. Without implementing this project continued degradation of soils and watershed values would occur.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible impacts to the already negative impacts to soil and water quality caused by pigs. Future projects that require driving or construction activities would negligibly contribute to air quality impacts associated with this alternative.

Issue 5: Socioeconomic Factors including Cultural Resources and Human Uses

Cultural Resources

Effects of Not Implementing Fennel Control

Many archeological sites occur within the dense fennel patch that occurs on the isthmus of Santa Cruz Island. Documentation of these sites show them to be severely impacted by feral pigs. The fennel patch as a whole receives relatively more extensive and intensive pig disturbance than adjacent habitats. It is estimated that all archeological sites (known or unknown) within the fennel area have been disturbed to some degree by pigs.

Without fennel control, fennel would continue to expand its footprint on the island. As the fennel expands it would likely encompass more archeological sites, and because the intensity of pig disturbance is greater in fennel stands, these sites would become vulnerable to irreversible pig disturbance.

Effects of Not Implementing Pig Eradication

Under this alternative, damage to archeological sites by feral pigs would continue essentially unabated. Continued pig rooting of archeological sites on the island would result in their loss of integrity, and ultimately loss of the values which made the Santa Cruz Island

Archeological District eligible for the National Register of Historic Places.

Pig rooting is currently estimated to have damaged nearly all of the archeological sites on the island, to a minor or major extent. Pig rooting to a depth of three feet has been noted in a number of sites, particularly in areas covered by fennel or wild cucumber (Dr. Jeanne Arnold, personal communication). The information potential of some shallow sites and surface scatters has been completely destroyed by pig rooting. Rooting in the upper layers of deeper, more complex, stratified sites profoundly disturbs time and spatial relationships and destroys the context of the information contained in these sites. In addition, pig rooting has disturbed ancient burials found in many locations on the island.

NPS would continue to try to prevent complete loss of the archeological record by fencing a small number of sites each year, as funds allow. This, however, is a costly alternative that preserves only a small number of sites and requires constant monitoring to ensure that the fences are adequately keeping out the pigs. This alternative also does not preserve the archeological values that were recognized in the park's enabling legislation or the values for which the island was listed on the National Register.

Cumulative Effects

The Santa Cruz Island Archeological District is significant for the large number and diversity of pristine sites found on the island. Sites range from isolated artifacts to huge, stratified sites encompassing habitation areas and specialized activity areas spanning a period of 8,000-9,000 years. Continued pig depredations throughout the island, with small-scale NPS efforts to fence and protect sites, would result in a truncated archeological database. The number and diversity of sites would be greatly reduced, destroying the values of the district, and resulting in de-listing of the National Register district, possibly leaving a

small number of individually eligible sites. The value of remaining archeological sites would be greatly reduced, and future researchers would be unable to take advantage of new research techniques that may be developed in the future.

The ranching era on Santa Cruz Island conducted land-disturbing activities that likely impacted archeological sites. The two land disturbing activities that impacted archeological sites to the greatest degree have been road building and the introduction of feral pigs. Those archeological sites that have been impacted by these activities have been irreversibly impacted. The impacts of those activities when added to continued pig disturbance, as described under this alternative, would have major cumulative impacts to archeological sites on Santa Cruz Island.

Present and future activities as described in the beginning of this chapter would add negligible impacts to the major cultural resource impacts that would result from continued pig presence on Santa Cruz Island. Negligible impacts are expected because all planned activities must undergo a review process that is intended to identify potential impacts to cultural resources. The review would specify mitigation measures that need to be implemented in order to minimize impacts to cultural resources. This review process does not account for unauthorized activities that may occur such as visitors taking artifacts, or anchored boaters coming ashore and disturbing archeological sites.

Human Uses

Effects of Not Implementing Fennel Control

No visual impairment due to smoke generated from the fennel prescribed burn would be realized. Emissions from a prescribed fire, which could affect air quality, would not be generated. The Del Norte trail goes through the middle of the fennel infestation, the height of the

fennel makes it so visitors who are hiking through this area cannot see the surrounding landscape, diminishing their experience.

Effects of Not Implementing Pig Eradication

Under Alternative One existing socioeconomic conditions would continue on Santa Cruz Island, with visitation increasing on the newly acquired isthmus. Visitation would continue to be heavy in the Scorpion area, but less so at Prisoner's, due to lack of services and visitation options, until these services are provided. The visitor experience would be somewhat impacted by the presence of feral pigs and by the effects of feral pigs. These effects to visitor experience include seeing scarred landscapes because of pig rooting, the occasional sighting of feral pigs, and continued impacts to native wildlife such as island foxes, which would continue to be at risk until pigs are removed from the island. Visitors would continue to observe the starvation of pigs, as visitor use increases on the isthmus, these encounters would increase.

Alternative Two: Simultaneous Islandwide Eradication of Pigs

Issue 1: Likelihood of Achieving Success

Effects of Implementing Fennel Control

The Nature Conservancy has been active since 1990 to find the best way to control the rapidly expanding fennel on the island. Two large studies (Dash and Gliessman 1994; Erskine unpublished data) were initiated by TNC during this decade and were used as the

basis for the fennel control protocols proposed in this analysis.

Erskine's study was initiated in the east portion of the Central Valley and had the best conclusive results for fennel control. The study looked at using prescribed fire and herbicide to decrease fennel cover. When compared to control plots, the study found that treating fennel with fire in the fall of the year and then applying herbicide (Garlon 3A) the following two springs resulted in the greatest decrease in fennel cover.

The Erskine study (unpublished) stresses that without the second application of herbicide, fennel could actually increase by 50% in the previously treated plots.

Dash and Gliessman (1994) looked at different methods for treating fennel including: cut and remove cuttings; digging out the root system; cut and apply herbicide (Roundup); and spring cut, summer cut, and clear. This study found that digging the fennel was the most effective way of removing fennel. For this project, and the need to treat approximately 1,800 acres of fennel, digging is not practical and would cause too much soil disturbance to be seriously considered for fennel control.

The proposed fennel control treatment reduced fennel cover better than the herbicide application trial conducted by Dash and Gliessman (1994). NPS prescribed fire specialists are confident that the prescribed fire to treat the isthmus fennel stand can be completed successfully. Likewise, using Global Positioning System (GPS) technology, herbicide application can be done successfully with a high degree of precision.

Another study done on Santa Cruz Island fennel (Brenton and Klinger 2002) compared two formulations of triclopyr. The two formulations included Garlon 3a (amine based) and Garlon 4 (ester based). They also compared different application rates, cutting the fennel prior to treatment, and time of year for optimum fennel treatment. The study concluded that two consecutive herbicide treatments would be sufficient for fennel control,

wet season application was more effective than dry season application, cutting did not improve the action of the herbicide, and the different formulations provided the same degree of control. Brenton and Klinger (2002) suggest that the ester formulation is better suited to species that have a waxier cutin, and the amine version would be better suited to fennel because of their supple leaves. Manufacturer studies show that the amine formulation translocated more thoroughly once inside the plant than the ester formulation.

Effects of Implementing Pig Eradication

In November 1998 the NPS and TNC assembled a one-time gathering of pig control experts, including biologists and land managers, on Santa Cruz Island. The purpose of this gathering was to discuss the issue of feral pig impacts and receive individual recommendations on how best to eradicate feral pigs from the island. In order to protect sensitive cultural and natural resources, the majority of individuals felt that the eradication of feral pigs should be of the highest priority for the management of Santa Cruz Island. If resources (personnel and budget) were not a limiting factor, most individuals felt that a high-intensity, short-duration islandwide eradication effort would have a high likelihood of success.

Direct and Indirect - As expressed by the opinions of individual pig experts, this alternative has a high probability of success for pig eradication. However, potential for failure exists should resource constraints become evident at any time during project implementation. For success, this alternative is heavily reliant on amassing a high intensity eradication effort for a concise short duration of time. Failure to maintain either component (high intensity or short duration) would result in a lower probability of success.

Issue 2: Vegetation Impacts

Native Communities

Effects of Implementing Fennel Control

Fire and herbicide effects would be the same for Alternatives Two, Three, and Four. The area on the isthmus that is to be burned and herbicided for fennel control is dominated by fennel (*F. vulgare*). Interspersed in between fennel plants are native species such as buckwheat (*E. grande*), coyote-brush (*Baccharis pilularis*), and bunchgrass (*Nasella* spp.). Adjacent to these large stands of fennel are relatively intact native plant communities such as coastal scrub and island chaparral. The intent of the proposed fennel project is to treat only those areas dominated by fennel and avoid large areas of intact native vegetation.

Fire Effects

Almost all wild fires and prescribed burns produce a mosaic of low, medium, and high intensity burned areas. High intensity burn areas are usually characterized by a white ash layer on the ground with no recognizable duff or litter and all small, medium, and most large diameter fuels being completely consumed. Low intensity burn areas are characterized by an incompletely burn duff layer (small bits of leaf and litter material are recognizable) and a fairly large presence of small and medium sized fuels. Medium intensity burn areas are of course somewhere in between the two extremes. Classification of an area between low and medium and medium and high is based on professional judgement and experience.

Forbs - Most native and invasive forb species have set seed well before October or November, the approximate time of fire prescription. Except for high intensity areas, the fire should not directly affect forb seeds in the seedbank and even in those high intensity burn areas there are usually viable seeds left in the

soil. The fire should not directly affect forb seeds in the seedbank. The prescribed burn would remove most, if not all, above ground forb biomass transforming the plants' masses and nutrient contents into ash.

The ash produced by the prescribed burn would increase the nutrient content of the soil, which would increase nutrient availability to forb seedlings. With sufficient water availability, the increased soil nutrient content would allow for a flush of spring forb growth the year following the prescribed burn. Decreased above ground litter would also allow for greater photosynthetic photon flux density for those forbs that were light limited.

Grasses - The prescribed burn would consume most, if not all of the dead aboveground biomass of the annual grasses. Depending on the intensity of the fire, a negligible amount of perennial grasses would be consumed and killed in the fire. The prescribed fire should not reach intensity levels that kill below ground plant parts, but is intended to remove above ground biomass, therefore the majority of perennial grasses should survive the prescribed burn and re-sprout the following spring (Erskine unpublished data). For the same reason, the prescribed burn should not affect the seedbank of either the perennial or annual grasses (Erskine unpublished data).

As with the forb species, the ash produced by the prescribed burn would increase the nutrient content of the soil, which would increase nutrient availability to grass seedlings and re-sprouting perennial grass tussocks. With sufficient water availability, the increased soil nutrient content would lead to a flush of spring grass growth the year following the prescribed burn. Decreased above ground litter would increase photosynthetic photon flux density to seedlings. The prescribed fire may result in a flush of annual grasses. Annual grasses are good competitors against native species (native forb, grass and shrub seedlings). Upon the removal of grazing from Santa Rosa Island, native species, particularly needlegrass, continue to reemerge into annual grasslands.

Shrubs – The steeper slopes of the larger drainages within the fennel treatment area have chaparral or other shrub communities. Single fire events do not negatively affect relatively undisturbed chaparral and other California/Santa Cruz Island shrub communities. Most native shrubs (if not all) that were burned during the fall 1997 fire conducted in Santa Cruz Island’s Central Valley fully recovered, and in certain areas, appear to be doing better than unburned areas of chaparral. This same negligible effect is expected for shrubland habitats within the proposed fennel treatment area. (For example in the Central Valley- *Ceanothus sp.* (California lilac) and *Lupinus sp.* (lupine) flowered prodigiously in the areas of fire escape in spring 2000). Depending on the intensity of the burn some or most of the above-ground portion of the shrub would be consumed. Most native chaparral shrub species are adapted to some form of periodic burning. Normally they follow one of two avenues after experiencing a burn. Some species are termed “sprouters” and even though their above-ground tissue has been consumed would re-sprout from basal burls or protected buds below ground. Other species are known as obligate seeders and rely on an extensive seed bank for population regeneration because the adult shrubs are killed by typical fire events. Even those shrubs said to be sensitive to fire (*Artemisia californica*- coastal sagebrush) have the ability to resprout from single fire events. Repeated burning, which is not proposed as part of this action, usually kills such “sensitive” established shrubs (Mooney and Drake 1986).

Fire has been shown to promote the seed germination of many chaparral shrubs including *Arctostaphylos sp.* (manzanita) and *Adenostoma fasciculatum* (chamise) (Everett 1957; Keeley 1987; Keeley and Keeley 1987) both present in the native plant communities (Minnich 1980). Seed germination of these shrubs could encourage the recruitment of such shrubs into the fennel-infested community.

Most of the gentler slopes within the fennel treatment area are dominated by fennel.

However, approximately 15% of the fennel treatment area (all located in the western part of the treatment area on ridgetops and gentle slopes) are annual grassland mixed with fennel. Fennel cover in these areas is generally less than 50%. In disturbed areas where annual grasses have established there may be a negligible increase in the cover and density of these grasses, with grasses normally taking up the space of the treated fennel. Annual grasses can often out compete native species (native forb, grass and shrub seedlings). Once an area becomes dominated by introduced annual grasses recolonization by native shrub and herbaceous species can be problematic, especially when there is continued disturbance. Various studies have shown inconsistent recovery of native shrubs into annual grasslands (Kirkpatrick and Hutchinson 1980; Eliason and Allen 1997). In relatively undisturbed native shrublands a single burn is generally not enough to cause type conversion to annual grassland.

Herbicide Effects

Forbs - As with fennel, forbs would readily absorb Garlon 3A, a broad-leaf herbicide. Symptoms of Garlon toxicity can include epinasty of the leaves, petioles, and stems, growth inhibition, wilting, chlorosis at the meristems, and necrosis (Ahrens 1994). Forb species would die within 3-5 weeks.

Most forb species within the grassland/fennel infested areas are ephemeral and have set seed by late April (protocol recommends an early May herbicide spray). Garlon only affects growing plants and would not affect seeds in the seedbank. Sensitive communities such as riparian communities, cliff embankments, and oak woodlands, which contain forb species as well as woody dicots, should not be sprayed with herbicide. Mitigation that avoids spraying these communities would be implemented to avoid accidental impacts.

Included in grassland and disturbed community forb species are a variety of invasive

species such as *Centaurea solstitialis*, *Centaurea melitensis*, and *Cardaria draba*. These species are late bloomers (especially *Centaurea* sp.) and may be sprayed with Garlon before fruiting. This allows Garlon not only to eliminate some of the *Foeniculum vulgare*, but also to prevent invasion by a different noxious weed. Native forb and woody community development could be impeded by the invasion of these disturbed areas with Mediterranean annual grasses. Preventative measures such as cleaning fire equipment, spot checking and treating any new infestation after both the burn and herbicide treatments would be taken to minimize spread of these invasive species into the burn and spray area.

Grasses - There are no direct effects of Garlon on grasses. Garlon is a herbicide that specifically targets the metabolism of dicot species. Garlon 3A would indirectly effect grasses by killing/decreasing fennel and other dicot species allowing for greater growth of both native and nonnative grass species establishment the following spring. The annual and perennial dicot species would release a larger quantity of nutrients into the soil because they would die before reallocating nutrients from leaves and stems into seeds. The macronutrients and micronutrients from decaying plant tissue would go directly into the soil for microbes and other plant species to use.

Shrubs - Garlon 3A produces epinastic bending, chlorosis, growth inhibition, irregular appearances and wilting in many dicot plant species (Ahrens 1994). Although Garlon would negatively effect native shrub species that come in contact with the herbicide, these plant species would not likely be killed. Necrosis of the leaves and branches is common, and the appearance of death may even occur, but many dicot shrubs resprout from the crown the year after, and sometimes the summer after, coming in contact with the herbicide (Erskine personal observation). Native California shrubs are adapted to harsh xeric conditions and contain thick waxy cuticles on often evergreen leaves. These leaves do not readily absorb the herbicide,

and although the plants may be injured by the herbicide, they do not often die.

Indirectly, the herbicide would negatively affect the fitness of shrubs that are sprayed. Most shrubs sprayed with the herbicide would use their nutrient supplies to recover from the spray, and would not reproduce that year (Erskine personal observation). Shrubs observed in the Central Valley Fennel Removal Project recovered from two successive years of spray with Garlon 3A.

Assessment of effects assumes that feral pigs are eliminated following treatment. Long-term pig disturbance following fire would compound the negative effects of fire and contribute to the decline of natives.

Effects of Implementing Pig Eradication

Short-term Impacts

Alternative Two would involve the use of up to five teams of hunters and dogs simultaneously in an islandwide intensive hunting effort. This eradication effort would be expected to last 2 years. Extensive stands of wild fennel (*Foeniculum vulgare*) in the isthmus area would be treated with a combination of prescribed burning and the application of the herbicide Garlon.

Negative effects to native vegetation and individual plants by the five teams of hunters and dogs would be short-term and likely insubstantial. Short-term impacts to native vegetation would occur as feral pigs are chased and cornered. These impacts would include trampling of the vegetation, damage to individual plants as leaves, branches, and shoots are torn by running animals and hunters. Additionally, even with the current road system, the teams would create trails as they moved between different areas on the island. These trails would compact the soil and could facilitate the movement of non-native, invasive plants into previously non-infested areas.

The seeds of invasive non-native plant species could also be carried on the boots and clothing of the hunters as well as in the fur of the hunting dogs. Vehicles used by the hunting teams can also transport non-native plant seeds in their tires and the under-carriage. Areas where invasive plant species are transported and become established would require active treatment to prevent trading one problem for another.

The formation of new trails could also lead to a short-term increase in soil erosion. The increase in soil erosion and the impacts to the soil micro-flora would likely decline once the pigs are eradicated from Santa Cruz Island and use of the hunting trails is discontinued. However some of the soils on Santa Cruz Island are highly erodible and the possibility exists that the new trails could cause substantial erosion and gullyng without remedial action.

Trampling of the soil by vehicles and the hunters can cause alterations in the soil micro-flora and cryptobiotic soil crusts may be damaged. As discussed previously, cryptobiotic soils are important components of soils in arid and semi-arid environments. Trampling, especially during the dry season easily damages these soil crusts. These soil crusts have the ability to re-colonize disturbed areas from nearby non-disturbed land, however re-colonization and re-establishment of soil crusts in an area can be somewhat slow depending on various environmental factors.

There is also an increased risk in starting an accidental fire under this alternative. Hunters could start a fire primarily in one of two ways. By a hunter who might smoke and absentmindedly toss a cigarette away in the course of the hunt or by a spark generated from the ricochet of a bullet. A mandate of no smoking may decrease or eliminate the first cause but there is no remedy for the second. Because fire suppression resources are limited on Santa Cruz Island, the potential exists for any fire to rapidly spread.

A large accidental fire could have a significant impact to island plant communities that are just recovering from almost a century of severe grazing. In a healthy Mediterranean plant community, the infrequent occurrence of a naturally-caused fire is not necessarily adverse. In many cases, fire is a beneficial and integral mechanism by which the community renews itself. Many plant species in Mediterranean ecosystems have adaptive mechanisms in response to fire. Some plant species such as toyon, oaks, lemonade berry are termed obligate sprouters. This is because although their seeds may not survive the fire, they resprout vigorously after fires. Other species however, produce large amounts of seed (obligate seeders) which accumulate in the soil seed bank. Once a fire has passed through, the heat or smoke from the fire would cause these seeds to germinate. So, even though the parent plant may not survive, there is a high probability that it would be replaced by its progeny in the plant community. The problem for these plants occurs if continual disturbance from severe grazing has led to accelerated erosion and the subsequent loss of the seed bank. If a fire should occur before this seed bank is replenished, there would be no replacement for the parent plant. This is the state that some of the plant communities on Santa Cruz Island are currently in. An accidental fire could lead to the elimination of certain species from a particular plant community and a loss in native species richness. The resulting 'gaps' in the community could allow for increased invasion by non-native plant species.

Long-term Impacts

Once all the feral pigs are removed from the island, the long-term effects to the native island flora are likely to be beneficial and substantial. Because they would no longer be preferentially consumed, native plants should be able to compete better with non-native plant species. The lack of disturbance patches caused by feral pig rooting, wallowing, and bedding and the removal of pigs as a vector for the transport of

weedy plant seeds should significantly slow the spread of non-native, invasive plant species. Certain island plant communities such as chaparral, grassland, riparian zones, and oak woodland would likely benefit the most with the removal of feral pigs since they are the communities being the most impacted. Seeds, berries, and acorns produced in these communities, and now actively consumed by feral pigs, would be stored in the soil for natural disturbance episodes or available for seedling generation in open available habitat.

Overall the native island flora would return to a more natural composition, and the cover and frequency of native plants should increase. This has been demonstrated within the Park on Anacapa, Santa Barbara, and San Miguel Islands. The native vegetation on those islands had been devastated by introduced herbivores such as rabbits, goats, burros, and sheep (Sauer 1988). Today, after the removal of all the non-native herbivores from those islands, the native vegetation has flourished and occupies much of its former extent (Sauer 1988; data on file, Channel Islands NP).

Litter retention, although no doubt improving with the removal of feral sheep, would be further enhanced with the removal of feral pigs. The increase in litter retention would lead to a reduction in soil erosion to more “natural” levels. The soil micro-flora and fauna, now confined to limited undisturbed areas should be able to re-colonize those areas where they have been eliminated.

Alternative Two would eliminate pig disturbance within two years, eliminating the vector for Mediterranean annual grass invasion. Feral pig removal would eliminate the last remaining feral quadrupeds, animals that are known to facilitate the spread of such weedy species. Native perennial bunch grasses are often in direct competition with Mediterranean annual grasses; therefore the decrease in vectors of spread for Mediterranean annual grasses may facilitate the recovery of native perennial bunch grasses. However, full recovery and

establishment of these species may require out-planting with plugs.

Alternative Two would result in a vigorous eradication of feral pigs from Santa Cruz Island. The removal of feral pigs would prevent the invasion of shrub communities by invasive species via disturbance. The lack of rooting in shrub communities may facilitate in the recovery of native shrub species. The lack of disturbance would allow natural regeneration of shrubs via germination of seeds beneath the shrub canopies.

Cumulative Effects

Fennel Control + Pig Eradication

In the above discussion individual elements (fire, herbicide, and pig eradication) of Alternative Two were discussed. However, it is the combination of these activities that would have major beneficial impacts to native communities. Alternative Two as a whole would significantly decrease the cover and density of *Foeniculum vulgare* allowing forb species the ability to reestablish in fennel infested communities. The removal of both fennel and feral pigs, in an extremely short period of time, would decrease disturbance dramatically on the isthmus of Santa Cruz Island. With the removal of heavy disturbance, it is expected that ruderal (establishes following disturbance) invasive species would have a more difficult time invading native communities. There are unique opportunities for restoration, because fennel infested communities are surrounded by native plant species. These native plant communities (chaparral, oak woodland, coastal sage) produce a seedbank adjacent to the fennel-infested communities. Fruit-eating birds, insects, wind, and small mammals would carry seeds from the native communities into the fennel treated communities beginning the successional process in this now degraded landscape. Generally annual and perennial forbs are the first species to begin the successional process.

The lack of disturbance would allow natural regeneration of shrubs via germination of seeds beneath the shrub canopies. This regeneration may also lead to the encroachment of shrubs into the degraded fennel/treated community, and the continued recovery of other disturbed communities throughout Santa Cruz Island.

Past, present, and future activities

Alternative One – Native Communities (pg. 70-73) described the past, present, and future activities that would impact native plant communities and will be used as the basis for the incremental impacts associated with Alternative Two.

Past activities have had a major impact on the current island vegetation conditions. With the implementation of this alternative the current vegetation composition, especially those in a low seral condition, and those communities with a high weedy component, would respond differently to the removal of pigs and the control of fennel. Removing the disturbance that keeps communities in low successional status would allow them to start successional recovery, allowing native species to colonize these communities over time. High seral communities would benefit by feral pig removal and fennel control because the continual disturbance that makes them vulnerable to invasion by undesirable species would no longer be occurring.

Implementing present and future activities as described under Alternative One would add only negligible impacts to the short-term direct and indirect effects associated with implementing this Alternative. The addition of these negligible impacts would not effect the long-term beneficial impacts that would occur to native communities as a result of eradicating pigs and control of fennel as described under this alternative.

Mitigation and Monitoring

- Buffer zones would be maintained between the fennel-dominated treatment area and adjacent native plant communities for both prescribed burn and herbicide activities. Buffers would minimize accidental overspray of Garlon 3A into adjacent intact native plant communities. Buffer zones can be treated with herbicide by hand if necessary.
- The prescribed burn and herbicide implementation strategies need to identify actions to mitigate the unnecessary burning or spraying of large, intact native plant communities within the treatment area. These actions are necessary to protect native plant refugia that can serve as native plant seed sources for the treated areas.
- Monitoring should be done to measure the increases in noxious weeds such as yellow starthistle. If infestations begin to occur, immediate action should be taken to remove such invaders. This would avoid causing a secondary invader species to become established and causing the same or more severe ecological impacts as the initial species being treated.
- All vehicles traveling from yellow starthistle infested areas should be cleaned before entering the project area. Areas where it is known to occur on the isthmus - along the roadside near Prisoner's Harbor – should be treated as soon as possible. Monitoring should be conducted within the treated area for two years following the large-scale treatment and any detected infestations of yellow starthistle should be rapidly treated.

Threatened and Endangered Plant Species

Effects of Implementing Fennel Control

The only Threatened or Endangered species currently known to exist in or directly adjacent to the fennel treatment area is *Galium buxifolium* or Sea-cliff bedstraw (U.S. Fish and Wildlife Service 1999). No other Threatened or Endangered species would be affected with implementation of the fennel treatment as proposed. As the only species that may be affected by fennel treatment the following discussion will focus on this species.

Fire effects on T&E species

Galium buxifolium is a dioecious woody shrub in the Rubiaceae family that grows on coastal bluffs and north-facing sea cliffs. Associated native shrub species with *G. buxifolium* are *Artemisia californica*, (Coastal sagebrush) *Coreopsis gigantea*, (Giant coreopsis) *Eriogonum grande ssp. rubescens*, (Red buckwheat) and *Rhus integrifolia* (lemonade berry) among others (U.S. Fish and Wildlife Service 1999). Mitigation to avoid burning coastal bluffs containing this endangered species should be done. If a spot fire occurs in the coastal bluff, it is possible that the *G. buxifolium* would recover, as its native woody species counterparts are able to recover from fire. Because little is known about the life history of this endangered species, fire should be avoided.

Herbicide effects on T&E species

Galium buxifolium is a dicot species that may be susceptible to death by Garlon 3A. Although other woody species found in the same plant community as the bedstraw are able to recover from the herbicide spray, mitigation should be implemented to avoid spraying herbicide on this T&E plant if it is found within the fennel treatment area. This population is one

of eight populations known on Santa Cruz Island.

If fennel infestations are removed from *Galium* communities, more areas may open up for re-introduction of the native species via seed and plugs.

Effects of Implementing Pig Eradication:

Direct Impacts

Limited population size for T&E species make them more vulnerable to major impacts than other widely abundant species. Pig eradication activities that may directly impact T&E species include hunter trampling, and accidental fires that may result from firearm shooting, spike camp activities, or smoking.

T&E species most vulnerable to trampling are annuals like *Thysanocarpus conchuliferus* and *M. indecora*. Although these species would be protected for much of the year when they exist only as seeds in the soil, they would be prone to trampling effects when they are actively growing. Other species like *Galium buxifolium*, and *M. squalida*, would be protected due to their location on steep, coastal bluffs, areas that are unlikely to be traversed by either feral pigs or pig hunters.

Dudleya nesiotica is also in a fairly remote area but it is more accessible. Should trampling occur in a population of *Dudleya nesiotica* the impact would be negligible because of the large number of plants (30,000 – 60,000) within the population. *Berberis pinnata ssp. insularis* and *Malacothamnus fasciculatus var. nesioticus* would likely be protected from trampling because of their stature as large perennial shrubs.

Helianthemum greenei, a perennial shrub located in mostly inaccessible areas, is somewhat insulated from impacts associated with trampling. In the event of an accidental fire this species would likely be unaffected because its known life history appears to be that of a fire follower. There are four relatively large

occurrences of this plant on SCI, ranging from 500 to 1,000 plants each. These large number are believed to be related to the occurrences having been burned in 1994. It is likely then that the 10 smaller occurrences each have a substantial seed bank, which would be expressed once they are burned.

Arabis hoffmannii, limited to three sites on Santa Cruz Island, could be moderately impacted should severe trampling occur at these sites. *A. hoffmannii* is a short-lived perennial plant with a slender stature. Individuals could be trampled relatively easily. The severity of such an impact may depend on which stage of its life cycle the plant is disturbed. If an individual is disturbed in a non-flowering season, it is possible the plant may recover and reappear the following year. If the plant is in flower however this may not be the case as the plant normally dies after having flowered and set seed.

In the case of an accidental fire, the adverse impacts to threatened and endangered species – except for *H. greenei* – could be more severe. A large fire could cause major impacts to T&E occurrences within the burn area. T&E plants located on steep, coastal bluffs, or other areas where fire may not likely burn, would not be impacted. Fires which occur in the fall would only negligibly impact *T. conchuliferus* and *M. indecora* because they would be relatively insulated as seeds in the soil.

With the eradication of feral pigs, *Galium buxifolium* would have the ability to recover from pig grazing and rooting. *Galium*'s location on extreme coastal bluffs slopes should not be negatively effected by the eradication process, because vehicles, hunters, and dogs would not be frequenting such areas during the eradication process.

Long-term Beneficial Impacts

In the long-term, rare plant species should experience increased survivorship and seedling establishment and recruitment. Upon pig removal, rare plant species would likely benefit from decreased disturbance levels, increased

litter retention, and re-development of the soil crusts. As plant populations recover, they should be able to better withstand any natural disturbance events that may occur. Larger population numbers ensure against the loss of a few individuals and the formation of genetic bottlenecks. Replenishment of the seed bank - for those species that rely on natural disturbance events - means adequate seedling establishment and recruitment would occur when the next disturbance event hits.

An example of recovery by a rare plant species was demonstrated on Santa Barbara Island with the Santa Barbara live-forever (*Dudleya traskiae*), a succulent perennial that is endemic to the island. Santa Barbara live-forever was considered extinct due to the presence of feral rabbits on the island, which had been brought to the island by military personnel during World War II. By 1955, the feral rabbit population on the island peaked at about 2,600. Around that time, the National Park Service began shooting the rabbits. By 1958, the rabbits were largely extirpated from the island and by 1974, Santa Barbara Island live-forever began to reappear in areas that had been largely denuded by the rabbits (Sauer 1988). Today there are approximately 500 individuals of Santa Barbara Island live-forever.

Cumulative Effects

Past grazing disturbance is the largest factor that created unsuitable habitat for Santa Cruz Island's T&E species.

Present and future activities, as described in the beginning of this chapter and in Alternative One – Native Communities cumulative effects section, would only cause negligible additive impacts when considered with the impacts of this Alternative. This is because activities that could impact listed species or their habitat require review by NPS botanists for impacts. In addition, projects that may affect a T&E species' viability must have approval from the US Fish and Wildlife Service in order to be implemented. To avoid or minimize impacting T&E species,

mitigation would be incorporated into the project design. Prior to final approval for a project, NPS biologists are required to conduct field surveys to identify if T&E plants would be impacted by the project (as was done for this project). For example, when the park proposed opening up hiking trails from Prisoners Harbor to Scorpion Anchorage, NPS botanists surveyed for T&E plants. In one section of the trail where T&E plants were found to be vulnerable to trampling damage, mitigation was incorporated into the design of the trail to avoid impacts.

Mitigation and Monitoring

- Monitoring should be done to measure the increases in noxious weeds such as yellow starthistle. If infestations begin to occur, immediate action should be taken to remove such invaders. This would avoid causing a secondary invader species to become established and causing the same or more severe ecological impacts as the initial species being treated.
- Monitor T&E species for impacts caused by the eradication program. Should impacts be detected, immediately protect T&E plants by educating individuals if human caused, or by fencing the population or implement localized pig control.
- Post-eradication: out-plant with native species in highly degraded areas to encourage native species recruitment and soil protection.
- Continue efforts to propagate, and seed bank listed species in order to minimize the effects of a

potential catastrophic event. The park has received a permit from the US Fish and Wildlife Service (Permit # TE044846, 10/29/2001) to begin collection.

Fennel

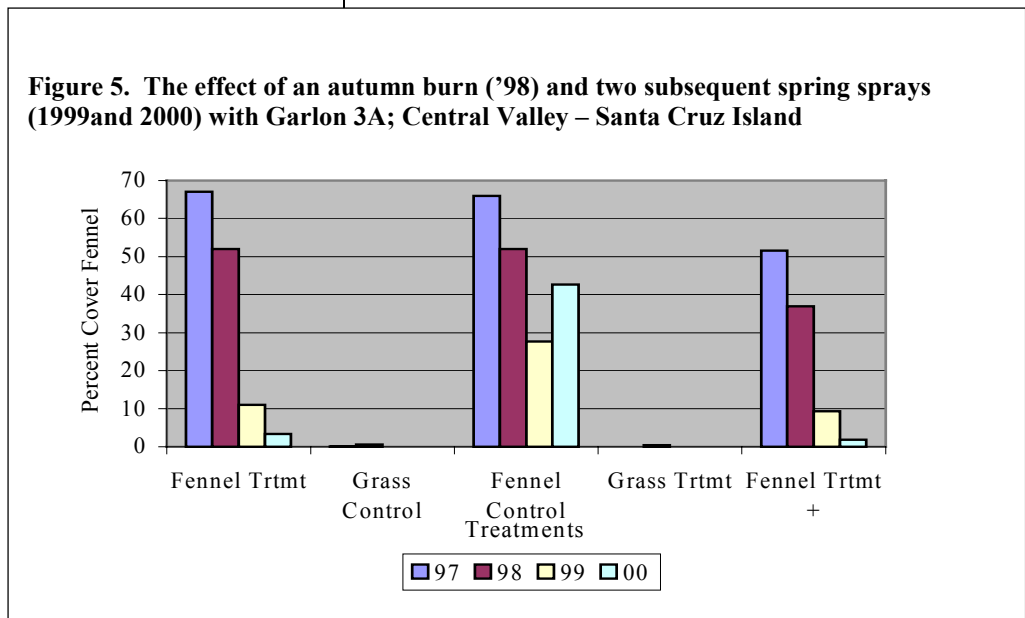
The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from being redundant, the direct and indirect “effect analysis” detailed below will be the same for Alternatives Three and Four.

Effects of Implementing Fennel Control

Fire Effects on Fennel

Direct and Indirect - Unless a fire has an extremely long residence time, the prescribed burn would not directly kill a significant portion of the fennel. Fire would consume the previous years’ woody stalks and leaves. A fire with a long residence time and a lot of heat may kill a portion of the fennel plants (See Figure 5 Comparison of ‘97-pre-burn to ‘98-post-burn). The prescribed burn would most likely not consume the fennel seedbank.

The prescribed burn would clear most of the fine fuels from the fennel treatment area leaving



bare disturbed areas of soil and gaps in the canopy. These types of soil and light conditions (open soil and more intense photon flux densities) are optimal for fennel seed germination; therefore the indirect effect of a prescribed burn may be the germination of many fennel seeds. The removal of dry fennel biomass would leave gaps in the fennel monoculture canopy as well, also producing optimal conditions for fennel seed germination. The removal of dead fennel biomass and the production of gaps around the individual fennel plants would increase the efficacy of the herbicide treatment because more fennel leaf surface area would be exposed to the herbicide.

Herbicide Effects on Fennel

Direct and Indirect - Garlon 3A is an auxin-type herbicide readily absorbed by both leaves and roots of plants (Ahrens 1994). Once absorbed by the plant Garlon translocates through the symplast of plants and accumulates at the meristems. Symptoms of the herbicide include epinastic growth of the stems, leaves, and petioles, abnormal leaf shape and vein appearance, and swelling of the nodes. Death generally occurs within 3-5 weeks if death is going to occur. Because fennel is a perennial plant, plant death after one year of spray only occurs in approximately 50% of the plants (Erskine unpublished data).

Although fennel cover decreased by over 75% after the first spray (1999) in the Central Valley fennel project (Fig 5), fennel cover also decreased by nearly 50% in the untreated (fennel control) plots. The winter of 1998/1999 was a La Niña winter with very little rainfall. Subsequently, the minute amount of precipitation negatively affected fennel growth. From 1999 to 2000 fennel cover increased by nearly 50% in the fennel control plots. If the fennel treated plots were only sprayed once, there could have been a nearly 50% increase in fennel cover in the previously treated plots. Instead, the second spray (2000) decreased fennel cover by an additional 70-80% (Figure 5).

Those fennel plants that survive the herbicide treatment have the ability to recover and set seed later the treated summer (Erskine personal observation). Of those plants that set seed, over 75% of the seeds produced from treated plants are viable (Erskine unpublished data). The greater the precipitation during the winter and spring, the greater the chance of fennel plant recovery. Because of the fluctuating environmental conditions, a minimum of two successive sprays is integral for fennel control. The first spray would thin out the expansive fennel stands making the second spray even more effective.

Cumulative Effects

Alternative Two includes fennel management and aggressive pig eradication. The proposed fennel treatment would decrease fennel cover facilitating hunters' ability to eradicate pigs. The pig eradication would stop the disturbance that is rapidly promoting the spread of fennel across Santa Cruz Island. With the eradication of pigs, fennel control would be a feasible goal on the isthmus, and in other areas of Santa Cruz Island where fennel occurs. Remnant fennel plants would still exist, but would be a minor component in the island's plant communities. Until fennel control is implemented on the isthmus, fennel seeds would continue to be spread by people and animals, possibly spreading seeds into fennel-free areas.

The result of past activities has had a major effect on the existing condition of fennel on the island. By implementing this alternative a major reduction in fennel would occur. Fennel would become a minor component in the island's vegetation communities.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible negative impacts to the mostly positive effects associated with the control of fennel. Present and future activities that could negatively contribute to fennel control would be the potential for humans and animals to transport seeds to areas that are

fennel-free. The greatest chance for this to occur is in the Central Valley and isthmus fennel patch, and would only be a negligible concern once the fennel control treatments are implemented.

Mitigation and Monitoring

The implementation of Alternatives Three and Four would require this same mitigation measure to avoid unintentional spread of fennel seed.

- To avoid spreading fennel to uninfected areas, personnel working in fennel infested areas will inspect and clean fennel seeds from clothing, shoes, equipment, and dogs in designated areas prior to leaving such areas.

Other Weeds

Effects of Implementing Fennel Control

Implementing fennel control would have limited benefit to decreasing other weed species on the island. The treatment area (isthmus fennel) proposed for fennel control is almost exclusively fennel in composition. However, the fire treatment may cause other weedy species to germinate if available in the seed bank. Germinating dicotyledons would be exposed to the Garlon 3A and would succumb along with the fennel.

Effects of Implementing Pig Eradication

Cessation of soil and vegetation disturbance by pigs would immediately, rapidly, and steadily benefit all native plant species, as well as non-native species such as the large suite of annual grasses already present. This would result in rapidly developing live and dead vegetation cover, which would prevent many seeds of invasive weeds from germinating. Since no alien plants are being controlled or restricted by pigs, cessation of pig impacts to soils and

vegetation would not increase alien plant distributions or abundances.

Dispersal of weed seeds by pigs from infested to weed-free areas would cease. Prevalence of favorable weed-seed germination conditions created by pig rooting and trailing would rapidly decrease.

Cumulative Effects

Past grazing and human disturbance have allowed the transport of weed seeds to Santa Cruz Island and has resulted in the current weed infestation on Santa Cruz Island. Implementing this alternative would decrease the existing footprint of weeds on Santa Cruz Island, benefiting many natural resource values.

Present and future activities, as described in the beginning of this chapter, could add negative effects to the weed effects identified under this alternative. Under this alternative, the potential for weed spread is generally lessened because pig disturbance is eliminated. Some localized weed spread may be noticed in areas where there is disturbance due to this alternative's implementation actions. Human activities have the greatest chance of transporting weeds from mainland sources to Santa Cruz Island. Continued pig presence poses the largest threat for transport and establishment of weeds intra-island.

This alternative would result in major beneficial changes to the vegetation and soil conditions making them less susceptible to weed infestation. Introducing other weeds as a result of human activity would add minor negative cumulative impacts to the long-term beneficial reduction in weed spread that would result in implementation of this alternative.

Mitigation and Monitoring

- Ground disturbing activities associated with the implementation of this alternative would be monitored to ensure that disturbed areas do not become weed-infested. These areas

would be treated if they pose a threat to natural resource values.

Issue 3: Island Fauna Impacts

Native Island Fauna

Effects of Implementing Fennel Control

Effects for implementing fennel control on island fauna is the same for Alternatives Two, Three, and Four.

Fire Effects on Vertebrate Species

There would be some direct and indirect effects of prescribed fire on rodents, reptiles and invertebrates, and virtually no effect on landbirds. The fire prescription for the fennel burn calls for a very hot fire in order to burn off fennel stalks, thatch, and seeds in the upper part of the soil. This would leave a mosaic with some patches of incompletely burned fennel in a matrix of ash. This type of burn would cause some direct mortality of deer mice, but the effect on the island's deer mice population would be moderate. Although woodland habitats may be better for mice than fennel (Mayfield et al. 2000), R. C. Klinger (unpublished data) found one fennel mouse grid to have 3-4 times as many deer mice in winter than grids in chaparral, coastal sage scrub, grasslands, and oak woodlands. Deer mice would recolonize burned areas once there is sufficient plant cover to provide protection from predation, and a food source exists (plants produce seed). Thus mice may be absent from a burned area for up to a year following the burn. If the burn blocks are large, this would also delay colonization. The fennel treatment (prescribed fire and two years of herbicide treatment) is likely to convert the fennel stands to alien annual grassland. Grasslands on the Channel Islands may be less desirable habitats for mice (Mayfield et al. 2000), and may be occupied primarily during years of high mouse abundance, when animals

disperse from the high-density, high-quality habitats (Schwemm and Coonan 2001).

Some Santa Cruz Island harvest mice, a federal species of concern, may be killed by a prescribed burn in the fennel. A small mammal grid in the Isthmus fennel was one of four plots where harvest mice were found during winter small mammal trapping from 1991 to 1995 (R. C. Klinger, unpubl. data).

The prescribed burn would thin the plant cover in the treatment area, which would decrease cover for lizards. Plant community structure and composition are important components in the determination of lizard species diversity and abundance (Pianka 1966, Gibson 2000). Gibson (2000) found a decrease in southern alligator lizards (*Elgaria multicarinata*) and an increase in side-blotched lizards (*Uta stansburiana*) after prescribed burning. *Elgaria* prefers cool humid environments (Kingsbury 1991), provided by fennel, and presumably relocates to these types of communities when the fennel is removed. Side-blotched lizards are "sit and wait" predators that exploit open spaces and ambush their insect prey when opportunity strikes (Pianka 1966). Grasslands or more open-structured, patchy communities are optimal for such foraging regimes. Prescribed burns lead to more open, patchy communities and would therefore favor *Uta* over *Elgaria*.

The prescribed fire would have both direct and indirect effects on Channel Island spotted skunks. There would be direct mortality of some skunks which are unable to avoid the hot, rapid fire called for in the prescription. Crooks and van Vuren (1995) found skunks to prefer ravines and avoid fennel grasslands, but skunk densities have increased on Santa Cruz Island concurrent with the island fox decline (Roemer 1999, Crooks and van Vuren 2000) and Dennis et al. (2001) had at least nine skunk captures in the fennel areas of the isthmus. Skunk use of burned-over former fennel habitat is likely to be light until significant vegetation recovery occurs. The prey base for skunks (invertebrates, mice) would be decreased for some time by the

prescribed burn. Spotted skunks are currently very abundant on Santa Cruz Island (Crooks and Soule' 1999, Dennis et al. 2001) and loss of a few individuals on the Isthmus is likely to have a negligible effect on the island population.

Herbicide effects on vertebrate species

Treatment with Garlon 3A would not directly affect lizards, birds or small mammals because in small concentrations, Garlon is not toxic to these creatures (Ahrens 1994). The reduction in fennel would change the structure and composition of the treated area. This structure change would indirectly affect insectivorous birds and lizards because plant community structure affects invertebrate species (Thorpe unpublished data). As mentioned above, Alligator lizards prefer more cool and humid environments, therefore the abundance of Alligator lizards would decrease with the herbicide treatment because of the decrease in fennel cover (Gibson 2000). Side-blotch lizards should increase with the increase in patchiness of the community. Small mammals that rely on fennel for protection from predators may relocate to more dense-canopy communities such as the chaparral and would likely decrease in fennel-treated areas.

Acute oral toxicity of triclopyr to mammals and birds can be found in risk assessments done for USDA (1992) and SERA et al. (1996) and are incorporated by reference into this Final EIS. Because no aquatic habitat exists within treatment area, no impacts to aquatic species would occur. Buffered between the treatment area and the Pacific Ocean are coastal bluffs. There is minimal chance that incidental spray drift or runoff would introduce herbicide mix into the ocean. Considering the low application rate and the required no-spray buffers, herbicide residues that reach the ocean would be undetectable and be of no toxicological consequence to aquatic organisms. Triclopyr does not bioaccumulate so long-term persistence in the food chain and subsequent toxic effects are not expected. In addition, there is expected to be no neurotoxicity, immunotoxicity, or

endocrine disruption effects to wildlife with the use of triclopyr (Durkin and Diamond 2002).

Use of R-11[®] surfactant around aquatic environments have been linked to impacts to aquatic organisms. The chemical linked to this impact is nonylphenol (NP), the raw ingredient needed to make NPE, the main ingredient in R-11[®] (Bakke 1999). No impacts are expected to aquatic organisms because there is no aquatic habitat within the treatment area. NPE and NP rapidly breaks down in aerobic conditions into primarily carbon dioxide and water (Bakke In Prep.). This rapid microbial degradation would make it unavailable in the environment. Use of R-11[®] is not expected to pose any ecotoxicological impacts to terrestrial species within the treatment area because of the low concentration of use within the herbicide mix and its rapid degradation in aerobic conditions. Bakke (1999) is incorporated by reference into this Final EIS and will be available for review upon request. Toxicity information for NPE is given below.

Nonylphenol polyethoxylate (NPE)

Oral – Rat LD50 580-1,620 mg kg⁻¹
Dermal – Rabbit LD50 >2,000 mg kg⁻¹
Subchronic – Rat LOEL 25 mg/kg/day

Fire effects on Invertebrate Species

Overall, fire would not affect populations of invertebrate species on the island. There would be some direct mortality of some invertebrates consumed in the fire, and invertebrates that favored fennel would not recolonize the burned area until sufficient plant recovery occurs.

Herbicide effects on invertebrates

Garlon 3A should not directly affect the invertebrate species unless invertebrates receive approximately 100µg of Garlon 3A. The lethal dose of Garlon for honeybees was found to be greater than 100µg/bee (Ahrens 1994). Garlon 3A is an auxin-mimicking herbicide, and auxin is a hormone only found in plants.

The herbicide would have minor indirect effects to invertebrate species by changing the structure of the treated area. Those areas sprayed would have more gaps and less vertical structure than unsprayed communities (both native communities and fennel monoculture communities). Preliminary data indicate that fennel infested areas have over 15% more invertebrate families than grassland communities when comparing invertebrates attracted to aerial and ground-placed yellow bowls, common invertebrate collection techniques (Thorpe unpublished data). Invertebrate species that prefer highly structured communities would likely move from fennel-treated communities to more structured communities such as oak woodland and chaparral. Invertebrate species that prefer less vertically structured plant communities should increase in the years following the Garlon spray.

Fire and Herbicide Effects on Island Foxes

To mitigate direct impact, the prescribed fire would be conducted to avoid adverse impacts to island foxes. Recent island fox investigations show that fennel stands on the isthmus harbor one quarter to one third of the island's remaining 50-60 island foxes (Dennis et al. 2001). Foxes may be using the fennel because it provides good cover and protection from aerial predators. Several foxes trapped in the fennel had eye injuries, perhaps to the point of blindness. Eye injuries are likely a result of being poked by the dried brittle fennel stalks that get shoved over by the feral pigs. A hot, rapidly spreading prescribed fire could cause direct mortality of some foxes. To mitigate this, foxes would be trapped and held during the period of the burn. Because not all foxes will likely be trapped, there is still a possibility that several foxes could perish in the burn. To mitigate this, the prescribed burn and subsequent herbicide treatment would be deferred until the fox population has recovered to the point where it can withstand some direct mortality from a fire.

Indirect effects of the prescribed burn on island foxes involve changes in habitat quality.

Although fennel is not a natural habitat type on the islands, it is favored by foxes (Crooks and van Vuren 1995, Dennis et al. 2001) perhaps because it provides protection from predation. Prescribed fire and subsequent herbicide treatment would greatly reduce vegetative cover in the area, and would expose remaining foxes to predation. Deferring the burn until all golden eagles are removed may offer additional protection to these remaining foxes.

Use of prescribed fire would also likely disrupt fox reproduction in the isthmus, for perhaps one breeding season. Island foxes typically exist as mated pairs which defend territories, and loss of foxes disrupts the social structure in an area (Roemer 1999). If foxes were to be trapped and held for the duration of a burn, upon release back into their former territory the profound changes in habitat structure may cause foxes to disperse from the area. Because the burn would occur in fall, this disruption would occur at the same time that island fox pair formation would be naturally occurring ahead of winter-spring breeding. It is therefore likely that fox pairs defending territories in fennel would have breeding disrupted for a season as a result of a prescribed burn. Appropriate mitigation for this would be to defer the burn until such time as the island's fox population could withstand loss of a breeding season for several pairs of foxes.

Short-term effects on island fox prey from a prescribed burn could be negative. Many invertebrates and deer mice would perish in the fire, and those prey would not occur in significant numbers until vegetation recovery occurs. Mid-term habitat effects on foxes could be beneficial, after invertebrates and deer mice reestablish, because the burned areas may be easier to hunt than other, thicker vegetation types. In the long term, the treated fennel areas may convert to annual grasslands, which are not preferred habitat for island foxes (Crooks and van Vuren 1995) and in fact may be avoided by island foxes because of the lack of suitable prey (G. Roemer, New Mexico State University, pers. comm.). Over time shrubland habitats are likely

to become established and would again become suitable fox habitat.

Treatment with Garlon 3A would not directly affect island foxes because in small concentrations, Garlon is not toxic to small mammals (Ahrens 1994).

Effects of Implementing Pig Eradication

Under this alternative, pigs would be removed from the islands in a two-year period. The removal of pigs overall would have major beneficial effects on island wildlife and fauna.

Removal of pigs would remove a direct mortality factor for invertebrates during certain times of year, since invertebrates are a part of the pig diet. Pigs would no longer adversely impact wildlife on Santa Cruz Island by destruction of suitable habitat. The cessation of pig rooting in specific locales would improve habitat for rodents, lizards, snakes, salamanders, foxes and skunks. Pig removal from riparian areas would improve riparian habitat for frogs, salamanders, and aquatic invertebrates. The removal of pig rooting for acorns in years of significant mast would improve habitat for those species, such as the Santa Cruz Island jay, which depend upon mast crops.

Implementation of simultaneous islandwide removal of pigs would cause a temporary increase in the number of pig carcasses on the island. For the two years of continuous hunting prescribed under this alternative, the annual number of pig carcasses would be numerous. After eradication, there would be no pig carcasses on the island. The temporary availability of those pig carcasses would provide scavengers such as common ravens, golden eagles, bald eagles, and other pigs with increased food opportunities. However, intense hunting activity would dissuade golden eagle use of hunted areas, because they are very sensitive to human disturbance. Ravens in particular may be temporarily more abundant on the island for those two years of hunting. On neighboring Santa Rosa Island, more raven

activity was noted during pig eradication efforts on that island (K. Faulkner, NPS, personal communication). Ravens in general tend to be abundant on the northern Channel Islands (Jones et al. 1989) where they may be supported by carrion such as pinniped and ungulate carcasses.

Over the long-term, removal of pigs would eliminate the primary prey base for non-native golden eagles. Pigs would no longer attract and support a breeding population of golden eagles on Santa Cruz Island. This would ensure that golden eagles would no longer be the primary mortality factor on island fox populations on the northern Channel Islands.

Pig eradication actions themselves would have slightly negative impacts on island wildlife and fauna over the two-year removal period. The dog-hunter teams, which would necessarily traverse almost all areas of the island at least once, would have the following impacts. Dogs and hunters moving through the brush may encounter and inadvertently harass wildlife species such as island foxes and spotted skunks. Foxes in particular may react negatively to dogs. Foxes are likely to flee from dogs, and thus fox use of habitat and home ranges may be altered. It is unknown if these shifts in use would result in reduced fitness or survival of individual foxes. To avoid fox harassment, any dog exhibiting persistent aggression towards island fox would be removed from service.

Dogs used in the pig hunting would be vaccinated for common canine diseases. This is to ensure that there would be no chance of transmission of such diseases to the island fox population on Santa Cruz.

Cumulative Effects

Alternative Two, the control of fennel and the immediate eradication of feral pigs, would initially displace those species that utilize the structure of fennel. Chaparral, coastal sage and oak woodlands, all structurally diverse communities surround the fennel stands on the isthmus. Those species displaced by the

removal of fennel would return to the native plant communities that they originally foraged in or inhabited. The removal of feral pigs would possibly allow for the succession of such native, structurally diverse communities into the previously fennel-infested areas. The reintroduction of native plant species would initially attract invertebrate species that prefer structurally rich communities, which would further support those vertebrate species originally displaced with the removal of fennel. Species that prefer the less structurally diverse grassland communities would use the fennel treated areas that are dominated by annual and perennial grasses.

Alternative Two, the control of fennel and the immediate eradication of feral pigs, would initially displace those invertebrate species that utilize the structure of fennel. Chaparral, coastal sage and oak woodlands, all structurally diverse communities, surround the fennel stands on the isthmus. Those species displaced by the removal of fennel would return to the native plant communities that they originally foraged in or inhabited. The removal of feral pigs would possibly allow for the succession of such native, structurally diverse communities into the previously fennel-infested areas.

Those invertebrate species that prefer vertically simple plant communities would initially benefit from fennel control and pig eradication. As successional processes proceed, their habitats would decrease, and they would have to relocate to other grassland areas.

Other management actions for natural resources on Santa Cruz Island would have effects on island fauna, particularly island foxes. Golden eagles are currently being relocated from Santa Cruz Island, and probably would be on an annual basis until pigs are removed from the island. Relocation of golden eagles from the island would increase survivorship of island foxes on Santa Cruz Island. The NPS is working with several other agencies to study the introduction of bald eagles to the northern Channel Islands. As part of the study release of juvenile eagles may occur on Santa Cruz as

early as summer, 2002. If bald eagles successfully breed on the island, their territorial nature may discourage golden eagle use of the island, thus preventing golden eagle predation of island foxes. These positive effects on fox survivorship would continue until pigs are removed. The removal of pigs would have positive effects on fox survivorship. Without a feral pig prey base, golden eagle use of Santa Cruz Island should be minimal.

The NPS and TNC will also begin a captive breeding program for island foxes in 2002. Combined with golden eagle removal, island fox captive breeding should help increase the wild fox population on Santa Cruz Island from the current 50-60 foxes to several hundred foxes, thus minimizing the chance of extinction for this subspecies.

Mitigation

These mitigation measures are the same for Alternatives Three and Four. To mitigate possible impacts to island foxes, the following measures will be taken:

- Defer the burn and herbicide treatments until the island's fox population is robust enough to withstand some direct mortality of a few individuals, and disruption of breeding for several territorial pairs of island foxes. Demographic modeling will be conducted to determine the target island fox population size that can withstand these effects.
- Trap as many island foxes as possible from the proposed treatment area, and hold until the burn is completed. Radiocollar foxes prior to release back into treated area, to determine effects on habitat use, dispersal, and breeding.
- Dogs, prior to being allowed on the island, will be vaccinated for all common canine diseases. Owners will be required to submit inoculation documentation.
- Dogs exhibiting persistent aggression toward island foxes encountered in the field will be removed from service.

Threatened and Endangered Species (Alts Two-Four)

As described in Chapter Three there are three T&E species that occur on Santa Cruz Island (Western snowy plover, California brown pelican, and Bald eagle). Bald eagles were just recently introduced in May 2002. The island fox is proposed for listing. The activities associated with pig eradication or fennel control is not expected to have negative effects to the snowy plover, brown pelican, or the recently introduced bald eagle.

Snowy plovers have been sighted on Christy, Pozo, and Johnson beaches, however, no nesting has been observed (Laughrin pers. comm). Activities associated with pig eradication would be minimal and infrequent in these locations. Brown pelicans occasionally roost on Santa Cruz Island but do not nest on the island. Pig eradication activities, on an infrequent basis, may occasionally disturb individual roosting pelicans causing them to temporarily relocate to an alternate roost site. Bald eagles are intensively being managed by wildlife experts during the feasibility study period. To ensure no negative effects, contact by humans at hack sites, where bald eagles are most vulnerable, is being managed by The Institute for Wildlife Studies. Free-soaring bald eagles may scavenge on pig carcasses, because non-lead bullets would be used to kill pigs, lead poisoning is not a concern.

Park biologists will seek concurrence with the U.S. Fish and Wildlife Service on its determination that implementation of pig eradication or fennel activities would have “No-Effect” on these listed species.

Non-native Fauna (Pigs)

Effects of Implementing Fennel Control

The current large fennel stands on Santa Cruz Island impede successful hunting of pigs within them. Treatment of these fennel stands

with the methods described in Chapter Two would decrease fennel cover enough to allow successful pig hunting operations to occur. It would also reduce suitable habitat for feral pigs.

Effects of Implementing Pig Eradication

Under this alternative, the entire pig population, estimated at approximately 3,000-5,000 individuals, would be removed over a two-year period. Pigs would be killed either by live-trapping and then shooting with a handgun, or by hunters teamed with dogs and shooting.

Cumulative Effects

Past activities, such as the initial introduction of pigs to Santa Cruz Island has resulted in the current feral pig population.

Present and future activities, as identified in the beginning of this chapter, would have negligible effects to feral pig population on the island. It has been reported that people have provided food to feral pigs, and if visitation increases, more unauthorized feeding may continue to occur. This intermittent feeding would have negligible effect in the interim period prior to eradication.

Issue 4: Impacts to Physical Resources including Soils, Water and Air Quality

Effects of Implementing Fennel Control (Alts Two-Four)

Fire Effects on Soils and Water Quality

Direct and Indirect - Fire converts a portion of the organic carbon from a system into CO₂ and CO during a fire. Fire also converts a large portion of the plant material into nutrient-rich ash. Nutrients are lost from the system as both gas and particles of smoke. Portions of the soil N and S are released as N₂ and SO₂ gas. Fire increases extractable P and the rate of

nitrification. Fire decreases organic P, phosphatase activity, and total soil N (Schlesinger 1997). Generally grassland fires do not heat up the soil to the point of soil sterilization (killing soil microbes).

With the accumulation of ash on the soil surface, there is an increase in nutrient availability. Ash also increases the availability of cations and P in the soil, and increases soil pH. Increased nitrification rates because of fire result in the loss of NO and N₂O, and the increased availability of NH₄⁺ and NO₃⁻ (Schlesinger 1997). The removal of vegetation from soil via fire can indirectly effect the soil by increasing the possibility of run-off and erosion, especially with heavy rain and lack of vegetation after a fire.

Herbicide Effects on soil and water

Direct and Indirect - Garlon 3A (active ingredient Triclopyr) does not strongly adsorb to the soil. Garlon is rapidly degraded by microbes and by photolysis in water, with a half-life of 10 hours at 25°C (Ahrens 1994). Garlon 3A's persistence in the soil is moderate, with a half life ranging from 10-46 days (averaging 30 days) depending on soil type. Garlon 3A is first converted to an acid, and then neutralized to a salt. Negligible amounts of Garlon 3A are lost to volatilization (Ahrens 1994). Studies have found that, in general, triclopyr does not tend to move below the top 15 cm of soil in significant amounts (Newton et al. 1990, Norris et al. 1987, Stephenson 1990).

In water, Garlon 3A is water-soluble and is degraded rapidly in the water column through photolysis and hydrolysis (McCall and Gavit 1986). Triclopyr acid has an immediate soil sorption capacity. Thus, movement of small amounts of triclopyr residues following the first significant rainfall are likely (McCall and Gavit 1986), but further leaching is believed to be minor (Newton et al. 1990), and movement in surface and subsurface runoff in areas with minimal rainfall is believed to be negligible (Stephenson et al. 1990). Norris et al. (1987)

found that neither leaching nor long-distance overland water flow contributed significant amounts of the herbicide into a nearby stream, concluding that the use of triclopyr posed little risk for "non-target organisms or downstream users". There is no live-water within the fennel treatment area.

Garlon 3A is readily absorbed by both monocot and dicot, leaves and roots. Living monocots quickly metabolize Garlon and are unaffected by the herbicide while dicots are killed. Microorganisms and weather conditions would degrade those plants killed by the herbicide releasing previously plant-bound nutrients into the soil. The herbicide treatment would also decrease the cover of fennel, which in turn would decrease cover for feral pigs, which should reduce the amount of rooting on the isthmus. The smaller fennel density would also lower the amount of fennel alkaloids secreted into the soil.

Air Quality Impacts from Rx Fire (Alts Two – Four)

Air quality impacts would be similar for Alternatives Two, Three, and Four.

Smoke from prescribed fires is a complex mixture of carbon, tars, liquids, and different gases. This open combustion source produces particles of widely ranging size, depending to some extent on the rate of energy release of the fire. The major pollutants from wildland burning are particulate, carbon monoxide, and volatile organics. Nitrogen oxides are emitted at rates of from 1 to 4 g/kg burned, depending on combustion temperatures. Emissions of sulfur oxides are negligible.

Particulate matter is the term for solid or liquid particles found in the air. Some particles are large or dark enough to be seen, such as soot or smoke. Others are so small they can be detected only with an electron microscope. Breathing particulate matter can cause serious health problems. Particulates also reduce visibility in many parts of the U.S.

Most particulate emissions from prescribed burning (over 90 percent) are less than 10 microns (μ) in diameter (PM-10). This size particulate is considered to pose particular health concerns because PM-10 is small enough to enter the human respiratory system and has been linked with premature death, difficult breathing, aggravated asthma, increased hospital admissions and emergency room visits, and increased respiratory symptoms in children.

Fine particles also scatter and absorb light, creating a haze that limits our ability to see distant objects. Particle plumes of smoke, dust, and/or colored gases that are released to the air can generally be traced to local sources such as industrial facilities or agricultural burning. Regional haze is produced by many widely dispersed sources, reducing visibility over large areas that may include several states.

Under favorable meteorological conditions, haze from the fennel fire would not likely affect the visibility on the mainland given the distance smoke would have to travel to reach the mainland (25+ miles). For the same reason, smoke pollutants would not likely pose a health risk to the mainland population. However, given the prevailing winds, visitors on East Santa Cruz Island could be exposed to both haze and smoke.

Effects of Implementing Pig Eradication

Soil and Water Quality Impacts from pig eradication

Direct - Soil disturbing activities from pigs would be eliminated within three years of implementation of this alternative. Elimination would eventually allow disturbed areas to heal over with vegetation. No new pig rooting areas would be established. Activities associated with the eradication effort could cause localized erosion, especially in areas where new road or trails become established. If use of these trails and roads cease upon conclusion of the activities, the impacts would be short-term.

Indirect – Eventually, erosion from already disturbed sites would decline as the sites establish vegetation cover. As vegetation cover increases, overall watershed conditions would continue to improve. As watershed conditions improve, runoff within the watershed would be more readily intercepted by vegetation and be absorbed on site. This would cause less intense runoff events and decrease the rate of gully erosion (aggradation and widening). Less intense runoff events would cause less sediment delivery into local waterways.

Pig carcasses can impact water quality depending on the number (mass) of dead animals in a given location, decomposition rate, distance to live water, and distance to groundwater.

Dead pig carcasses can release into its surroundings a whole host of water quality affecting compounds including: Nitrates, TDS (total dissolved solids), chloride, and ammonium-nitrogen. The rate of these releases is dependent on the decomposing environment. For instance, in anaerobic conditions (like underwater or extremely moist soil conditions) carcass decay is very slow. Release of these compounds off of the carcass would be prolonged with elevated concentrations above EPA standards. In contrast, in well-drained conditions a carcass can decompose fairly rapidly, with little or no effect on groundwater.

To keep concentrations of the above compounds at near normal ranges would require dead carcasses not be left in or near live water sources, or in shallow groundwater areas with poorly drained soils.

Air Quality Impacts from Pig Eradication

In general, emissions from construction activities for implementation of this alternative may include: 1) earth movement and brush clearing; 2) road and non-road construction vehicle exhaust emissions; and 3) fugitive dust emissions caused by vehicles traveling on unpaved roads. These activities would generally be occurring at very low intensity

levels and their impact to air quality would be negligible.

Cumulative Effects

Soil and Water Quality

Under this alternative fennel management would occur in conjunction with aggressive pig eradication. The burn and first of two sprays would occur before pig eradication begins, reducing the fennel cover and density to facilitate pig eradication. The two to three year time period for pig eradication would decrease the duration of pig rooting on the isthmus. Soil compaction would likely occur by the trampling of hunters and dogs, but the relatively short time period of this disturbance and the removal of pigs and pig-rooting disturbance would negate the compaction. The removal of pigs would decrease soil erosion by eliminating pig rooting, and by allowing plant species recovery in previously rooted areas.

The result of past activities, mainly domestic and feral livestock grazing, has had a major effect on the soil conditions on Santa Cruz Island. However, removal of cattle and sheep over the last 15 years has halted overgrazing and has prompted recovery in many areas. Major beneficial cumulative effects to soil and watershed conditions would be realized when the positive effects of removing sheep and cattle are combined with the eradication of pigs.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible detrimental soil and water quality impacts to the long-term beneficial effects that would be realized with the eradication of pigs.

Air Quality Cumulative Impacts (Alts. Two-Four)

The phenomenon of "Santa Ana" winds that come from a northeasterly, inland direction, can greatly affect air quality in the park. These winds usually occur during fall and winter and

are characteristically warm and dry and may be of very high velocity near the mainland shore. They primarily affect those islands close to the mainland by carrying out to sea the air pollution usually found onshore. Satellite images show that Santa Ana winds can carry pollutants several hundred miles offshore and have the potential to negatively affect all of the park islands. It is likely that the prescribed burn would not occur under Santa Ana wind conditions because of their unpredictable nature.

A bigger concern relative to air pollutants in the Channel Islands is a "Catalina eddy" that can bring pollutants up the coast from the Los Angeles basin and a post-Santa Ana event where the air pollutants that were pushed offshore come slowly back to the coast. The fennel burn in these conditions could add minor air pollutants to this air mass as it moves towards the mainland.

Another type of pattern that would bring moderate levels of air pollutants to the Channel Islands is an eastern Pacific high pressure system that causes light winds and poorly dispersed air. Normally, the sea breeze pushes the air pollutants to the coast and keeps low levels of air pollutants in the Channel Islands. The fennel burn conducted in these conditions would moderately affect air quality on Santa Cruz Island and negligibly affect air quality on the mainland.

Future projects that require vehicle use or construction activities would negligibly contribute to air quality impacts associated with this alternative.

Mitigation

Soil and Water Quality

- Dead carcasses will not be left in or near live water sources, or in shallow groundwater areas with poorly drained soils.
- Actions that result in significant soil disturbance will be evaluated to determine if erosion abatement needs to occur. Erosion

abatement would occur if NPS or TNC restoration biologists feel it necessary to protect soil resources.

- Herbicide will not be applied in drainages that do not contain the target species.

Air Quality

The NPS is required to conduct the fennel burn within certain limitations posed by the Santa Barbara Air Pollution Control District. These limitations are intended to minimize smoke impacts, they include but are not limited to:

- Begin ignition only when favorable meteorological conditions are present.
- The vegetation to be burned shall be in a condition that will facilitate combustion and minimize the amount of smoke emitted during combustion.
- The total amount of material to be burned each day shall be regulated according to criteria approved by the APCD Control Officer.
- NPS, working with the concessionaire, will give notification to visitors that have heart or lung disease, such as congestive heart disease, chronic obstructive pulmonary disease, emphysema or asthma to avoid areas that could become smoke infested.

Issue 5: Socioeconomic Factors including Cultural Resources and Human Uses

Cultural Resources

Effects of Implementing Fennel Control

Controlled burning of the fennel stands to reduce vegetation density for hunting creates the most potential for harm to cultural resources under this alternative. Within the fennel-

vegetated areas are archeological sites and burials, as well as fences and other features related to the island's historic ranching operations. At least 26 archeological sites have been identified within the 2,000-acre burn area.

The 1950 Campo Del Norte ranch complex and an unknown number of fences, corrals, telephone poles and stock tanks relating to the ranching era are also located within the burn area. All of these resources are susceptible to damage or destruction by fire, cutting of fire lines, staging activities, and vehicle and foot traffic. Adverse effects of these activities can be avoided or mitigated through surveying the areas for historic resources, hand-cutting vegetation on and around these resources, reburying known exposed burials (in consultation with the Chumash), and using an archeological monitor to avoid damage to archeological sites when establishing fire lines, access routes and staging areas. A post-burn archeological survey would be carried out, with the participation of a Chumash monitor, in case exposed human remains are encountered.

Effects of Implementing Pig Eradication

This alternative would result in the most rapid eradication of pigs and therefore result in complete islandwide protection of archeological resources from feral pig impacts in the shortest time period. The integrity of the island's National Register-listed archeological district has already been compromised to a great degree by pig rooting through disturbance of nearly all of the island's archeological sites, including ancient burials. Eradicating pigs is a necessary action for long-term protection of the archeological record on Santa Cruz Island.

Feral pigs would continue to disturb archeological sites and burials on the island until their eradication is complete. Pig rooting is currently estimated to have damaged nearly all of the archeological sites on the island, to some extent. Pig rooting to a depth of three feet has been noted in a number of sites, particularly in areas covered by fennel or wild cucumber (Dr.

Jeanne Arnold, personal communication). The information potential of some shallow sites and surface scatters has been completely destroyed by pig rooting. Rooting in the upper layers of deeper, more complex, stratified sites profoundly disturbs time and spatial relationships and destroys the context of the information contained in these sites.

Until pigs are eradicated, NPS would continue to try to protect the archeological record by fencing a small number of sites each year, as funds allow, and to monitor the fenced sites to ensure that they remain pig-free. Once the pig eradication was completed, the fences would be removed.

Impacts to the island's cultural resources by the hunting operations are anticipated to be negligible and would primarily take the form of vehicle and foot traffic over archeological sites. Impacts of this nature would be minimized by orienting the hunting groups to the sensitivity of these sites to damage and requesting that they avoid traffic over them whenever possible. Campsites and trap locations would be surveyed in advance to avoid locating them in any culturally sensitive locations.

NPS plans to upgrade existing facilities where needed, such as housing and infrastructure, for use by the contract hunters. NPS would evaluate the proposed repairs and alterations to historic buildings and structures to ensure that proposed work meets the Secretary of the Interior's *Standards for Rehabilitation*. NPS would consult with the State Historic Preservation Officer (SHPO) where necessary under the programmatic Memorandum of Agreement among the NPS, The National Conference of SHPOs and the Advisory Council on Historic Preservation.

NPS has initiated consultation with the State Historic Preservation Officer and the Chumash under Section 106 of the National Historic Preservation Act, with regard to the potential adverse effects of hunting activities and burning of the fennel and proposed mitigation actions

and is preparing a Memorandum of Agreement to address these effects.

The Santa Cruz Island Archeological District is significant for the large number and diversity of pristine sites found on the island. Sites range from isolated artifacts to huge, stratified sites encompassing habitation areas and specialized activity areas spanning a period of 8,000-9,000 years. Pig eradication would result in a larger archeological database. The number and diversity of sites would be retained allowing the National Register district to go forward with a greater number of eligible sites. The value of remaining archeological sites would be retained, and future researchers would be able to take advantage of new research techniques that may be developed in the future.

Cumulative Effects

The ranching era on Santa Cruz Island conducted land-disturbing activities that impacted archeological sites throughout the island. The land disturbing activities that impacted archeological sites to the greatest degree have been road building, sheep grazing (cause of most hillside slumping), and the introduction of feral pigs. These activities have been irreversibly impacted these archeological sites. The permanent impact of those activities when added to the potential permanent cultural resource impacts of implementing the fennel burn and the negligible impacts associated with pig eradication activities would result in a net increase in the number of sites permanently impacted. This increase may only be slight if the fennel burn incorporates mitigation measures to minimize harm to cultural resources.

Present and future activities, as described in the beginning of this chapter, would add negligible impacts to the already negligible cultural resource impacts that would result from pig eradication activities. Negligible impacts are expected because all planned activities must undergo a review process that is intended to identify potential impacts to cultural resources. The review would specify mitigation measures

that need to be implemented in order to minimize impacts to cultural resources. This review process does not account for unauthorized activities that may occur such as visitors taking artifacts, or anchored boaters coming ashore and disturbing archeological sites.

Mitigation

- Conduct hunter orientation to instruct hunters on how to avoid impacting archeological sites.
- Survey campsites and trap locations to avoid locating them in any culturally sensitive locations.
- If cultural resources are found during survey activities for the fennel burn: hand-cut vegetation around resources; rebury known exposed burials (in consultation with the Chumash); use an archeological monitor to avoid damage to archeological sites when establishing fire lines, access routes and staging areas.
- Conduct post-burn archeological surveys with Chumash monitor in case exposed human remains are encountered.

Human Uses

Effects of Implementing Fennel Control

Herbicide Application – Human Exposure (Alts 2-4)

The application of Garlon 3a (active ingredient triclopyr) poses minimal health risks to humans and animals. The standard for assessing these risks is through a risk assessment. A risk assessment evaluates the relative risk to humans based on the toxicity and potential exposure to the herbicide. Minimizing exposure to the herbicide minimizes the relative health risk. Proper protective equipment (PPE) can also minimize exposure to the herbicide.

The determination of relative risk associated with implementing the fennel treatment on the isthmus of Santa Cruz Island uses relevant information from two risk assessments (USDA 1992; SERA et al. 1996). These risk assessments are relevant because both risk assessments evaluate the same activities (aerial and ground application) and their exposure risk, and the same herbicide (triclopyr) and its toxicity, as those being proposed for fennel treatment. Both risk assessments are being incorporated by reference into this Final EIS and will be available for review upon request. A summary of relative risk associated with implementation of the fennel treatment is as follows:

Applicators

USDA (1992) assessment analyzes two scenarios for applicators and was based on worker-field studies. Routine-typical exposure scenario is based on average conditions, such as average application rate, average number of acres treated, average buffer distances, and average doses seen in field-based exposure studies. The routine-extreme exposure scenario is based on the upper limit of the 95-percent confidence interval of the doses observed in field studies instead of the mean dose. SERA (1996) uses central estimates for determining exposure rates.

Ground and Air Application – USDA (192) found that there is low risk (of systemic or reproductive effects) to workers applying triclopyr (aerial or ground) under routine-typical scenarios. Under routine-extreme scenario there are moderate systemic effects to workers performing aerial, backpack, or ground applications. There are high risk systemic effects to the mixer/loader for aerial operations and to hand applicators (hack and squirt). There are moderate risk reproductive effects for mixers/loaders for aerial application and high-risk reproductive effects for hand applicators (hack and squirt). There is low risk of cancer associated with workers using triclopyr under routine-typical or routine extreme scenarios.

Similar conclusions are made from SERA (1996). For workers, no exposures approach levels those are likely to produce frank signs of toxicity. However, there is a reasonable concern that workers applying triclopyr at 1lb AI/acre over a prolonged time in the course of a single season or over several seasons could be at risk of impaired kidney function. Workers who apply triclopyr only occasionally probably would not have any significant adverse effects.

Public

The exposure scenario used for the general public is considered to be short-term exposure. Both assessments analyzed health risk to the public for the use of triclopyr based on different application methods (aerial, backpack, and ground mechanical applications). The scenarios that were analyzed included spray drift dermal contact, vegetation contact by immediate reentry hiker, drinking directly sprayed water. USDA (1992) found low risk to the public from use of aerial or ground application of triclopyr. SERA (1996) concludes that there is little concern for acute exposure given the exposure scenario.

Accidents

In the event of an accident, members of the public and workers may be exposed to much greater amounts of herbicide than under normal exposure conditions but for relatively brief periods of time.

USDA (1992) found that workers who spill the concentrate or some of the prepared spray mixture on their skin during mixing, loading, or spraying operations or who are doused if a transfer hose breaks would be dermally exposed. Workers or members of the public who are accidentally sprayed with herbicide because they are beneath a spray aircraft or are too close to a truck or backpack applicator would receive a dermal dose.

Members of the public may be accidentally exposed to the herbicide by eating food or drinking water that has been directly sprayed. Under a scenario where an accidental spill of

triclopyr concentrate or mixture occurs in a waterway (depending on the amount of water) then drunk by the public would result in moderate to high systemic and reproductive effects. This scenario is unlikely within the fennel treatment area because there is no live water that is available for drinking. There is a closed water supply system that is supplied to Del Norte Ranch within the fennel treatment area.

Based on the accident scenario found in the risk assessment, for workers there is high risk of systemic and reproductive effects if there is purely a concentrate spill, or concentrate spill with carrier at maximum application rate. Dermal exposure to directly sprayed workers based on the scenario (maximum application rate and coverage of 2 ft.² of skin area exposed) would result in low risk of systemic or reproductive effects.

SERA (1996) based on their exposure scenario (immersion of hands and lower leg spill) would not result in levels of exposure that would result in any detectable adverse effect.

Neurotoxicity, Immunotoxicity, and Endocrine Disruption

Durkin and Diamond (2002) addressed the impact of triclopyr on neurotoxicity, immunotoxicity, and endocrine disruption on humans and other species. This report is being incorporated by reference into this Final EIS and will be available for review upon request. Summaries of their findings are as follows:

Neurologic Effects: There is no evidence for triclopyr being a direct neurotoxicant in humans or other species. Studies conducted on rodents, dogs, monkeys, birds, and amphibians have not provided evidence of direct neurotoxicity, even at the maximum tolerated dose. Two studies found evidence for possible neurologic effects of triclopyr in fish. This would be of no consequence to the fennel treatment program because there are no fish within the treatment area. Any input of triclopyr into the ocean would be done indirectly through

runoff or possibly drift. These amounts would be undetectable and of no consequence.

Immunologic Effects: The toxicology of triclopyr has been examined in subchronic, chronic, and multigeneration studies in rodents and in subchronic studies in dogs. In these reviews of the toxicity of triclopyr, morphologic abnormalities in lymphoid tissues – indicative of potential damage to the immune system – have not been reported.

Endocrine Disruption: Extensive testing in experimental animals provides reasonably strong evidence that triclopyr is not an endocrine disruptor.

Conclusion: Durkin and Diamond (2002) concluded that based on risk assessments and current literature, there is no scientific basis for asserting that triclopyr causes specific toxic effects on the nervous system, immune system, or endocrine function.

Bioaccumulation

Bioaccumulation is the buildup and storage of chemical residues in body tissues high in fat content. All currently used herbicides (including triclopyr) are quickly metabolized and excreted. Because modern herbicides are detoxified and/or eliminated fairly rapidly from the body, they are not stored in fatty tissues and therefore do not bioaccumulate (Felsot 2001).

Other Ingredients and Adjuvants

The Environmental Protection Agency has developed a policy for evaluating other (inert) ingredient that are in pesticides. The EPA places these ingredients into four categories (lists). List 1 are inerts of toxicological concern; List 2 are potential toxic inerts with high priority for testing; List 3 are inerts of unknown toxicity; and List 4 are inerts of minimal concern. Inerts that appear in List 4 have been judged by the EPA that their current use patterns in pesticide use products will not adversely affect public health and the environment. Exposure to the inert ingredients

and the adjuvants is significantly lower than to the active ingredients because they are added at much lower concentrations and only compose a very small portion of the overall herbicide mix.

The MSDS for Garlon 3a has listed three additional ingredients (55.6% of the formulation) in addition to triclopyr. These ingredients include ethanol, triethylamine (TEA), and ethylenediaminetetraacetic acid (EDTA).

TEA is considered a skin, eye, and mucous membrane irritants. Safety measures to be followed while working with this chemical include safety glasses, gloves, good ventilation, and removal of all sources of ignition from the working area. EPA classifies it as a List 3 ingredient. Its toxicological properties are as follows:

Triethylamine (TEA)

Oral – Rat	LD50 460 mg kg ⁻¹
Skin - Rabbit	LD50 570 mg kg ⁻¹
Oral – Mouse	LD50 546 mg kg ⁻¹
Intraperitoneal -Mouse	LD50 405 mg kg ⁻¹
Inhalation – Rat	*LCLO 1,000 ppm/4h

*LCLO – lowest published lethal concentration

EDTA is considered a skin, eye and respiratory irritant. EDTA is commonly used in soaps and shampoos in order to chelate calcium ions that would prevent the surfactant from effectively decreasing the water surface tension (Felsot 2001). Safety measures to be followed while working with this chemical include safety glasses (in case of contact with eyes, rinse immediately with plenty of water and seek medical advice) and protective clothing. EPA classifies it as a List 3 ingredient. EDTA's toxicological properties are as follows:

Ethylenediaminetetraacetic Acid (EDTA)

Intravenous – Mouse	LD50 28.5 mg kg ⁻¹
Intraperitoneal – Mouse	LD50 250 mg kg ⁻¹
Intraperitoneal – Rat	LD50 397 mg kg ⁻¹
Oral – Mouse	LD50 30 mg kg ⁻¹

Ethanol (ethyl alcohol) causes skin and eye irritation. Ingestion can cause nausea, vomiting and inebriation. It is highly flammable and is harmful if swallowed or inhaled. EPA classifies it as a List 4b ingredient. Its toxicological properties are as follows:

Ethanol (Ethyl Alcohol)

Oral – Child	*LDLO 2,000 mg kg ⁻¹
Oral – Mouse	LD50 3,450 mg kg ⁻¹
Oral – Rat	LD50 7,060 mg kg ⁻¹

*LDLO – lowest published lethal dose

To assist in the efficacy of the herbicide a non-ionic surfactant such as R-11[®], methylated seed oil (MSO), or combination thereof would be used with Garlon 3a. Surfactants optimize the wetting and spreading of the herbicide.

R-11[®] is a surfactant manufactured by Wilber-Ellis and has as a main ingredient nonylphenol polyethoxylate (NPE), which puts it into a broad class of chemicals known as alkylphenol ethoxylates (APEs). The raw material used to make NPE, nonylphenol (NP), has been shown to exhibit weak estrogenic properties in lab tests. Bakke (1999) and Bakke (in prep) describe the human and ecological risk of using NPE surfactants. Baake (in prep) conclude that there is no evidence that there would be any adverse effects on human health as a result of the use of NPE in surfactants. Bakke (1999) is incorporated by reference into this Final EIS and will be available for review upon request.

Nonylphenol polyethoxylate (NPE)

Oral – Rat	LD50 580-1,620 mg kg ⁻¹
Dermal – Rabbit	LD50 >2,000 mg kg ⁻¹
Subchronic – Rat	LOEL 25 mg/kg/day

Isopropyl alcohol may act as an irritant. It is considered to be harmful if inhaled, ingested, or absorbed through the skin. Safety glasses and sufficient ventilation are recommended when using this chemical. EPA classifies it as a List 4b ingredient. Its toxicological properties are as follows:

Isopropyl alcohol

Oral – Rat	LD50 5045 mg kg ⁻¹
Fathead minnow (<i>Pimephales promelas</i>)	LC50 11130 mg/l/96h
Freshwater Crustacean (<i>Daphnia magna</i>)	LC50 9500 mb/l/24h

Methylated Seed Oil (MSO): Several MSO products are available for use as a surfactant. Generally MSO's are considered non-toxic because they are derived by reacting seed oil (soy, cottonseed, rapeseed, canola, etc...) with an alcohol (usually methanol) to produce methyl esters. They have generally been considered a substitute for the use of non-ionic surfactants and petroleum based crop oils. Most methylated seed oil is exempt from residue tolerance under 40 CFR 180.1001 (Exemptions from the requirement of a tolerance). This exemption is allowed when it appears that the total quantity of the pesticide chemical in or on all raw agricultural commodities for which it is useful under conditions of use currently prevailing or proposed will involve no hazard to the public health.

Visitor Experience

The Del Norte hiking trail goes through the middle of the fennel forest. After the fennel is treated, it would become possible to view much more of the landscape, providing a better hiking experience. Over time some of the extensive disturbance within the fennel area caused by pigs would heal, making for a better visual experience over time.

Mitigation

To minimize exposure of workers and the public to herbicide the following mitigation measures will be implemented.

Aerial Application

- An implementation team will develop a complete implementation strategy that will

cover all aspects of aerial herbicide application including operations, logistics, and safety. The team will also will incorporate best management practices for herbicide use and develop a herbicide spill plan prior to commencing herbicide operations.

- Use a California certified applicators who is authorized to conduct aerial herbicide application.
- Helicopter will be equipped with a differential GPS guiding system allowing precise spraying of the treatment area.
- Helicopter spray system is required to have a positive liquid shutoff to eliminate leaks.

Ground Application

- Herbicide applicators will be properly trained and equipped for the safe and proper use of herbicide.
- Applicators will work under the direction of a certified applicator.
- Personal Protective Equipment (PPE) will be strictly adhered to minimize exposure to herbicide applicators.

Effects of Implementing Pig Eradication

The proposed action to conduct simultaneous islandwide eradication of pigs would have some short-term negative impacts on socioeconomic issues but would also have long-term positive impacts on the visitor experience. Visitor use would be restricted on NPS lands when hunting operations are occurring. Under this alternative islandwide eradication would be an intense effort over a short period of time 2-3 years. Depending on the particular operation that is being conducted during the three year operation period, NPS lands could be closed to visitation by visitors and researchers at any time during this period.

The annual visitation to Santa Cruz Island averages approximately 18,000 visitors per year.

Depending on when and for how long the closure is in place, a portion of these annual visitors could be denied access to the island.

The overall visitor experience would be enhanced upon eradication of pigs. Islandwide the extensive areas that have been heavily disturbed by pigs would begin to heal, resulting in better visual appeal. Visitors would not be exposed to the annual starvation of pigs.

***Alternative Three:
Eradicate Pigs on NPS
Property; Control Pigs and
Protect Selected Sensitive
Resources on TNC Property***

Issue 1: Likelihood of Achieving Success

Effects of Implementing Fennel Control

Same as Alternative Two.

Effects of Implementing Pig Eradication

NPS-Owned Lands

Short-term eradication of pigs may be accomplished on NPS property in the short-term (1-5 years), however; maintaining a pig free zone would be difficult to sustain long-term (10+ years). Relying on NPS personnel to continually maintain pig fence in a marine environment, monitor for pig sign, and then ultimately hunt pigs is costly and difficult to sustain over an extended length of time. Keeping the “pig free zone” free of pigs is possible for a short duration (1-2 years), however, has a very low likelihood of success in the long-term.

TNC-Owned Lands

This alternative would achieve some short-term protection to sensitive resources, however; long-term extensive, or area specific protection would likely not succeed. Personnel and funding limitations would be the biggest factor that would cause failure.

Issue 2: Vegetation Impacts

Native Communities

Effects of Implementing Fennel Control

Native community impacts under this alternative are the same as Alternative Two – Native Communities.

Effects of Implementing Pig Eradication

NPS-owned Lands

Under this alternative, native plant communities on NPS-owned property would be protected from feral pig impacts. The short-term and long-term impacts associated with this alternative would be similar to those described under Alternative Two – Native Communities. These impacts described under Alternative Two would hold true if pigs can be kept from re-invading NPS-owned property. It is predicted that feral pigs may sporadically enter into NPS-owned lands over time due to fence breeches or gates being left open.

Should feral pigs sporadically enter NPS-owned property they would create conditions conducive for re-establishment of fennel or other invasive species. They could quickly undo recovery that is occurring in localized shrub or tree dominated habitats. The degree of impact depends on how quickly actions are taken to remove the feral pig invaders. It is recommended that monitoring be put in place that would identify in a timely manner pig

invaders, and then have a quick response time to remove the invaders. The strong possibility of sporadic invasion of feral pigs makes it unlikely that fennel, (other weeds as well) can be controlled to the same extent as complete eradication.

TNC-Owned Lands

On TNC owned property (approximately 76% of the island) would be subject to direct and indirect impacts from feral pig remaining on this portion of the island. These impacts are fully discussed under the No-Action Alternative (Alternative One – Native Communities). Some protection would be afforded to some sensitive resources. These protections would be limited and may not persist long-term because of personnel and budget limitations. Native communities would ultimately be subjected to major impacts.

Cumulative Effects

The implementation of this alternative would result in two different management strategies being implemented on an island that experts agree should be managed as one ecological unit. It has long been recognized that to achieve recovery and a stable ecologically functioning ecosystem that the island as a whole should be integrated as much as possible. Implementation of this alternative would move TNC and NPS away from this necessary management objective and would ultimately affect the native communities on the island.

TNC-Owned Lands

The result of past activities has had a major impact on the current vegetation conditions on the island. Without implementing full eradication on TNC-owned lands current vegetation composition, especially those in a low seral condition - and those communities with a high weedy component, would continue to expand and effect the recovery of native communities. High seral communities would

continue to be negatively impacted by feral pigs causing less desirable species to continually be introduced into these communities and thereby reducing their resource value.

Implementing present and future activities as described in Alternative One would add only negligible impacts to the major negative direct and indirect effects caused by feral pigs to native communities under this alternative. Cumulative negative impacts to native communities would result on lands that have remaining feral pigs.

NPS-owned Lands

Alternative One – Native Communities described the past, present, and future activities that would impact native plant communities and would be used as the basis for the incremental impacts associated with Alternative Three.

The result of past activities has had a major impact on the current vegetation conditions on the island. With the implementation of this alternative the current vegetation composition, especially those in a low seral condition, and those communities with a high weedy component, would respond differently to the removal of pigs and the control of fennel. Removing the disturbance that keeps communities in low successional status would allow them to start successional recovery, allowing native species to colonize these communities over time. High seral communities would benefit by feral pig removal and fennel control because the continual disturbance that makes them vulnerable to invasion by undesirable species would no longer exist.

Implementing present and future activities as described under Alternative One would add only negligible impacts to the short-term direct and indirect effects associated with implementing this Alternative. The addition of these negligible impacts would not effect the long-term beneficial impacts that would occur to native communities as a result of eradicating pigs and control of fennel as described under this alternative. Increased visitation on the

island, or having increased administrative activities can allow for more opportunities for gates to be left open. This may result in increased chance of feral pig invaders to enter the NPS-owned pig-free area.

Mitigation and Monitoring

- Monitor to ensure feral pig invaders are identified in a timely manner, and ensure a rapid response to remove the invaders.

Threatened and Endangered Plant Species

Effects of Implementing Fennel Control

The effects for implementing fennel control on T&E plants for this alternative is the same as Alternative Two – T&E Plants.

Effects of Implementing Pig Eradication

Under this alternative, T&E plant occurrences would be protected to various extents on NPS and TNC property on Santa Cruz Island. Those occurrences on NPS property would be relieved of pig impacts and be able to expand beyond their current locations, as feral pigs would not be present on that portion of the island. Expansion of rare species into existing unoccupied habitat provides some measure of protection against extinction from random stochastic events. Expansion of listed species into unoccupied suitable habitat is an integral part of the recovery plan for these species (USFWS 2000). The long-term benefits to T&E plant species associated with eliminating pig impacts are discussed under Alternative Two – T&E plants.

The occurrences on TNC property however would be limited to their present locations, as feral pigs would have access to any current unoccupied habitat for those species. Without the possibility of expanding their number of occurrences these species would be at continued

risk of extinction from random stochastic events and continued pig impacts.

Because T&E plant occurrences on TNC property may be fenced, they would theoretically be free from direct predation by feral pigs. However, feral pigs are notorious for undermining fencing on Santa Cruz Island (Aschehoug, personal communication) and in order for the fencing to be effective, it would have to be constantly maintained. It is unlikely that the commitment of resources necessary for this type of maintenance is possible over the long-term and it is likely that some of the fencing would be breached in the future, allowing for direct predation on some of the “protected” T&E occurrences. For those occurrences, the T&E plants would be subject to the direct impacts associated with the presence of feral pigs, as listed under Alternative One.

While possibly initially free from direct predation, the T&E species on TNC property would still be subject to all of the indirect impacts associated with the presence of feral pigs, as listed under Alternative One.

There are seven known occurrences of listed plant species on NPS property – 5 occurrences of island rush-rose (*H. greenei*), 1 occurrence of island malacothrix (*M. squalida*) and 1 occurrence of island bedstraw (*G. buxifolium*). There are 28 known occurrences of listed plant species on TNC property. The occurrences are as follows: One occurrence of (*D. nesiotica*); eight occurrences of island bedstraw (*G. buxifolium*); three occurrences of island barberry (*B. pinnata ssp. insularis*); one occurrence of Santa Cruz Island malacothrix (*M. indecora*); three occurrences of Santa Cruz Island bushmallow (*M. fasciculatus v. nesioticus*); one occurrence of Santa Cruz Island fringe-pod (*Thysanocarpus conchuliferus*); three occurrences of Hoffman’s rockcress (*Arabis hoffmanii*); and eight occurrences of island rush-rose (*Helianthemum greenei*) (USFWS 2000).

Pig eradication on NPS property should encourage the survival and regrowth of *Galium buxifolium*. Escaped feral pigs from TNC

property may graze on the *Galium* if they break through the property fence; therefore regular fenceline surveys should be done to ensure T&E species are protected from feral pigs.

Cumulative Effects

Past grazing disturbance is the largest factor that created unsuitable habitat for Santa Cruz Island’s T&E species.

The implementation of this alternative would result in two different levels of management intensity to implement the recovery plan for T&E species. Because of the constant threat of pig disturbance, T&E plants located on TNC property would need more monitoring and protection. Whereas on NPS, the threat of pig disturbance would be less, and protection actions would not be necessary. It has long been recognized that to achieve recovery and a stable ecologically functioning ecosystem that the island as a whole should be integrated as much as possible. Implementation of this alternative would move TNC and NPS towards different T&E management intensity levels, which may ultimately affect the viability of some T&E species.

Present and future activities, as described in Alternative One – Native Communities (Cumulative Effects Section), would only cause negligible additive impacts when considered with the impacts of this Alternative. Present and future land disturbing activities have the greatest potential to impact T&E species. Outside of this project, the TNC does not have any large land disturbing projects planned in areas outside of already developed areas. For NPS, disturbance activities that could impact listed species or their habitat require review by NPS botanists for impacts. In addition, projects that may effect a T&E species’ viability have to obtain approval from the US Fish and Wildlife Service in order to implement the project. To avoid impacting T&E species, mitigation would be incorporated into the project design. Prior to final approval for a project, NPS biologists are required to conduct field surveys to identify if

T&E plants would be impacted by the project. For example, when the park proposed opening up hiking trails from Prisoners Harbor to Scorpion Anchorage, NPS botanists surveyed for T&E plants. In one section of the trail where T&E plants were found to be vulnerable to trampling damage, mitigation was incorporated into the design of the trail to avoid impacts.

Fennel

Effects of Implementing Fennel Control and Pig Eradication

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from being redundant, the direct and indirect “effect analysis” can be found under Alternative Two – Fennel.

Cumulative Effects

The isthmus would be the initial area of feral pig re-infestation if pigs are eradicated from only the NPS property of Santa Cruz Island. Left unattended and allowed to persist, feral pigs would cause soil disturbance and openings in the vegetation that would allow fennel to re-establish. Feral pigs could also bring in fennel seeds from TNC land via hooves and fecal matter. With the initial fennel treatment the fennel infestation would decrease in cover and density, and with continued monitoring and control of outlier populations can possibly be controlled. The strong possibility of feral pig entrance from TNC land makes it unlikely that fennel can be entirely eliminated from the isthmus. The early detection of pigs entering NPS property, and swift action to eliminate these pigs would moderate their impacts. Without feral pig control, fennel would continue to spread on TNC property.

The result of past activities has had a major effect on the existing condition of fennel on the island. By implementing this alternative a

major reduction in fennel would occur. Fennel would become a minor component in the island’s vegetation communities.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible negative impacts to the mostly positive effects associated with the control of fennel. Present and future activities that could negatively contribute to fennel control would be the potential for humans and animals to transport seeds to areas that are fennel-free. Compared to Alternative Two, there is higher likelihood of transport of weed seeds because weeds would still be prevalent on TNC property because of the continual soil disturbance caused by pigs.

Other Weeds

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from being redundant, the direct and indirect “effect analysis” can be found under Alternative Two – Other Weeds and is relevant to this discussion.

Effects of Implementing Pig Eradication

NPS lands would be pig-free under this alternative and would benefit similarly as described under Alternative Two.

On TNC lands, sensitive resources would continue to suffer severe and permanent depredation of native vegetation and increased weed presence and importance. The continued presence and activities of pigs over most of the island would continue to degrade island vegetation by further dispersal and establishment of invasive alien plants. Currently weed-infested areas would increase in size and population density. With continued pig disturbance, weed-free areas would be susceptible to weed infestation. Overall,

recovery and development of native island vegetation would be hampered, and in some places, permanently damaged. Distributions and abundance of most alien plants would continue to increase.

Cumulative Effects

Past grazing and human disturbance have allowed the transport of weed seeds to Santa Cruz Island and has resulted in the current weed infestation on Santa Cruz Island. Implementing this alternative would have a negligible effect on decreasing the existing footprint of weeds on Santa Cruz Island because more than half the island would be impacted by feral pigs.

Present and future activities, as described in the beginning of this chapter, could add negative effects to the weed effects identified under this alternative. Under this alternative there is high potential for weed spread on TNC lands (76% of the island) because of the persistence of feral pig impacts. Some localized weed spread may be noticed on NPS lands where there is disturbance due to pig eradication activities. Human activities have the greatest chance of transporting weeds from mainland sources to Santa Cruz Island. Continued pig presence poses the largest threat for transport and establishment of weeds intra-island.

This alternative would result in negligible changes to the vegetation and soil conditions on TNC lands as they would still be susceptible to weed infestation. Introducing other weeds as a result of human activity would add minor negative cumulative impacts to weed spread as a result of implementing this alternative.

Mitigation and Monitoring

- Ground disturbing activities associated with the implementation of this alternative would be monitored to ensure that disturbed areas do not become weed-infested. These areas would be treated if they pose a threat to natural resource values.

Issue 3: Island Fauna Impacts

Native Island Fauna

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from being redundant, the direct and indirect “effect analysis” can be found under Alternative Two – Native Island Fauna and is relevant to this discussion.

Effects of Implementing Pig Eradication

Under this alternative, the effects of full eradication mentioned above would apply to NPS lands, or those east of the isthmus boundary. Wildlife in those areas would reap the benefits of full removal, and be subject to the temporary negative effects of dog-hunter teams on the ground during eradication. Those effects of the eradication actions would also be seen in those areas on TNC lands slated for control efforts. Thus the effects would be the same at a much smaller scale.

Effects on island foxes may be negative, overall. Under this alternative, pigs would remain on central and west Santa Cruz, excluded on only selected sensitive resource areas. Thus, the pigs left on the island may still attract and maintain roosting, wintering or breeding golden eagles, which in turn would prey on foxes and skunks when piglets aren’t in season. Retention of feral pigs on Santa Cruz Island could thus retard recovery of island fox populations on the northern Channel Islands.

Cumulative Effects

Alternative Three, the control of fennel and the eradication of feral pigs from NPS property only, would initially reduce fennel cover displacing those species that utilize the structure of fennel. Chaparral, coastal sage and oak woodlands, all structurally diverse communities

surround the fennel stands on the isthmus. Those species displaced by the removal of fennel would return to the native plant communities that they originally foraged in or inhabited. The removal of feral pigs would possibly allow for the succession of such native, structurally diverse communities into the previously fennel-infested areas.

If continued disturbance from “escaped” feral pigs occur; woodland recovery is highly unlikely. The burn and spray treatment would not kill all fennel, and the remaining fennel would likely spread into previously treated areas if pig disturbance occurs and further fennel control is not taken. Native vertebrates can continue to use these patches of dense fennel on the isthmus for foraging cover and habitat.

Alternative Three, the control of fennel and the eradication of feral pigs from NPS property only, would initially reduce fennel cover displacing those species that utilize the structure of fennel. Chaparral, coastal sage and oak woodlands, all structurally diverse communities, surround the fennel stands on the isthmus. Those species displaced by the removal of fennel would return to the native plant communities that they originally foraged in or inhabited. The removal of feral pigs would possibly allow for the succession of such native, structurally diverse communities into the previously fennel-infested areas if continued disturbance from escaped feral pigs occurs, succession is highly unlikely. More likely, there would be a mosaic of patches of dense fennel, and structurally rich native communities on the isthmus that some native invertebrates can use as habitat, and grassland communities for those invertebrates that prefer structurally simple communities.

Other management actions for natural resources on Santa Cruz Island would have effects on island fauna, particularly island foxes. Golden eagles are currently being relocated from Santa Cruz Island, and probably would be on an annual basis until pigs are removed from the island. Relocation of golden eagles from the island would increase survivorship of island

foxes on Santa Cruz Island. Moreover, if a funding source is found, bald eagles may be released on Santa Cruz Island within the next several years. If bald eagles attempt to breed on the island, their territorial nature may discourage golden eagle use of the island, thus decreasing golden eagle predation of island foxes. These positive effects on fox survivorship would continue for the life of those individual programs. But without complete removal of pigs from the island, there would still be a prey base to support golden eagles.

Mitigation

Same as Alternative Two.

Non-native Fauna (Pigs)

Effects of Implementing Fennel Control

Same as Alternative Two.

Effects of Implementing Pig Eradication

On NPS property and in control zones on TNC property, pigs would be killed using the same methods as in Alternative Two. Pig density would be kept to nearly zero on NPS property and would remain at historical levels on TNC property.

Cumulative Effects

Past activities, such as the initial introduction pigs to Santa Cruz Island has resulted in the current feral pig population.

Present and future activities, as identified in the beginning of this chapter, would have negligible effects to feral pig population prior to and post-eradication on TNC property. On NPS property, increased visitation, research, or project activity may result in more chances for gates to be left open and pigs entering onto NPS property. This would result in minor fluctuations in pig density on NPS property. As

the pig fence between NPS and TNC begins to age, pigs breaching the fence would be more common causing major fluctuations in the pig densities on NPS property.

Issue 4: Impacts to Physical Resources including Soils, Water and Air Quality

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from repeating information, these discussions refer to the analysis provided in Alternative Two. The analysis there is relevant to the impacts under this alternative.

Fire Effects on Soil and Water Quality

The effects are the same as Alternative Two.

Herbicide Effects on Soil and Water Quality

The effects are the same as Alternative Two

Air Quality Impacts

The effects are the same as Alternative Two.

Effects of Implementing Pig Eradication

Soil and Water Quality

Direct and Indirect – Pig exclusion on TNC owned lands at cultural and sensitive resource sites would not abate pig rooting over the majority of TNC-owned lands. Pig rooting, and the resulting erosion would continue to occur. Impacts of pigs on TNC-owned lands would have similar soil and water quality effects as described in Alternative One.

Impacts from pig rooting would cease on NPS owned lands and watersheds within this area would begin to heal. The expected watershed level beneficial impacts would be similar as described under Alternative Two.

Pig carcasses can impact water quality depending on the number (mass) of dead animals in a given location, decomposition rate, distance to live water, and distance to groundwater.

Dead pig carcasses can release into their surroundings a whole host of water quality affecting compounds including nitrates, TDS (total dissolved solids), chloride, and ammonium-nitrogen. The rate of these releases is dependent on the decomposing environment. For instance, in anaerobic conditions (like underwater or extremely moist soil conditions) carcass decay is very slow. Release of these compounds from the carcass would be prolonged with elevated concentrations above EPA standards. In contrast, in well-drained conditions a carcass can decompose fairly rapidly, with little or no effect on groundwater.

To keep concentrations of the above compounds at near normal ranges would be to avoid dead carcasses in or near live water sources, or in shallow groundwater areas with poorly drained soils.

Cumulative Effects

Soil and Water Quality

Alternative Three would have much the same beneficial effects on soil and water quality on NPS-owned lands as Alternative Two. The isthmus is on the border of TNC/NPS properties, and if pigs were to break through pig proof fences into NPS land, the isthmus would be the first NPS property negatively affected by the feral pigs. Therefore the isthmus may continue to incur soil disturbance. The degree of disturbance would depend on how many pigs, and how long they are allowed to linger on NPS property. Soil resources on TNC property would continue to be degraded through pig rooting. Pig rooting would erode soils and these areas would likely colonize with fennel or other ruderal species.

The result of past activities, mainly domestic and feral livestock grazing, has had a major effect on the soil conditions on Santa Cruz Island. However, removal of cattle and sheep over the last 15 years has halted overgrazing and has prompted recovery in many areas. On NPS-owned lands, major beneficial cumulative effects to soil and watershed conditions would be realized when the positive effects of removing sheep and cattle are combined with the eradication of pigs. On TNC-owned lands, the positive soil and water quality effects that occurred when sheep and cattle were removed would be overshadowed by the continued impacts of feral pigs.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible detrimental soil and water quality impacts to the long-term beneficial effects that would be realized with the eradication of pigs on NPS-owned lands. Similarly, these same activities would add only negligible impacts to the adverse effects of continued pig disturbance on TNC-owned lands.

Cumulative Effects Air Quality

Same as Alternative Two

Mitigation

Soil and Water Quality

Measures to minimize soil and water quality impacts for this alternative are the same as Alternative Two.

Air Quality

Measures to minimize air quality impacts for this alternative are the same as Alternative Two.

Issue 5: Socioeconomic Factors including Cultural Resources and Human Uses

Cultural Resources

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from repeating information, the discussion of effects is provided in Alternative Two. The analysis there is relevant to the impacts under this alternative.

Effects of Implementing Pig Eradication

Under this alternative, damage to archeological sites by feral pigs would continue essentially unabated on TNC property. Continued pig rooting of archeological sites on that portion of the island would result in their loss of integrity, and ultimately loss of the values which make the Santa Cruz Island Archeological District eligible for the National Register of Historic Places. Rapid eradication of pigs would protect cultural resources on NPS lands.

Pig rooting is currently estimated to have damaged nearly all of the archeological sites on the island, to some extent. Pig rooting to a depth of three feet has been noted in a number of sites, particularly in areas covered by fennel or wild cucumber (Dr. Jeanne Arnold, personal communication). The information potential of some shallow sites and surface scatters has been completely destroyed by pig rooting. Rooting in the upper layers of deeper, more complex, stratified sites profoundly disturbs time and spatial relationships and destroys the context of the information contained in these sites. In addition, pig rooting has disturbed ancient burials found in many locations on the island.

NPS would continue to try to prevent complete loss of the archeological record by

fencing a small number of sites each year, as funds allow. These actions would not be viable mitigation because the work cannot be guaranteed to occur, is costly to implement, difficult to maintain, and preserves only a small number of sites. This alternative also does not preserve the archeological values as a whole for which the island was listed on the National Register.

The Santa Cruz Island Archeological District is significant for the large number and diversity of pristine sites found on the island. Sites range from isolated artifacts to huge, stratified sites encompassing habitation areas and specialized activity areas spanning a period of 8,000-9,000 years. Continued pig depredations on the three-quarters of the island belonging to TNC, along with efforts to control the pig population and fence and protect selected sites would result in a truncated archeological database. The number and diversity of sites would be greatly reduced, potentially resulting in de-listing of the National Register district. The value of remaining archeological sites would be greatly reduced, and future researchers would be unable to take advantage of new research techniques that may be developed in the future.

Eradication on NPS lands would negligibly impact cultural resources when vehicles or people may trample archeological sites. Proper cultural resource sensitivity orientation to people involved in the eradication would minimize these impacts. Prior to establishing hunter camps, kennels, or pig traps cultural resource clearance surveys would be done in order to avoid impacts on culturally sensitive sites.

Impacts of hunters traversing archeological sites would be minimized by orienting the hunting groups to the sensitivity of these sites to damage and requiring that they avoid traffic over them whenever possible.

NPS plans to upgrade existing facilities where needed, such as housing and infrastructure, for use by the contract hunters. NPS would evaluate the proposed repairs and

alterations to historic buildings and structures to ensure that proposed work meets the Secretary of the Interior's *Standards for Rehabilitation*. NPS would consult with the State Historic Preservation Officer (SHPO) where necessary under the programmatic Memorandum of Agreement among the NPS, The National Conference of SHPOs and the Advisory Council on Historic Preservation.

NPS has initiated consultation with the State Historic Preservation Officer and the Chumash under Section 106 of the National Historic Preservation Act, and is preparing a memorandum of agreement with regard to the potential adverse effects of fencing, hunting activities and burning of the fennel and proposed mitigation actions.

Cumulative Effects

The ranching era on Santa Cruz Island conducted land-disturbing activities that impacted archeological sites throughout the island. The two land disturbing activities that impacted archeological sites to the greatest degree have been road building and the introduction of feral pigs. These activities have irreversibly impacted these archeological sites. The permanent impact of those activities when added to the potential permanent cultural resource impacts of implementing the fennel burn and the negligible impacts associated with pig eradication activities would result in a net increase in the number of sites permanently impacted. This increase may only be slight if the fennel burn incorporates mitigation measures to minimize harm to cultural resources.

Present and future activities, as described in the beginning of this chapter, would add negligible impacts to the already negligible cultural resource impacts that would result from pig eradication activities. Negligible impacts are expected because all planned activities must undergo a review process that is intended to identify potential impacts to cultural resources. The review would specify mitigation measures that need to be implemented in order to

minimize impacts to cultural resources. This review process does not account for unauthorized activities that may occur such as visitors taking artifacts, or anchored boaters coming ashore and disturbing archeological sites.

Mitigation

- Conduct hunter orientation to instruct hunters on how to avoid impacting archeological sites.
- Survey campsites and trap locations to avoid locating them in any culturally sensitive locations.
- If cultural resources are found during survey activities for the fennel burn: hand-cut vegetation around resources; rebury known exposed burials (in consultation with the Chumash); use an archeological monitor to avoid damage to archeological sites when establishing fire lines, access routes and staging areas.
- Conduct post-burn archeological surveys with Chumash monitor in case exposed human remains are encountered.

Human Uses

Effects of Implementing Fennel Control

Herbicide Application – Human Exposure

Same as Alternative Two.

Visitor Experience

Same as Alternative Two

Effects of Implementing Pig Eradication

Visitor Experience

Impacts to visitors under this alternative would be similar to impacts under the proposed

action, because pigs would still be hunted on NPS lands, where most visitation occurs. Additionally, some impacts on the visitor experience would be annual and recurring, since NPS would be in the position of defending a fenced boundary against invasion by pigs. Thus, annual trapping and/or hunting would occur on NPS lands near the isthmus boundary with TNC.

Net impacts on researchers would be less under this alternative than under the proposed action, since islandwide eradication under the proposed actions would affect researchers in all parts of Santa Cruz Island. Targeted protection around sensitive resources on TNC lands would not have the pervasive effects on island use that the proposed action would have. However, islandwide actions under the proposed approach would be phased by zone, so interruption to research would also be phased and limited in time.

Alternative Four: Sequential, Islandwide Eradication by Fenced Zone Hunting

Issue 1: Likelihood of Achieving Success

Effects of Implementing Fennel Control

Same as Alternative Two.

Effects of Implementing Pig Eradication

Strategy

Alternative Four's pig eradication strategy is modeled after the pig eradication program on Catalina Island. The six-year eradication program on Catalina Island is currently in its fourth year of implementation. Catalina Island has four zones, with one zone one being pig free

and another zone being nearly pig free. They are currently working on the zone that contains the city of Avalon, and Middle Ranch Zone. Because of hunting restrictions placed on the operation by the city, the Avalon zone is proving to be the most challenging zone to achieve eradication.

The difficulties the Catalina pig eradication operation has are mostly related to people leaving gates open on the island between zones, and having to alter their eradication techniques in the Avalon zone. Despite these difficulties the operation is on schedule to complete islandwide pig eradication within their estimated six-year schedule.

One way to estimate the potential success of SCIPRP is to compare the most difficult obstacles (defined as actions that could affect efficacy) that are being encountered on the Catalina operation to the circumstances that would be encountered as part of the SCIPRP. Having the ability to overcome these obstacles would bode well for the success of SCPRP. The most difficult obstacle being faced by Catalina's operation are gates being left open, or more serious, people purposefully breaching the fence. Because Catalina Island's operation has more gates to manage, and more vehicle use than Santa Cruz Island, their operation requires more constant vigilance regarding people-related fence breaching. On SCI people-related fence breaching is less of a concern because management on SCI has greater ability to control people-related activities. For instance, unlike Catalina, vehicle use on SCI roads is highly controlled on both TNC and NPS properties because all vehicles and their use on the island are under direct control of NPS, or TNC. This means that people driving the roads would most likely be: contractors associated with the eradication project; TNC, NPS, or UC reserve employees; or people specifically authorized by TNC or NPS. These people would have a high degree of knowledge and support regarding the operation and would be unlikely to perform acts that would compromise the project, such as leaving gates open. In

addition, SCIPRP requires fewer gates, another factor in maintaining fence integrity.

Funding and Logistics

The park has both logistic and funding concerns regarding trying to implement a high intensity/short duration eradication strategy as outlined under Alternative Two. The budget that the park has to implement this project is more closely aligned to be able to support the deliberate, longer-term eradication strategy provided under Alternative Four.

The park also has to consider whether the operation can be supported by its already burdened transportation system. Supporting a high intensity, albeit short-term operation on Santa Cruz Island would require the park to make major adjustments to the servicing of other park islands. Supporting the logistics associated with Alternative Four could be done with only negligible impacts to the servicing of other park islands.

Issue 2: Vegetation Impacts

Native Communities

Effects of Implementing Fennel Control

The effects to native plant communities for this alternative is the same as Alternative Two – Native Communities.

Effects of Implementing Pig Eradication

Direct and Indirect Impacts

In the long-term direct and indirect impacts to native, island plant communities would be beneficial and similar to those described under Alternative Two. However, the beneficial effects would be delayed in those areas of the island that are not hunted free of pigs until the later sequential years.

Short-term moderate impacts would occur with the construction of the 40+ miles of fence line. Trampling and crushing of the island vegetation would occur and individual plants may be completely uprooted. Areas that are trampled bare, especially those on steep slopes, may experience increased water run-off and soil loss during winter rain events. Gullies could form in some areas. Placement of erosion control matting, waddles, or other materials to dissipate energy from water runoff would mitigate these impacts.

Periodic fence inspection and maintenance is necessary for the fence to keep its structural integrity. Feral pigs are notorious for undermining fencing systems and have repeatedly done so on Santa Cruz Island. Inspecting the fence and fixing fence breaches require periodic walking of the fence line. Each time the fence line is inspected and/or fixed provides an opportunity for trampling and forming trails, and spread of non-native plant seeds. Formation of trails may be inevitable, however, should trails form alongside fences they should be carefully monitored to ensure that they do not become entrenched and eroded. Establishing waterbars, or placement of waddling or other erosion control material can lessen the erosion impacts of a trail formed on steep slopes. Mitigation to lessen weed spread would be to require fence inspectors to inspect and remove weed-seed from their clothing, shoes, and equipment prior to going into an area that is weed-free. Likewise, after coming out of a weed-infested area, inspect and remove weed seeds from clothing, shoes and equipment.

Removal of the pig zone fence would have similar direct and indirect effects as those associated with its construction.

Pig eradication by island zone would allow for rooting disturbance to continue on the isthmus for up to four to five years following the initiation of the eradication procedure. During that time period, fennel would continue to establish in areas of the isthmus that are disturbed by pigs. This disturbance regime would negatively effect native forb regeneration

and would likely cause more soil erosion to occur, in turn allowing for other invasive species to spread onto the isthmus such as yellow starthistle, tocalote, and *Erodium sp.* Although this option would lead to the eventual eradication of feral pigs, it would also subject degraded communities to pig disturbance for up to four years more than predicted under Alternatives Two or Three.

If invasive species infestations are controlled as they occur on the isthmus during and after the pig eradication process, native species succession may occur.

Alternative Four would lead to feral pig eradication from Santa Cruz Island in a minimum of six years. Pig eradication by island zone would allow for pig disturbance to continue to some extent on the isthmus for this six-year period. In the interim time prior to eradication of the isthmus zone, NPS can implement localized pig control to protect sensitive resources.

Historical grazing impacts have allowed annual grasses to invade native communities such as chaparral, coastal sage and oak woodlands. As disturbance is allowed to continue, invasion of non-native grasses into native communities would also continue. It is not known if the additional four years of feral pig disturbance would be severe enough to type convert some of these high seral shrub communities (i.e. coastal sage) into annual grasslands. Restoration techniques may be needed to facilitate the re-establishment of native shrub communities in areas of heavy invasive species infestations.

Cumulative Impacts:

The cumulative impacts of this alternative would be similar to those discussed under Alternative Two (Cumulative Effects – Native Communities).

Mitigation and Monitoring

- New weed infestations caused by the project's activities would receive timely treatment. Other weed infestations that are encountered, but are not caused by the project, need to be reported to NPS or TNC biologists.
- Intensive vegetation monitoring should be done pre and post treatment so that successional processes are understood. This information would be useful to plan necessary post-treatment native vegetation restoration work should it be necessary.
- Fencing activities including construction, inspection or maintenance that cause bare soil conditions shall be monitored to determine if erosion abatement activities need to occur. Erosion abatement activities will be conducted in erosion prone areas (steep slopes) where gully, sheet or rill erosion is likely to occur.
- Personnel constructing, inspecting, or performing maintenance on fences will inspect and clean weed seeds from clothing, shoes, and equipment prior to working in a weed-free area. Inspect and clean clothing, shoes, and equipment for weed seeds after working in a heavily infested weed area.

Threatened and Endangered Plant Species

Effects of Implementing Fennel Control

The effects of implementing fennel control on T&E plants is the same as described in Alternative Two – T&E Plants.

Effects of Implementing Pig Eradication

Direct Impacts

Direct impacts to T&E plant species would occur if fencing were placed within areas where

T&E plants are rooted. Individual plants could be crushed or uprooted when fence posts are placed in the ground. Personnel involved in the eradication project i.e. hunters and dogs could also inadvertently crush plants by walking or driving over them. This could occur when initially constructing the fence or during maintenance of the fence. To avoid potential impacts, surveys for T&E plants would be done prior to fence construction with the fence location to be modified accordingly. Furthermore, personnel involved in the eradication effort would receive information on sensitive areas to avoid, as well as training to identify T&E plants should they come upon them while working in the field. However, botanical surveys can sometimes overlook T&E plant occurrences. The accuracy of the survey depends on the timing (when the survey is conducted) and the familiarity of the surveyor with the plants in question. The possibility exists that even with botanical surveys being conducted that T&E plant occurrences could be missed and subsequently impacted by the installation of the fence. To avoid missing plants, to the extent possible, surveys would be conducted at a time of year when plants are most readily detectable.

Until a zone is hunted free of pigs, any T&E listed plant occurrences in the zone would be subject to the direct impacts associated with the presence of feral pigs as described under Alternative One. For those T&E occurrences in the last zone to be hunted free of pigs, this would mean an additional six years of impacts associated with the presence of feral pigs. Monitoring would be done to determine if impacts are occurring to known locations of T&E plants that are scheduled later in the eradication schedule. If impacts were occurring, a determination of how to protect these plants would be done. Options to protect these plants include fencing the population, or conduct limited pig control around these areas to obtain short-term relief from the pig impacts.

Indirect Impacts

Indirect impacts to T&E plants could occur if invasive non-native seeds are transported into occupied T&E plant habitat either on the fencing material itself or on the boot and clothing of personnel or dogs involved in the eradication. As discussed previously, invasive weed species are able to out-compete native plant species including T&E plants for available water, nutrients, and sunlight. Mitigation to avoid introducing non-native plants would include washing vehicles, removing seeds from boots and clothing, and educating those involved in constructing the fences about the dangers of invasive weed species.

Until a zone is hunted free of pigs, any T&E listed plant occurrences in the zone would be subject to the indirect impacts associated with the presence of feral pigs as described under Alternative One. For those T&E listed plant occurrences in the last zone to be hunted free of pigs, this would mean an additional six years of impacts associated with the presence of feral pigs. As mentioned above, monitoring for pig impacts to T&E plants would be done, and protection would be implemented if impacts are found to be occurring.

Cumulative Effects

The cumulative impacts associated with this alternative would be similar to those discussed under Alternative Two – T&E Plants (cumulative effects).

Mitigation and Monitoring

- Surveys for T&E plants prior to fence construction with the fence location to be modified accordingly.
- Provide training to personnel involved in the eradication effort on sensitive areas to avoid, as well as training to identify T&E plants
- Monitor T&E plant occurrences for pig disturbance in the zones that are last in the eradication sequence, and if impacts are occurring protect these plants by fencing or

implementing pig control (localized pig eradication).

- To avoid introducing non-native plants, wash vehicles in a designated area to avoid transporting seeds, removing seeds from boots and clothing, and educate personnel involved in the eradication program about the dangers of invasive weed species.

Fennel

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from being redundant, the direct and indirect “effect analysis” can be found under Alternative Two – Fennel and is relevant for describing the effects for this alternative.

Effects of Implementing Pig Eradication

Direct and Indirect Effects

The effects of implementing this alternative are similar to those described under Alternative Two except for the elongated time frame in which pigs would be eradicated in parts of the island. Alternative Four would lead to feral pig eradication from all of Santa Cruz Island in a minimum of six years from the completion of phase one. With the zone fences, almost 50% of the island would be mostly free of pigs within two years. Within four years, greater than 75% of the island would be mostly pig-free.

The zone that contains the largest fennel patch (isthmus) would likely be the last zone scheduled for eradication. Until fennel is treated the rate of spread of fennel would be similar to the average rate of spread since 1991. Fennel treatment may occur within three-years after eradication begins in zone 1.

Using 1991 as the year in which fennel began its rapid expansion (Colvin and Gliessman 1994), the number of years that

fennel would be able to expand is 14 years for Alternatives Two, Three, and Four (Table 9).

Table 9. Number of years of fennel expansion prior to treatment.

Alternative	*Estimated Treatment Date	Years of expansion before treatment
Alt. One	No treatment	Unlimited
Alt. Two	Fall 2005	14
Alt. Three	Fall 2005	14
Alt. Four	Fall 2005	14

*Fennel treatment would occur as soon as Island fox population could withstand direct mortality of individuals in the fennel treatment area (see island fox mitigation)

In the long-term, fennel could re-establish if pig disturbance is not significantly reduced. Eliminating pig disturbance (eradicating pigs) would occur at different times under the four alternatives. Alternative One would not eliminate pig disturbance and result in continued fennel expansion. Alternative Two and Three would immediately begin pig eradication in the isthmus zone, even prior to fennel control. Both alternative would likely control fennel in the long-term (Alt 3 would have to swiftly ensure pigs are removed if they move over from TNC property – see fennel mitigation alt. 3). Alternative Four may not begin pig eradication in the fennel zone until two-three years after fennel treatment which could create enough oases of disturbed soil to establish new fennel plants from the seed bank, and establish new fennel communities in the fennel zone.

Under Alternative Four, in the interim period prior to full eradication to begin in the fennel zone, localized control of pigs in and adjacent to the fennel infestation could lessen

the chance for fennel to re-establish after fennel treatment.

Fence building and maintenance could cause soil disturbance sufficient to create conditions for fennel to become established. The best chance for this to occur is if construction or maintenance occurs in an area where a fennel seed source available. This is a negligible concern if done in areas where fennel is not present. Actions to prevent transporting seed to fennel-free is important.

Cumulative Effects

Other past, present, and future activities could effect the fennel population on Santa Cruz Island. Any human activity that is conducted in fennel infested areas could ultimately lead to transferring weed seeds to other relatively weed-free areas. For instance, the Del Norte and Montañon trail system currently traverse through heavily infested fennel areas, hikers walking through this area have the potential to carry seeds to other non-infested hiking areas. Increased visitor use is expected to increase with the completion of Prisoners Pier. Equipment used to maintain roads are often called upon to move to different parts of the island. If this equipment has operated in the fennel infested areas this could also cause transport of fennel seeds. Natural and cultural research and monitoring personnel working in fennel infested areas could also transport seeds.

Until significant fennel control is achieved on the isthmus, an education program that focuses on the risks and dangers of transporting invasive non-native weed seeds should be implemented for those people who may come in to associated or those people who may come in contact with the fennel. The program should also include how to inspect and clean clothing, shoes, and equipment for non-native weed seeds.

Mitigation and Monitoring

Same as Alternative Two.

Other Weeds

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from being redundant, the direct and indirect “effect analysis” can be found under Alternative Two – Other Weeds and is relevant to this discussion.

Effects of Implementing Pig Eradication

Direct and Indirect Effects

Cessation of soil and vegetation disturbance by pigs would immediately, rapidly, and steadily benefit all native plant species in the section being cleared, as well as non-native species such as the large suite of annual grasses already present. These together would provide rapidly developing live and dead vegetation cover, which would prevent many seeds of invasive weeds from germinating. Since no alien plants are being controlled or restricted by pigs, cessation of pig impacts to soils and vegetation would not increase alien plant distributions or abundance.

Dispersal of weed seeds by pigs from infested areas within the area to weed-free sections would cease. Prevalence of favorable weed-seed germination conditions created by pig rooting and trailing would rapidly decrease.

The activities associated with fence construction such as the staging of material, the ingress and egress of accessing material, create weed-vulnerable openings in vegetation, and disturb soil. These impacts would facilitate weed seed dispersal and weed establishment, both during fence construction and for the length of the project, since fences would need to be frequently monitored and maintained. Pigs would adopt new access tracks and trails, and rapidly disperse weed seed along them into previously minimally impacted areas. Travel by hunters in and out along these routes and

within and hunted areas would disperse seeds, as vehicles, boots, and equipment are transported between infested and weed-free areas. If left unattended, impacts would continue after completion of the project wherever road scars and weed populations have developed. To avoid long-term impacts, new weed infestations caused by the project’s activities should have a timely treatment response. Other weed infestations that are encountered, but are not caused by the project, need to be reported to NPS or TNC biologists.

Overall effects of Alternative Four are similar to those described for Alternative Two, however; the zones treated later in the eradication sequence would continue to have pig impacts facilitating soil disturbance and weed establishment. If monitoring shows that weed infestations are increasing as a result of pig disturbance, actions should be implemented that enact localized pig control and/or treatment of the infestation. Alternative Four would be substantially better than Alternative Three because in the long-term because the entire island would eventually be pig-free.

Cumulative Effects

Other past, present, and future activities could effect weed establishment on Santa Cruz Island. Any human activity that is conducted in weed infested areas could ultimately lead to transferring weed seeds to other relatively weed-free areas. For instance, hikers walking through weed infested areas have the potential to carry seeds to other non-infested hiking areas. Increased visitor use is expected to increase with the completion of Prisoners Pier. Equipment used to maintain roads are often called upon to move to different parts of the island. If this equipment has operated in weed infested areas, then moved to uninfested areas, could cause introduction of weeds to weed-free areas. Natural and cultural research and monitoring personnel working in weed infested areas could also transport seeds unintentionally.

An education program that focuses on the risks and dangers of transporting invasive non-native weed seeds should be implemented for those people who may come in contact with weed infested areas. The program should also include how to inspect and clean clothing, shoes, and equipment for non-native weed seeds.

Mitigation and Monitoring

- To avoid introducing non-native plants, wash vehicles in a designated area to avoid transporting seeds, removing seeds from boots and clothing, and educate personnel involved in the eradication program about the dangers of transporting invasive weed species.
- Ground disturbing activities associated with the implementation of this alternative would be monitored to ensure that disturbed areas do not become weed-infested. These areas would be treated if they pose a threat to natural resource values.

Issue 3: Island Fauna Impacts

Native Island Fauna

Effects of Implementing Fennel Control

Same as Alt.Two (See discussion Alt.Two)

Effects of Implementing Pig Eradication

Direct and Indirect Effects

Building and maintaining 40+ miles of fence would have slight negative effects on wildlife and fauna. Movement of wildlife would generally not be affected by pig-proof fencing, except possibly to slow the movements of Island spotted skunks. Island foxes have great climbing ability and would not be affected by a fence.

Fence building itself could have temporary negative impacts, as presence and activities of

fence builders may disturb wildlife. However, this is unlikely, since much of the fencing would be along road or ridgelines with little cover and less chance of harboring wildlife at any particular time.

During pig hunting, wildlife and fauna in the fenced zones would be subject to the same effects identified in Alternative Two. Those effects, generally, are major long-term beneficial effects associated with pig removal, and slightly negative short-term effects of removal actions themselves.

Alternative Four, the control of fennel and the eradication of feral pigs by island zone, would allow for six years of additional disturbance in the last zone to be hunted. This extended disturbance regime would allow the continued spread of fennel in the remaining grassland areas of the isthmus. The spread of fennel would continue to displace those vertebrate species (i.e. *Uta*) which prefer less structurally diverse plant communities, and would increase the habitat of those vertebrates that prefer structurally diverse plant communities. With the treatment of fennel and the eradication of feral pigs, there would be an increase in structurally simple plant communities. Those vertebrate species displaced by fennel encroachment would relocate back into the structurally simple habitats.

Alternative Four, feral pig eradication by island zone, would allow for continued pig disturbance during the initial eradication process. Disturbance would allow fennel to continue spreading in disturbed sties, increasing habitat for invertebrate species that prefer structurally diverse communities, and decreasing habitat for those that prefer structurally simple plant communities.

When the isthmus zone is treated and pig eradication occurs, it may be more difficult to control the expanded fennel. Post-treatment, the isthmus would likely be a patchy mosaic of grasslands, fennel stands and shrub stands. This diversity in plant communities, whether native

or not, would provide habitat for both classes of invertebrate species leaving a zero net effect of treatment on invertebrates under Alternative Four.

Cumulative Effects

Other management actions for natural resources on Santa Cruz Island would have effects on island fauna, particularly island foxes. Golden eagles are currently being relocated from Santa Cruz Island, and probably would be on an annual basis until pigs are removed from the island. Relocation of golden eagles from the island would increase survivorship of island foxes on Santa Cruz Island. Moreover, pending outcome of the feasibility study, bald eagles may be released on Santa Cruz Island within the next several years. If bald eagles attempt to breed on the island, their territorial nature may discourage golden eagle use of the island, thus decreasing golden eagle predation of island foxes. These positive effects on fox survivorship would continue until pigs are removed. The removal of pigs would have positive effects on fox survivorship outweighing those of either golden eagle removal or bald eagle introduction. Without a feral pigs prey base, golden eagle use of Santa Cruz Island should be minimal.

Mitigation

Same as Alternative Two.

Non-native Fauna (Pigs)

Effects of Implementing Fennel Control

Same as Alternative Two.

Effects of Implementing Pig Eradication

In fenced units, pigs would be killed using the same methods as in Alternative Two. Once units are fenced, pigs would be confined. Pigs having territories that cross between units would

likely challenge the fence. Trails would likely form along fencelines. No changes in pig densities are expected as a result of having pigs confined within a unit.

Cumulative Effects

Past activities, such as the initial introduction of pigs to Santa Cruz Island has resulted in the current feral pig population.

Present and future activities, as identified in the beginning of this chapter, would have negligible effects to the feral pig population on the island. It has been reported that people have provided food to feral pigs, and if visitation increases, more unauthorized feeding may continue to occur. This intermittent feeding would have negligible effect in the interim period prior to eradication.

Issue 4: Impacts to Physical Resources including Soils, Water and Air Quality

Effects of Implementing Fennel Control

The method for treating fennel is the same for Alternatives Two, Three and Four. To keep from repeating information, these discussions refer to the analysis provided in Alternative Two. The analysis there is relevant to the impacts under this alternative.

Fire Effects on Soil and Water Quality

The effects are the same as Alternative Two.

Herbicide Effects on Soil and Water Quality

The effects are the same as Alternative Two

Air Quality Impacts

The effects are the same as Alternative Two.

Effects of Implementing Pig Eradication

Soil and Water Quality

Direct and Indirect – This alternative is similar to Alternative Two in that eventually pigs would be eradicated from the island. Beneficial impacts would eventually be realized as described under Alternative Two. The difference between the alternatives is the time delay in which the beneficial effects would be realized. Under Alternative Four, pig impacts would continue to occur in zones that have not been hunted.

This alternative has zones that are the most difficult to hunt being implemented first. The topographic relief and the amount of vegetation cover within the zone determined hunting difficulty. Since zones being hunted first have the greatest vegetation cover, they also have the best watershed conditions. The zones to be hunted last have poorer watershed conditions. These zones would have up 4 years of continued pig disturbance prior to pig eradication.

Air Quality

In general, emissions from construction activities for implementation of this alternative may include: 1) earth movement and vegetation clearing for fence construction; 2) road and non-road construction vehicle exhaust emissions; and 3) fugitive dust emissions caused by vehicles traveling on unpaved roads. These activities would generally be occurring in isolated areas on the island and their emissions on a regional scale would be negligible.

Cumulative Effects

Soil and Water Quality

Alternative Four would eventually lead to pig-eradication and the end of pig-caused disturbance and erosion on Santa Cruz Island. Because the eradication process is expected to take four to five years, and fennel treatment

would not occur until the end of the eradication process, erosion would continue to occur on the isthmus and other zones until the pigs are eradicated. The dense cover and density of fennel currently present on the isthmus would prevent some erosion by pig rooting, but the increased duration of fennel in these areas may increase the amount of secondary compounds left in the soil after fennel treatment. Studies have not been done on the duration of fennel secondary compounds in the soil.

Pig disturbance may increase on the isthmus during the eradication process, which may increase rooting, erosion and the spread of fennel. This would make fennel control more difficult and, in turn, pig eradication from the isthmus zone more difficult. The eventual eradication of pigs from the isthmus would leave the isthmus in a degraded state with potentially large fennel stands and eroded soils which may decrease the ability of native species to re-establish.

The result of past activities, mainly domestic and feral livestock grazing, has had a major effect on the soil conditions on Santa Cruz Island. However, removal of cattle and sheep over the last 15 years has halted overgrazing and has prompted recovery in many areas. Major beneficial cumulative effects to soil and watershed conditions would be realized when the positive effects of removing sheep and cattle are combined with the eradication of pigs. These positive cumulative effects would be realized earlier in areas that are first to be eradicated of pigs, and 4-6 years later in units that are eradicated of pigs towards the end of the eradication effort. Regardless, islandwide benefits would occur to soil and water quality long-term.

Implementing present and future activities, as summarized in the introduction of this Chapter, would add only negligible detrimental soil and water quality impacts to the long-term beneficial effects that would be realized with the eradication of pigs.

Air Quality

Same as Alternative Two.

Mitigation

Soil and Water Quality

It is likely that soil disturbance and erosion would occur as a result of new road and trail development, or more intensive use of already established roads and trails. It is likely that many of these localized disturbed sites may heal over time after operations cease. However, recovery of these sites would heal faster should active restoration techniques be implemented. Site restoration would occur under the direction of the Park's restoration biologist on NPS lands, and under the direction and discretion of TNC on TNC-owned lands. Site restoration may include, but not limited to erosion abatement, seeding, and planting. Other mitigation measures include those mentioned under Alternative Two. These measures are as follows:

- Dead carcasses will not be left in or near live water sources, or in shallow groundwater areas with poorly drained soils.
- Actions that result in significant soil disturbance will be evaluated to determine if erosion abatement needs to occur. Erosion abatement would occur if NPS or TNC restoration biologists feel it necessary to protect soil resources.
- Herbicide will not be applied in drainages that do not contain the target species.

Air Quality

Measures to minimize air quality impacts for this alternative are the same as Alternative Two.

Issue 5: Socioeconomic Factors including Cultural Resources and Human Uses

Cultural Resources

Effects of Implementing Fennel Control

Same as Alternative Two (See "Effects of Implementing Fennel Control on Cultural Resources")

Effects of Implementing Pig Eradication

Under this alternative archeological sites in different units would remain subjected to varying degrees of ongoing damage through continued pig disturbance. The zones in which pigs were hunted first archeological resources would be protected and would suffer less long-term irreversible damage; zones in which pigs were hunted last would subject archeological resources to irreversible disturbance from pig damage for up to four extra years compared to Alternative Two. This span of four years may only cause moderate impact to archeological resources when compared to the 150 years of pig disturbance these same resources have been subjected to since pigs were introduced to the island. The overall amount of damage to archeological resources caused by pigs would decrease each year as zones are hunted out and the number of pigs decreases.

Since the introduction of pigs to the island, the integrity of the island's National Register-listed Archeological District has been compromised to some degree by pig rooting. This behavior has affected nearly all of the island's archeological sites, including ancient burials. Under this alternative, feral pigs would continue to disturb archeological sites and burials on the island until they are eradicated. The length of time required to completely eradicate pigs would have a minor to moderate effect on the integrity of the island's archeological resources because these resources

have already been subjected to almost 150 years of impact. Until pigs are eradicated, continuing damage to a large number of would result in the loss of scientific data, some of which may be irretrievable. The archeological value of the sites would be reduced and future archeologists would be less able to take advantage of new technology that may be developed to investigate the island's archeology.

Pig rooting is currently estimated to have damaged nearly all of the archeological sites on the island, to a minor or major extent. Pig rooting to a depth of three feet has been noted in a number of sites, particularly in areas covered by fennel or wild cucumber (Don Morris and Dr. Jeanne Arnold, personal communications). The information potential of some shallow sites and surface scatters has been completely destroyed by pig rooting. Rooting in the upper layers of deeper, more complex, stratified sites profoundly disturbs time and spatial relationships and destroys the context of the information contained in these sites.

Archeological resource monitoring conducted in zones yet to be eradicated may indicate that some sites require protection from pig disturbance. Cultural resource professionals may determine to protect these sites in advance of pig eradication activities being implemented. Fencing or initiating limited pig control (killing pigs in the local vicinity) are protection measures that could be used to protect these sites. Once the pig eradication was completed, the fences would be removed.

The islandwide fencing program has the potential to adversely affect cultural resources. Desirable locations for placing fencing, such as broad ridges, are also likely locations of archeological sites. The fencing program also may conflict with the fence and pasture patterns established during the historic ranch period, requiring alteration or removal of some of these historic features. Cultural resource surveys conducted prior to fence construction would help avoid adversely affecting archeological resources. In the event that sites cannot be avoided, NPS would consult with the California

State Historical Preservation Office, the Chumash Tribe and lineal descendants prior to resuming activities. Cultural resource surveys would also help avoid the alteration or removal of historic features. In the event that activities cannot avoid alteration or removal of historic features NPS will consult with the California State Historical Preservation Office prior to resuming activities.

Impacts to the island's cultural resources by the hunting operations are anticipated to be minimal and would primarily take the form of vehicle and foot traffic over archeological sites. Mitigation to minimize these impacts would be to orient the hunting groups to the sensitivity of these sites to damage and requiring that they avoid traffic over them whenever possible. Mitigation also includes surveying campsites and trap locations in advance to avoid locating them on any culturally sensitive sites.

NPS plans to upgrade existing facilities where needed, such as housing and infrastructure, for use by the contract hunters and fence builders. NPS would evaluate the proposed repairs and alterations to historic buildings and structures to ensure that proposed work meets the Secretary of the Interior's *Standards for Rehabilitation*. NPS will consult with the State Historic Preservation Officer (SHPO) where necessary under the programmatic Memorandum of Agreement among the NPS, The National Conference of SHPOs and the Advisory Council on Historic Preservation.

Section 106 Summary

Under regulations of the Advisory Council on Historic Preservation (36 CFR 800.9) addressing the criteria of effect and adverse effect, actions proposed under this alternative would have the potential to adversely affect the Santa Cruz Island Archeological District significant historic properties. As required with such a finding the NPS has initiated consultation with the State Historic Preservation Officer and the Chumash under Section 106 of the National

Historic Preservation Act. Consultation resulted in a Memorandum of Agreement that stipulates, through a treatment plan, how the NPS would carry out pig eradication activities that affect cultural resources. These stipulations would mitigate adverse effects to cultural resources and is incorporated by reference into this Final EIS and is available for review upon request.

Cumulative Effects

Cumulative effects on cultural resources under this Alternative will be similar to those under Alternative 2, however impacts from pig depredations would continue on portions of the island for several additional years, until the pigs are eradicated from all zones.

Human Uses

Effects of Implementing Fennel Control

Herbicide Application – Human Exposure

Same as Alternative Two.

Visitor Experience

Same as Alternative Two.

Effects of Implementing Pig Eradication

Visitor Experience

Essentially the island would be divided into zones and sequentially trapped and hunted for pigs. While each zone is being hunted, impacts to the visitor experience in that zone would be substantial. For example boaters visiting specific anchorages on central and west SCI would not be permitted to come ashore while hunting operations are occurring. The isthmus and the east end would comprise one zone, and so effects to park visitors coming ashore would be confined largely to this zone.

While the zone is hunted, visitor access to the zone would be reduced, if not eliminated

altogether. Thus, the isthmus and east Santa Cruz may be closed to visitor use during pig hunting activities, thus preventing thousands of visitors from recreating on Santa Cruz Island for perhaps as long as six months or a year. The number affected on east Santa Cruz would be some portion of the 18,000 visitors that currently go ashore.

Access for researchers may also be reduced or eliminated during pig-hunting activities in a zone. Thus, up to 20 researchers per year may be prevented from completing a portion or all of their research projects on Santa Cruz Island.

Long-term positive effects on the visitor experience include the elimination of pigs and pig effects from the ecosystem of Santa Cruz Island.

Impairment of Park Resources or Values

The fundamental purpose of the National Park System, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid or minimize to the greatest degree practicable adverse impacts on park resources and values. However, the laws do give the NPS management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values.

Although Congress has given the NPS management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an

impact that, in the professional judgement of the responsible NPS manager, would harm the integrity of park resources or values, including opportunities that otherwise would be present for the enjoyment of those resources or values. An impact to any park resource or value may constitute impairment. However, an impact would more likely constitute impairment to the extent it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- Identified as a goal in the Park's General Management Plan or other relevant NPS planning documents.

Impairment Analysis by Alternative

Alternative One – No Action

The no-action alternative would allow for pigs to remain throughout the island. Pig disturbance, as described in Chapter One, is responsible for the decline of important park resources including: native island vegetation including Threatened and Endangered plant species; island fox, archeological sites, and soil resources.

Enabling Legislation: Title II § 202 of Public Law 96-199 states that Channel Islands National Park is established in order to protect the nationally significant natural, scenic, wildlife, marine, ecological, archaeological, cultural, and scientific values. The Park has determined that in order to meet enabling legislative intent and protect natural and cultural resources, pigs must be removed from the island. Protection cannot be afforded to these resources and impairment of park resources is occurring under this alternative.

Natural and Cultural Resource Integrity/ Enjoyment of the Park: Damage to natural and cultural resources as a result of pig disturbance can be found in every major watershed of Santa Cruz Island. Experts in the fields of wildlife biology, botany, and archeology believe that continuance of pig presence on Santa Cruz Island significantly compromises the integrity of natural and cultural resources.

Park enjoyment for people who work or visit SCI is diminished by:

- visible scars on the landscape of SCI from pigs rooting large areas
- large patches of alien weeds that are perpetuated because of pig disturbance
- improbable chance of viewing native wildlife, especially the island fox
- viewing pig starvation because of the lack of adequate food resources on SCI

General Management Plan: The GMP (1985) specifically calls for the removal of swine from Santa Cruz Island.

Pigs have been identified as the greatest perturbation to the island's cultural and natural resources. Under this alternative they would remain on the island which is contrary to GMP policy.

Alternative Three

Enabling legislation designates all of Santa Cruz Island as wholly within the boundaries of Channel Islands National Park. It also allows for federal funds to be expended for the cooperative management of TNC lands on Santa Cruz Island. Alternative Three would not result in cooperative management of TNC lands because different levels of protection would be implemented based on land ownership. Equal protection of park resources would not be attained resulting in degradation of cultural and natural resources as a whole. Degradation of resources would result in a decline in both park enjoyment and natural and cultural resource integrity. Every significant cultural or natural

resource on Santa Cruz Island is of interest to the park. Lack of cooperative management, degradation of natural and cultural resources, and decline in visitor enjoyment would result in impairment.

Alternatives Two and Four

Enabling Legislation and General Management Plan: Alternatives Two and Four both propose eradicating pigs on all of Santa Cruz Island. Eradicating pigs in order to protect the natural ecosystem is consistent with goals and objectives found in the Park's enabling legislation and the Park's GMP. The actions proposed to implement these alternatives have varying degrees of impacts. However, these impacts are expected to be short-term and reversible, with the exception of impacts to cultural resources, which are not reversible. Based on enabling legislation, GMP, and the findings of this EIS these actions would not impair park resources.

Natural and Cultural Resource Integrity/Enjoyment of the Park: Unlike Alternative One and Three, these alternatives would improve natural resources and protect cultural resources on all of SCI. By improving these resources, enjoyment of the Park would be enhanced.

Sustainability and Long Term Management

This section of the analysis will focus in on the relationship between local short-term uses of the environment and the maintenance and enhancement of long term productivity, irreversible and irretrievable commitments of resources, and adverse impacts that cannot be avoided.

The Relationship between Local Short-term uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

For any of the alternatives considered, no long-term management possibilities or park productivity of resources are being traded for the immediate use of NPS owned lands. Islandwide resource impacts would continue to occur if action is not taken on pigs on Santa Cruz Island. Future visitors to Santa Cruz Island could notice a change in the landscape (visual change in vegetation) with the removal of pigs from Santa Cruz Island. The action of eradicating pigs on Santa Cruz Island would be a sustainable action with favorable environmental consequences.

Irreversible and Irretrievable Commitments of Resources

No permanent or long-term (irreversible) commitment of natural resources would result from implementing Alternatives Two, Three or Four.

Alternatives One could jeopardize the continued existence (irretrievable) of some Threatened and Endangered plant species because pigs would not be eradicated from the island. In addition, under Alternative One, pigs would remain on the island to the detriment of the island fox. Commitment of resources concerning the captive breeding program to restore the island fox population may be irreversible with the continue presence of pigs on the island.

Under Alternative One, cultural resource impacts caused by feral pigs would continue and would be irreversible. Alternative Two would halt pig related impacts the fastest. Under Alternative Four, there would be ongoing, irreversible cultural resource impacts caused by feral pig until the zones are free of pigs.

In this analysis the Park determined that this analysis does not require analysis of energy requirements (1502.16), nor does it require an economic impact analysis (EO 11821).

***Adverse Impacts that Cannot be Avoided
Should the Action be Implemented***

The action alternatives (Two-Four) considered in this analysis do not result in impacts that cannot be fully mitigated or avoided.

Adverse impacts to cultural resources have been ongoing since 1857, these adverse impacts would continue on the island as a whole or in part under Alternatives One and Three. Alternative Four would subject a part of the island to the adverse effects of pigs up to four years longer when compared to Alternative Two. Cultural resources can be protected from the adverse effects of feral pigs by fencing, or implementing localized pig control, however; because of the widespread nature of cultural resources throughout the island, it would be impracticable to protect all cultural sites during the interim period prior to eradication.

***Summary of Impacts by
Alternative***

For each alternative action, the Park analyzed the potential environmental impacts that would likely occur. Environmental impacts were divided into the following categories: Native Plant Communities, Rare and Listed Plants, Non-native Plants, Native Island Fauna, Non-native Island Fauna, Soil and Water Resources, Cultural Resources, and Human Uses.

The preferred alternative by the Park is Alternative Four: Sequential, Islandwide Eradication by Fenced Zone Hunting. Under this alternative there would be some short-term impacts to native flora, fauna, soils, waters, cultural resources, and human uses due to the activities associate with fennel control and feral pig eradication. However, following fennel control and eradication of feral pigs from a given zone, protection of irreplaceable island resources would be immediate and recovery of many impaired natural resources would begin immediately.

Table 10. Summary Table of Environmental Consequences

	ALTERNATIVE ONE (NO ACTION)	ALTERNATIVE TWO (SIMULTANEOUS ISLANDWIDE ERADICATION)	ALTERNATIVE THREE (ERADICATE NPS; EXCLUSION ON TNC)	ALTERNATIVE FOUR (FENCED HUNTING ZONES)
LIKELIHOOD OF SUCCESS	<p>Would not enact the minimum actions to control fennel. Treatment of fennel would not meet restoration goals set for this project. Fennel control would only occur to the level that has been done in the past, which would not be enough to control the rapid rate of spread of fennel.</p> <p>TNC and NPS would not attempt eradication but would protect resources with a pig control program. This type of program has not proven effective in protecting natural or cultural resources. Long-term it would have significant ecological cost due to significant natural resource damage and irreversible cultural resource impacts.</p>	<p>Alternatives Two is an excellent strategy for protecting island resources but would be very difficult to achieve because of the need to fund and support a very large operation over a short period of time. Funding realities substantially lessen the “Likelihood of Success” for this alternative.</p>	<p>Alternative Three has a low “Likelihood of Success” because more than 3/4 of the island, containing extremely significant natural and cultural resources, would continue to be subjected to feral pig impacts. Additionally, it is expected that maintaining a pig-proof fence across the island would be expensive and an exercise in futility. Pigs are very adept at breaking through fences. It is doubtful that park personnel, with all the demands and issues they face, could sustain in perpetuity the effort necessary to hold a fenceline into the indefinite future.</p>	<p>Alternative Four has a high “Likelihood of Success” because it achieves the best balance of expeditiously and comprehensively protecting resources in a manner that the NPS is likely to be able to support financially and logistically. This program is modeled after the pig eradication program on Catalina Island. Catalina is in its 4th year of a 6-year eradication program. The most difficult obstacles being faced with this project is gates being left open and having to modify techniques in the Avalon zone. These obstacles would not be faced with the SCIPRP because access is much more restrictive, and the jurisdiction is fully within the control of NPS or TNC.</p>

	Alternative One	Alternative Two	Alternative Three	Alternative Four
NATIVE PLANT COMMUNITIES	<p>Fennel would continue to spread, aided by rooting pigs. Pigs would continue impacts on vegetation through rooting, accelerated soil erosion, seed predation, carrying of weed seeds, and creation of trails. Pigs would continue to suppress natural regeneration of woody species, especially oaks. Pigs would continue to impact riparian areas, another preferred habitat.</p>	<p>Fennel burn would increase soil nutrients in the short term, and kill some native plants. Fire would stimulate seed germination of some native plants. Native dicots within the treatment area may experience mortality due to herbicide effects. Native communities are more likely to colonize the isthmus area post-treatment than under the dense fennel that currently exists. The control of fennel and eradication of feral pigs would have substantial and positive long-term effects on native plant communities.</p>	<p>Effects from fennel burn and herbicide application same as Alternative Two. The control of fennel and eradication of feral pigs would have substantial and positive effects on native plant communities on approximately NPS lands. On TNC lands the island's native plant communities would be exposed to the feral pig impacts described in Alternative One.</p>	<p>The environmental consequences are substantially similar to Alternative Two. The primary difference is that the project would take approximately 4 years longer to complete and there would be impacts from fence building and removal. Effects from fennel burn and herbicide application same as Alternative Two. The control of fennel and eradication of feral pigs would have substantial and positive effects on native plant communities.</p>
T & E PLANT SPECIES	<p>The factors that led to the decline of rare and listed plants would largely continue. Feral sheep, which also contributed to rare plant declines, have been removed. However, feral pigs continue to impact almost all known populations of listed plant species. Failure to remove pigs would go against the recovery strategy developed for these species.</p>	<p>One listed plant species, <i>Galium buxifolium</i>, occurs on the isthmus where the dense fennel occurs. However, the <i>Galium</i> does not co-occur with the fennel. No burning or herbicide is planned for the coastal bluff habitat inhabited by the <i>Galium</i> and no effect is anticipated. The nine listed plant species and numerous rare plants should all benefit from the eradication of feral pigs.</p>	<p>Some protection would be afforded to rare and listed plant species due to fencing existing populations. However, sustained protection would be difficult due to the ability of pigs to break through fencing. Populations would not be able to colonize suitable habitat because these habitats would continue to be severely impacted by pigs.</p>	<p>Same as Alternative Two except that it would take approximately 4 more years to achieve the feral pig eradication and protect the rare and listed plants.</p>

	Alternative One	Alternative Two	Alternative Three	Alternative Four
NON-NATIVE PLANTS	Non-native plants would continue to benefit from the ground disturbance activities of feral pigs. Fennel would continue to expand into native plant communities and annual grasslands establishing dominance.	Achieve fennel control to the same extent observed in the Central Valley Fennel Project. Fennel burn and herbicide treatment may enhance annual grasses, and reduce other non-native dicots. Removal of pig disturbance would substantially reduce long-term establishment and spread of non-native plants.	Environmental consequences would be similar to Alternative One on TNC-owned lands. To the extent that pigs can be excluded from NPS-owned lands, the environmental consequences would be similar to Alternative Two.	Same as Alternative Two. Fence building and removal would likely create some bare ground and may increase weed spread into disturbed areas near fencelines.
NATIVE ISLAND FAUNA	Pigs would continue to directly and indirectly impact native wildlife through destruction of habitat, predation, and competition for food, supporting enhanced populations of predators (such as ravens). Island Foxes would face continued predation from non-native golden eagles.	There would be short-term effects on small animals due to the fennel burn. Elimination of dense fennel stands would cause changes in species composition in the long-term. Herbicide treatment is not expected to affect island fauna. Feral pig eradication would remove direct competition and predation on many island animal species. Island foxes would not face predation from non-native golden eagles nor competition for food.	Same as Alternative One for Island Foxes. Native wildlife, such as mice, lizards, and snakes on NPS-owned lands would benefit (similar to Alternative Two) from the eradication of feral pigs in that area. On TNC-owned lands, wildlife impacts would be the same as Alternative One.	Same as Alternative Two, although approximately 4 more years would be needed to eradicate the feral pigs.
NON-NATIVE FAUNA	Pigs would provide a food supply adequate to support nesting by non-native golden eagles. The golden eagles would also prey on native island endemic species such as the island fox and the island spotted skunk. Fennel, a preferred habitat for pigs, would continue to expand, possibly creating more suitable habitat and increase in the pig population.	Removal of pigs would eliminate the primary prey base for golden eagles. Golden eagles would no longer be able to sustain resident populations on the island.	Effects from fennel burn and herbicide application same as Alternative Two.	Same as Alternative Two, although approximately 4 more years would be needed to eradicate the feral pigs.

	Alternative One	Alternative Two	Alternative Three	Alternative Four
SOIL, WATER, AIR	Pig rooting and herbivory would continue to reduce plant cover and greatly increase soil disturbance leading to increased erosion. Pigs would continue impact live-water streams and seeps decreasing water quality. The fennel burn would not occur so no smoke emissions would occur.	Fennel burn and herbicide would reduce standing biomass and could create small bare areas and localized erosion. Soil nutrient levels would increase in the short-term causing a flush in vegetation growth. Eradication of feral pigs would greatly reduce soil disturbance, destruction of cryptobiotic crusts, and lessen soil disturbance and erosion leading to beneficial water quality effects.	To the extent the NPS is successful keeping pigs from re-invading NPS-owned lands, the environmental consequences in this area would be the same as Alternative Two. However, for TNC-owned lands (with the exception of selected fenced areas) the environmental consequences would be the same as Alternative One.	Same as Alternative Two, although approximately 4 more years would be needed to eradicate the feral pigs.
CULTURAL RESOURCES	Pigs would continue to destroy irreplaceable archeological sites and would degrade the scientific importance of the Santa Cruz Island Archeological District.	The fennel burn could affect archeological sites and historical resources, such as fencelines. Fire lines in fennel could cause ground disturbance. Protection of archeological sites from feral pigs would occur within two years.	Most of the Santa Cruz Island Archeological District would continue to be impacted by feral pigs. To the extent that pigs are excluded from NPS-owned lands, archeological sites in that area would be protected. Fennel burn impacts are the same as Alt. 2.	Protection of archeological sites from feral pigs would occur within six years. Fence building may impact archeological sites, although impacts would likely be avoided with mitigation.
HUMAN USES	Human uses would be largely unchanged. The aesthetics of visits to Santa Cruz Island would be lessened due to fennel stand, the reduction of native wildlife, landscape disturbance, and destruction of archeological sites. The scientific value of the island would decrease. Pigs may occasionally be dangerous to people in certain situations. People would continue to witness starvation of pigs.	Elimination of dense stands of fennel would improve the attractiveness of the isthmus for visitor use. Visitor use and access may be limited while hunting of feral pigs is active in selected areas. Elimination of pigs would improve island aesthetics, scientific values, and recreational opportunities.	Environmental effects would be similar to Alternative Two for most recreational uses. The scientific value of most of the island would decrease. Pigs may occasionally be dangerous to on TNC-owned lands.	Same as Alternative Two, although approximately 4 more years would be needed to eradicate the feral pigs.

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