National Park Service
U.S. Department of the Interior

Channel Islands National Park
Ventura, California

Santa Cruz Island Primary Restoration Plan

Final Environmental Impact Statement

June 2002

National Park Service
U.S. Department of the Interior

Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

FINAL ENVIRONMENTAL IMPACT STATEMENT

Channel Islands National Park

Santa Cruz Island - Santa Barbara County, California

June 2002

Responsible Official

John Reynolds, Regional Director
Pacific West Region
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Lead Agency:

U.S. Department of Interior
National Park Service

For Further Information

Attention: SCIPRP
Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

Abstract

This Final Environmental Impact Statement (FEIS) was prepared in accordance with the Department of the Interior National Environmental Policy Act (NEPA) regulations, and the National Park Service (NPS) NEPA guidelines (NPS-12). This environmental analysis has been prepared because actions proposed as part of this Final EIS may be a major federal action significantly affecting the quality of the human environment.

Channel Islands National Park, The Nature Conservancy and other natural and cultural resource experts have identified the impacts of non-native feral pigs and fennel invasion as the most significant perturbations affecting the sensitive natural and cultural resources on Santa Cruz Island. To address the degradation of these resources, Channel Islands National Park, in coordination with The Nature Conservancy, developed management actions that would eradicate feral pigs and control fennel on Santa Cruz Island.

The proposed management action (Alternative Four) to eradicate feral pigs consists of constructing six fenced management units of roughly 12,000 acres each. The pig proof fence will mostly follow existing and historical fence lines. Within these units, feral pigs will be eradicated, clearing one zone before moving to the next. It is estimated that it would take approximately one year to clear a management unit of pigs, therefore, island-wide eradication is estimated to take approximately six years to complete. Fennel control consists of reducing large stands of fennel through controlled, prescribed fire and two successive sprays of herbicide. Fennel control using these methods would only occur in areas of higher fennel density located on the isthmus, and will be based upon the successful Central Valley Fennel Removal Project. This protocol consists of burning large fennel stands to reduce standing biomass, followed by spraying with the herbicide Garlon 3A in low application rate of 1 lb AI/acre for two successive growing seasons to kill resprouts and new seedlings. Under the proposed action, there would be some short-term impacts to native flora, fauna, soils, waters, cultural resources, and human uses due to the activities associated 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.

Three additional alternatives to the proposed action were developed and evaluated. Alternative One (No Action) would not implement pig eradication or extensive fennel control. Alternative Two would attempt to eradicate pigs without fencing the island into management units and would treat fennel control the same as the proposed action. Alternative Three would eradicate pigs on NPS-owned lands, but allow pigs on TNC-owned lands, controlling their destructive actions by excluding them from sensitive resources through fencing. 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.

No sooner than 30 (thirty) days after the Final EIS Notice of Availability appears in the Federal Register, a Record of Decision (ROD) will be executed. John Reynolds, Regional Director, Pacific West Region, is responsible for the final decision. Tim Setnicka, Superintendent, Channel Islands National Park, is responsible for plan implementation and monitoring activities.

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SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

SUMMARY OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT

Introduction

Santa Cruz Island, the largest of the Channel Islands off the coast of Southern California, is home to a variety of wildlife including a significant number of plants and animals that can be found nowhere else in the world. Nine of its plants are listed as endangered or threatened under the Endangered Species Act. It is this uniqueness that makes Santa Cruz Island a bastion of biological diversity. An estimated 3,000 archeological sites associated with the Chumash culture are located on Santa Cruz Island. Ninety percent of the island is listed in the National Register of Historic Places (NRHP) for its archeological significance. Channel Islands National Park was established to protect and restore these nationally significant resources.

Non-native, species introduced to the island throughout the last 200 years have caused extensive damage to the island's rich resources. Without aggressive management actions to reverse the tide of degradation caused by the exotics, the island's rare biological and archeological resources are in danger of being lost forever.

This primary restoration plan proposes actions to: 1) eradicate non-native feral pigs; 2) reduce the spread and presence of fennel (*Foeniculum vulgare*), a weed that has aggressively spread and taken over a large area on the isthmus of Santa Cruz Island; 3) promote the conservation and recovery of rare species of plants and animals and the habitats on which they depend; and 4) eliminate disturbance and degradation of extensive archeological resources.

Description of the Alternatives

The proposed action, Alternative Four, would reduce ecosystem and archeological site disturbance and promote species recovery by implementing a six-year pig eradication program. The program includes fencing the island into six hunting units and sequentially eradicating pigs unit by unit until pigs are totally removed from the island. To assist pig eradication, large stands of fennel on the island's isthmus would be treated. Controlling fennel involves burning the stand in the fall then applying herbicide the next to springs following the burn.

Approximately 45 miles of fence would be constructed. The fence would be located mostly along existing fence lines resulting in the island being divided into five management units of roughly 12,000 acres each, and one unit of approximately 3,000 acres. Within these units, feral pigs would be eradicated.

Priority for early hunting would be given to units that have thick vegetation, causing the unit to become increasingly difficult to hunt. Fennel treatment would be focused in areas of high fennel density that would inhibit pig removal efforts, and would be based upon the successful Central Valley Fennel Removal Project (co-funded by The Nature Conservancy and the Mellon Foundation). This protocol consists of burning large, monoculture stands of fennel to reduce standing biomass, followed by treatment with the herbicide Garlon 3A in low application rates of 1 lb AI/acre for two successive growing seasons to kill resprouts and new seedlings.

	Alternative One	***Alternative Two***	***Alternative Three***	***Alternative Four***
Alternative Features	No Action	Simultaneous Island-Wide Eradication of Pigs	Eradicate Pigs from ESCI/ Exclude Pigs from Selected Sensitive Resources on C/WSCI	Sequential Island-Wide Eradication by Fenced Zone Hunting
Pig Eradication Strategy	No Eradication Strategy would be implemented	Hunt all areas simultaneously until all pigs are eradicated	Create two pig zones: eradicate pigs in NPS zone; exclude pigs from selected resources on TNC property	Trap and hunt pigs by zone until all pigs are eradicated
Miles of Fence Construction	None	None	~10	~45
Duration of Project	0	2 years of eradication, 5 years inspect and monitor	2 years of eradication, exclude forever	6 years of eradication, 5 years inspect and monitor
Fennel Control	None	Prior to pig eradication - Burn fennel in the fall; aerially spray with herbicide two consecutive springs	Same as Alt. Two	Same as Alt. Two

Alternatives Considered and Rejected

Dismissed Alternatives and Techniques for Feral Pig Eradication

- *Live capture of feral pigs and relocation to the mainland*
- *Use of poison*
- *Use of snares*
- *Use of contraceptives or sterilization*
- *Public hunting*
- *Introduction of swine diseases*

Dismissed Alternatives for Fennel Control

- *Mechanical Fennel Control Only (No Prescribed Burn or Herbicide Application)*
- *Mechanical Fennel Control and Hand Application of Herbicide (No Aerial Spraying)*
- *Prescribed Burn Fennel Control and Hand Application of Herbicide(No aerial Spraying)*

Summary of Environmental Impacts

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 Proposed Action is Alternative Four: Sequential, Island-wide Eradication by 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 associated 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.

Native Plant Communities

- *Alternative One* - Fennel would continue to spread, aided by pig rooting. Pigs would continue to cause impacts to vegetation through rooting, accelerated soil erosion, seed predation, carrying of weed seeds, and creation of trails. Lack of regeneration of oaks would continue.

- *Alternative Two* - Fennel burn would increase soil nutrients in the short term, and kill some native plants. Fire would stimulate seed germination of some native plants. Small patches of native plants and boundary areas may experience mortality due to herbicide effects. The control of fennel and eradication of feral pigs would have substantial positive long-term effects on native plant communities.
- *Alternative Three* - Effects from fennel burn and herbicide application on NPS lands would be the 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 24% of the island. On TNC land the island's native plant communities would be exposed to the feral pig impacts described in Alternative One. Lack of regeneration of oaks on TNC owned lands.
- *Alternative Four* - The environmental consequences are similar to Alternative Two. The primary difference is that the project would take approximately four years longer to complete and there would be impacts from fence building and removal. Effects from fennel burn and herbicide application would be the same as Alternative Two. The control of fennel and eradication of feral pigs would have substantial long-term positive effects on native plant communities.

Threatened and Endangered Plants

- *Alternative One:* Feral pigs would continue to impact almost all known populations of listed plant species.
- *Alternative Two:* One listed plant species, *Galium buxifolium*, occurs on the isthmus where the dense fennel occurs. However, the *Galium* does not co-occur with the fennel. No burning or herbicide is planned for the coastal bluff habitat inhabited by the *Galium* and no effect is anticipated. The nine listed plant species and numerous rare plants should all benefit from the eradication of feral pigs.
- *Alternative Three:* 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 over time. Populations would not be able to recover to new habitats because of the continued presence of feral pigs.
- *Alternative Four:* Same as Alternative Two except that it would take approximately 4 more years to achieve the feral pig eradication.

Non-native Plants

- *Alternative One:* 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.
- *Alternative Two:* Fennel burn may enhance annual grasses. Fennel would be greatly decreased. Herbicide application would greatly reduce fennel and should reduce other non-native broad-leaved plants. Removal of pig disturbance would substantially reduce long-term establishment and spread of non-native plants.
- *Alternative Three:* Environmental consequences would be similar to Alternative One on TNC owned lands. To the extent that pigs can be excluded from the eastern 24% of the island, the environmental consequences there would be similar to Alternative Two.

- *Alternative Four:* 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

- *Alternative One:* Pigs would continue to directly and indirectly impact native wildlife through destruction of habitat, predation, competition for food, supporting enhanced populations of predators (such as ravens). Island foxes would face continued predation from non-native golden eagles.
- *Alternative Two:* 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. Native wildlife, such as mice, lizards and skunks would benefit. Island foxes would not face predation from non-native golden eagles nor competition for food by pigs.
- *Alternative Three:* On TNC owned lands effects would be similar as described under Alternative One. Native wildlife, such as mice, lizards, and snakes on the NPS owned lands would benefit (similar to Alternative Two) from the eradication of feral pigs in that area.
- *Alternative Four:* Same as Alternative Two, although approximately four more years would be needed to eradicate the feral pigs.

Non-native Island Fauna

- *Alternative One:* Pigs would remain abundant on the island. Pigs present a readily available food source adequate to support the continued nesting by non-native golden eagles. The golden eagles would continue to opportunistically prey on native island endemic species such as the island fox.
- *Alternative Two:* 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.
- *Alternative Three:* Effects from fennel burn and herbicide application same as Alternative Two.
- *Alternative Four:* Same as Alternative Two, although approximately 4 more years would be needed to eradicate the feral pigs.

Soil and Water

- *Alternative One:* Pig rooting and herbivory would continue to reduce plant cover and greatly increase soil disturbance and erosion.
- *Alternative Two:* Fennel burn and herbicide would standing biomass and could lead to small areas of bare soil and erosion. Eradication of feral pigs would greatly reduce soil disturbance, erosion, destruction of cryptobiotic crusts, and lessen soil erosion and stream sedimentation. Soil nutrient levels would increase in the short-term from the fennel burn and likely cause a flush in vegetation growth.
- *Alternative Three:* To the extent the NPS is successful keeping pigs from reinvading the eastern portion of the island, the environmental consequences in this area would be the same as Alternative

Two. However, for the remainder of the island (with the exception of selected fenced areas) the environmental consequences would be the same as Alternative One.

- *Alternative Four:* Same as Alternative Two, although approximately 4 more years would be needed to eradicate the feral pigs.

Cultural Resources

- *Alternative One:* Pigs would continue to destroy irreplaceable archeological sites and would degrade the scientific values of the Santa Cruz Island Archeological District.
- *Alternative Two:* The fennel burn could affect historical resources, such as fencelines. Fire lines in fennel could cause ground disturbance. The primary impactor of archeological sites, feral pigs, would be eliminated in approximately two years.
- *Alternative Three:* Most of the Santa Cruz Island Archeological District would continue to be impacted by feral pigs. To the extent that pigs are excluded from the eastern portion of the island and fenced out of selected sites on the remainder of the island, archeological sites in those areas would be protected.
- *Alternative Four:* Same as Alternative Two, although approximately four more years would be needed to eradicate the feral pigs.

Human uses

- *Alternative One:* Human uses would be largely unchanged. The aesthetics of visits to Santa Cruz Island would be lessened due to the reduction of native wildlife, reduction of plant cover, and destruction of archeological sites. The scientific value of the island would decrease. Pigs may occasionally be dangerous to people in certain situations. Visitors would continually encounter seasonal starvation of feral pigs.
- *Alternative Two:* 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. Eradication of pigs would improve island aesthetics, scientific values, and recreational opportunities.
- *Alternative Three:* 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 people in the central and western portions of the island.
- *Alternative Four:* Same as Alternative Two, although approximately four more years would be needed to eradicate the feral pigs.

Likelihood of Success

- *Alternative One*: Alternative One (No Action) would not allow the NPS to achieve its goals for conserving natural and cultural resources on Santa Cruz Island and restoring the natural ecosystems of the island. Nine plant species from Santa Cruz Island have been listed as threatened or endangered, and island foxes have declined precipitously in recent years, are indications of the destruction of native resources caused by feral pigs. Feral pigs have irreversibly damaged numerous archeological sites.

- *Alternative Two:* This 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 and logistical realities substantially lessen the "Likelihood of Success" for this alternative.
- *Alternative Three*: This has a low "Likelihood of Success" because more than three-fourths of the island, containing extremely significant natural and cultural resources, would continue to be subjected to feral pig impacts. Additionally, it is expected that maintenance of 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. Once pigs breached the fence, even accomplishments on the eastern fourth of the island would be lost or would be extremely expensive and time consuming to recover.
- *Alternative Four*: This has the highest "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. The longer time necessary to complete the project would allow more post-sheep removal vegetation recovery, increasing the difficulty of feral pig eradication.

Response to Comments

In total, 36 letters or e-mail correspondence were provided to the Park during the 60-day comment period for the Draft EIS. From this correspondence, the Park identified 66 substantive comments. Substantive comments are those that are not simple statements for or against the proposal, but rather those comments requiring additional explanation or analysis of data and those that debated facts or conclusions rendered in the Draft EIS. These comments were divided into 14 categories. In the "Response to Comments" section the Park provides responses to all 66 substantive comments received on the project.

Draft EIS Commentator List

Government Agencies	Groups and Organizations	Individuals	Individuals
U.S. Environmental Protection Agency	In Defense of Animals	Betine Corimby	Ms. Gayle Harris Birk
U.S. Fish and Wildlife Service	National Anti-Vivisection Society	Mrs. Phyllis E. Grame	Pinky Jain Pan
U.S. Army Corps of Engineers	Santa Cruz Island Foundation	Jeanne E. Arnold	Larry L. Loeher, Ph.D.
	Santa Barbara Audubon Society	Maureen Edwards	Allison Marie Memmo Geiger
	Catalina Island Conservancy	Linda Saffell	Brian Ehler
		Helene Schwartz	Jennifer Graham
		Dieter Wilken, Ph.D.	Jeannette Ferro
		Siobhán Gephart	
		Dolores and David Ferraro	

Government Agencies	Groups and Organizations	Individuals	Individuals
	People for the Ethical Treatment of Animals California Native Plant Society Santa Barbara Museum of Natural History University of California, Davis California State University, Long Beach	Betty L. Jeppesen Diana Cora Joy M. Zakarian, M.P.H Andrea Heaton	Ms. Robin Betian Brian Ehler Jennifer Graham Jeannette Ferro

Comment Categories

Category	General Comment Summary
Herbicide	Use of Garlon 3A
T&E Plants	Protection of T&E plants from herbicide application
Water Quality / Erosion	Water quality and use of herbicide/ Activities effect on WQ
Alternatives	Clarification or suggestion on alternatives
Exotic Species	Response of exotic species to fennel control program
Cultural Resources	Mitigation activities to protect cultural resource sites
Air Quality	Air Quality impacts from prescribed burn and eradication activities
Economic	Sport hunting of pigs/ Cost of pig eradication and fennel control
Purpose and Need	Purpose and Need
EIS Organization	Literature Cited
Effects Analysis	Clarification or comment on effects analysis
Island Fox	Effect of hunting dogs on the Island fox
Sterilization/ Ethical Treatment of Animals	Use of Gonex sterilant/ Ethical treatment of pigs
Access	Access restrictions for the public and researchers

NPS Response to the Two Most Common Comments

Comment: *The Park needs to consider the use of Gonex, a sterilant, to eradicate pigs on Santa Cruz Island*

Response:

Gonex

Gonex is a chemical compound currently under development for use as an injectable sterilant for all mammals. It works by destroying the gonadotropin hormones secreted by the anterior pituitary gland. Those hormones are required for successful reproduction, and are the same in all mammals.

Gonex does not have Food and Drug Administration (FDA) approval and therefore cannot be used on this project. There is no indication that this drug would receive FDA approval in the near future. Even if Gonex were to gain FDA approval there is no indication that it would be a viable tool for feral pig eradication, since sterilants in general have proven ineffective for use in an eradication program.

Sterilization

Sterilants in general cannot be used for this project because: 1) use of a sterilant would require injecting and marking each pig on the island; and 2) they are unproven for an eradication program.

Requires Injecting and Marking Each Pig on the Island: The logistics of delivering the sterilant to all pigs on the island comprises an insurmountable obstacle. Because a certain percentage of pigs become trap shy (avoid traps), delivering injections to all pigs would be impossible. The annual effort required would exceed the capabilities of NPS and TNC. And unless treated animals were marked, it would be impossible to distinguish treated pigs from untreated pigs. There is no permanent marking for a feral animal that is not directly handled.

Unproven for an Eradication Program: Sterilants are unproven for any mammal eradication program. Use of any sterilant on Santa Cruz Island feral pigs would be a waste of money and would not achieve the purpose of this plan, which is to eradicate feral pigs island-wide. Use of any sterilant would, at best, control pig populations for the period of time that teams of hunters would be funded, and certainly could not eradicate them. Short-term control of the pig population is not acceptable, because pigs would quickly multiply and continue to impact natural and cultural resources.

Comment: *The Park needs to consider a more humane method to deal with the pigs on Santa Cruz Island.*

Response:

Humane Treatment

The EIS did look into other methods of killing pigs, including snares, poison, and introduction of swine diseases. These methods were dismissed in part because they would not have the efficacy of a well-placed gunshot. These other methods could also inflict more pain and suffering to the pigs. In a report sponsored by the American Veterinarian Medical Association (2001) they indicate that an accurately delivered gunshot is an acceptable method of euthanasia. For wild or free-ranging species, a gunshot may be the most practical and logical method of euthanasia and has the advantage of minimizing stress induced by handling and human contact (AVMA 2001).

Annually, Park and TNC staff, as well as the visiting public, witness the starvation of pigs on the island. Park staff, especially those who work on the island, feel strongly that it is more humane to deal with pigs in the manner proposed in this EIS, versus having to witness the annual starvation that occurs to pigs on the island. The Park and TNC agree with the characterization of the humane treatment of pigs on Santa Cruz Island provided by Adrian M. Wenner, Professor emeritus, Department of Ecology, Evolution and Marine Biology UCSB:

> *"As a biologist, I have had extensive experience on the island and can report first-hand about the pig situation there. Feral pigs on the island number in the thousands. In good years, they reproduce to their full ability and soon exceed their food source. As they run out of easily obtainable food, such as acorns, they desperately plow up the ground in search of bulbs, roots and tubers, leaving the soil open to being washed away in future rains; and thereby exterminating native plants. They then eat non-nourishing grass as they starve. During the 1988 and 1989 droughts, for example, perhaps nine-tenths of the pigs died of starvation. But pigs don't starve immediately; as the weaker ones succumb, they get attacked and eaten by stronger pigs. At those times we could hear the squeals of pigs in such fights. By the end of 1989, nearly every pig I encountered was nothing more than a bag of bones that could hardly move. When they noticed us, they most often fell over as they tried to move. Even in good years feral pigs suffer. Last week we grabbed a piglet for examination. Dozens of black-legged ticks -- vectors of Lyme disease, fleas and lice lived on its soft underside. Island feral pigs, when they overpopulate, cannot migrate to greener pastures; they starve. Is it more humane to let these feral pigs continue their overpopulation, starvation and cannibalism or eliminate a few thousand from the island now, before untold thousands die in the future during such cycles?" (Wenner 2001)*

SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

GLOSSARY OF TERMS AND ABBREVIATIONS

APHIS	Animal and Plant Health Inspection Service
CDFG	California Department of Fish and Game
CHIS	Channel Islands National Park
C/WSCI	Central and West Santa Cruz Island; TNC owned
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESCI	East Santa Cruz Island and Isthmus; NPS owned
Feral	Having escaped domestication and become wild
GMP	Channel Islands National Park General Management Plan
NEPA	National Environmental Policy Act
NPS	National Park Service
NRHP	National Register of Historic Places
RMP	Resources Management Plan - Channel Islands National Park
SCI	Santa Cruz Island
TNC	The Nature Conservancy
USFWS	US Fish and Wildlife Service
T&E	Threatened and Endangered
Final EIS or FEIS	Final Environmental Impact Statement
Draft EIS or DEIS	Draft Environmental Impact Statement

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SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

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SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

CHAPTER ONE
PURPOSE AND NEED

Introduction

The National Park Service (NPS) and The Nature Conservancy (TNC) have long considered the most critical management actions needed to achieve primary restoration of Santa Cruz Island to be: a) eradicate feral sheep, b) eradicate feral pigs, and c) control fennel. Approximately 35,000 feral sheep were eradicated from TNC property during 1981-87. In 2000 the National Park Service concluded an intensive 3-year effort to remove sheep from east Santa Cruz Island. This effort successfully removed approximately 9,270 sheep from the island. At publishing time of this document it is believed that Santa Cruz Island is sheep-free; however, vigilant monitoring for remaining sheep is on going. Substantial and unaided recovery of native vegetation communities is occurring following removal of sheep from TNC property. However, many native habitats and species continue to be severely impacted by feral pigs, fennel, and other non-native plant species.

The presence of feral pigs greatly facilitates the spread of fennel and other invasive weeds. Pig rooting causes massive destruction of native species and leaves bare ground that can be easily colonized by weeds. The removal of non-native pigs would greatly reduce the spread of non-native plants and result in substantial natural recovery of native island resources.

Ownership

The ownership of Santa Cruz Island is divided between the NPS and TNC. NPS owns the eastern 24% of the island (ESCI); TNC owns the western 76% of the island (C/WSCI). (Figure 1).

All of Santa Cruz Island is within the boundaries of Channel Islands National Park, since the Park's establishment in 1980 (Figure 2). The Park's enabling legislation recognizes the value and appropriateness of achieving park goals through projects anywhere on the island and authorizes the use of federal funds on privately held portions of the park in order to protect and restore valuable resources.

The NPS and TNC share similar mandates for the conservation and protection of natural resources. The mission of Channel Islands National Park is to protect the nationally significant natural, cultural, scientific, and scenic values of the Channel Islands and adjacent marine waters and to provide present

and future generations appropriate opportunities to experience and understand park resources. The Nature Conservancy, a private non-profit conservation organization, is committed to preserving sustainable ecosystems that maintain and enhance native biological diversity (The California Nature Conservancy 1997).

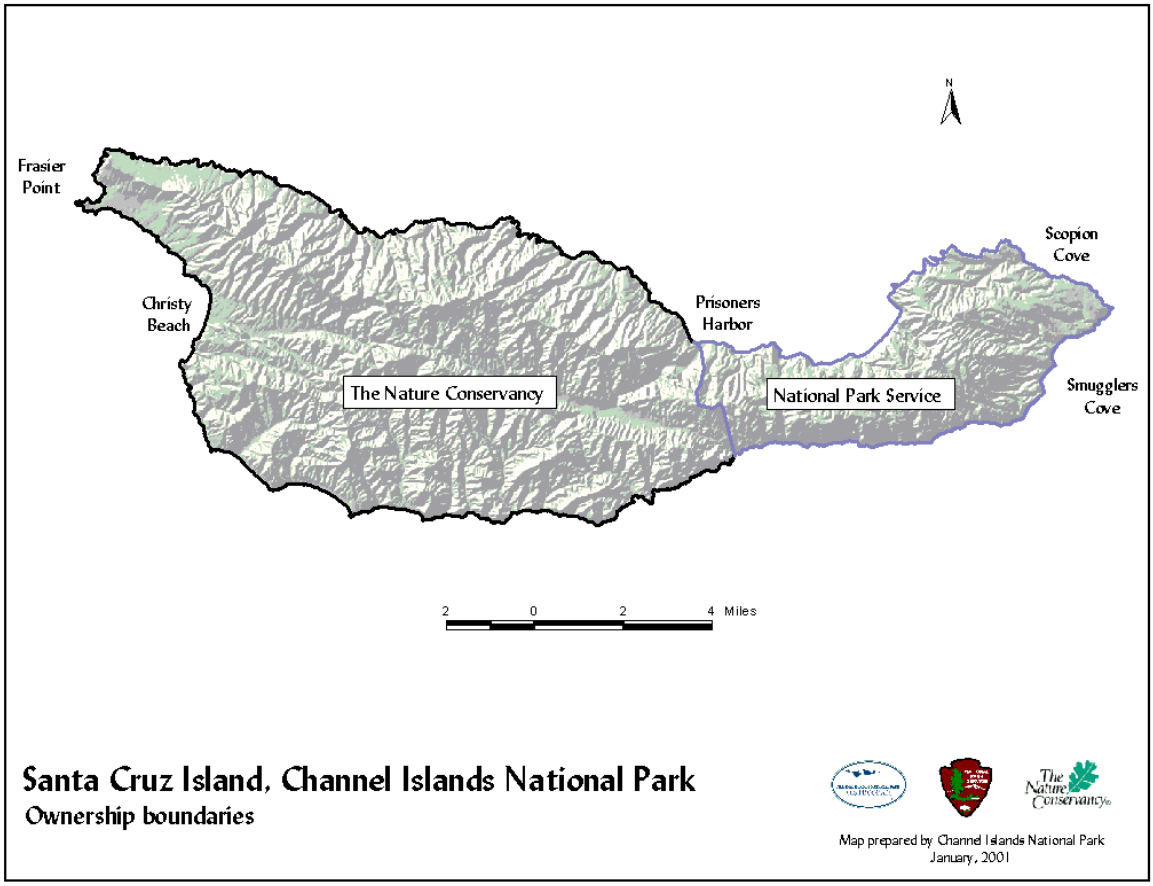
Guidance and Authority for Resource Management

The 1916 NPS Organic Act, (16 USC 1 et seq.) directed that NPS lands be managed to conserve the resources contained within "in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The Redwoods Act of 1978 (16 USC 1a-1) reaffirmed this principle. In general, these two statutes confer upon the Secretary of the Interior the discretion to determine how best to protect and preserve park resources.

Since the establishment of Yellowstone National Park in 1872 and the subsequent formation of the National Park Service in 1916, the philosophy of natural resources management has evolved. Simple concepts such as protection of wildlife from poaching gradually gave way to recognition of the complexities of comprehensive ecosystem management in a regional and global context (NPCA 1989).

In 1961, the Secretary of the Interior convened a blue-ribbon panel to evaluate how NPS should manage large mammals and other animals. The resultant report (Leopold et al. 1963) clearly directed NPS toward *ecosystem management*, which is the management of all components of an ecosystem as a whole, rather than single species management. The Leopold Commission promoted the concept that national parks should be managed as "vignettes of

Figure 1: Santa Cruz Island Ownership Boundaries



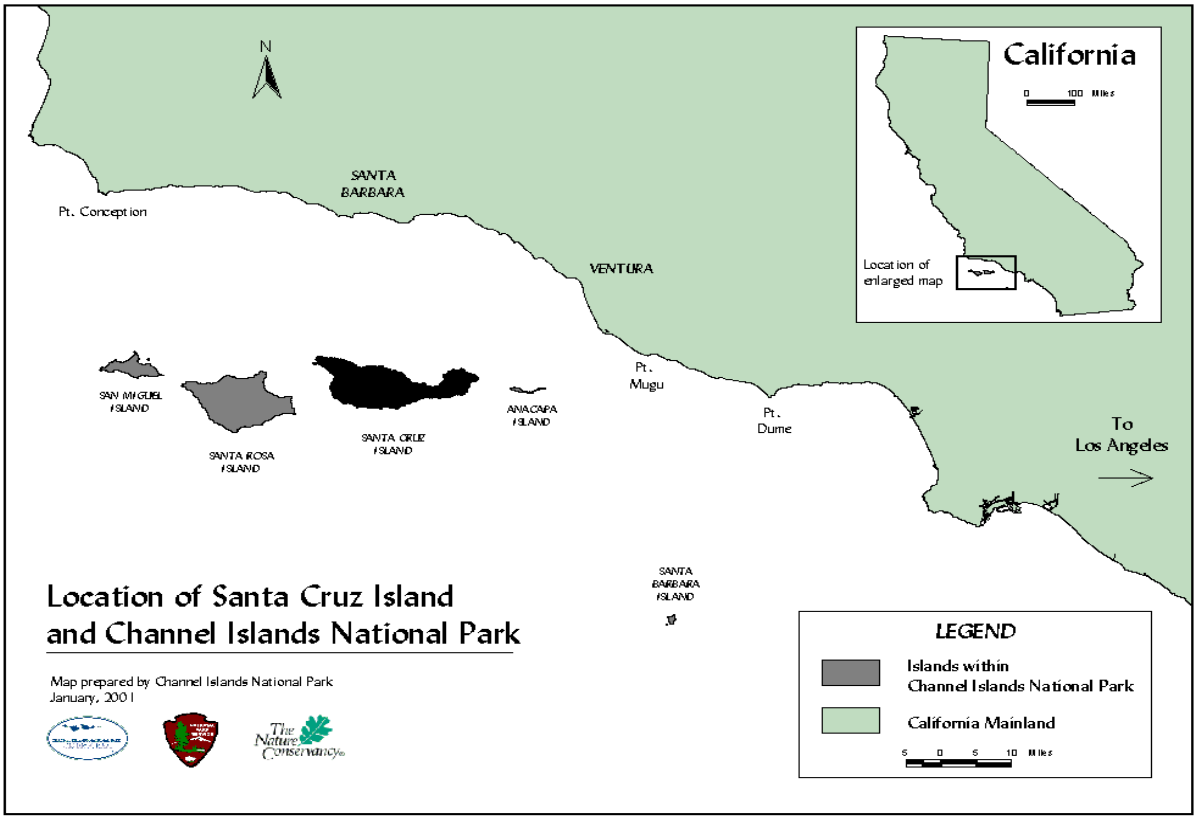
primitive America" in order to preserve, to the extent possible, the biota that existed or would have evolved had European humans not colonized North America. Although this has been interpreted by some as a call for "hands-off" management of a static primitive condition or scene, the Leopold Commission actually promoted an aggressive stewardship of parklands with "hands-on" management techniques, and perpetuation of dynamic, evolving ecosystems. For example, the report called for restoration of natural fire regimes in parks.

More recent work has built upon the findings of the Leopold Commission regarding resource management in NPS parks. Parsons et al. (1986) states that the principal aim of National Park Service resource management in natural areas is the unimpeded interaction of native ecosystem processes and structural elements. Parks should protect not only structural elements such as plants, animals, soil, water, and air, but also dynamic ecosystem processes such as natural fire, biotic evolution, and nutrient cycling.

In 1989, NPS again convened a blue-ribbon panel to assess the role of resource management and research in the future of national parks. The resulting report (NPCA 1989) validated findings of the Leopold Commission, affirming that the focus of park management should be to maintain or restore native biota and ecosystems and to resist establishment of alien, non-native organisms. Where possible, ecosystem management should attempt to preserve natural processes operating at a scale consistent with the evolution of the ecosystem being managed. The report recommended that NPS move well beyond static scene management to provide stewardship for the elements and processes contained in parks.

National Park Service management policies (NPS 2000) also reflect the development of ecosystem management concepts. In part, the policies state that natural resources should be managed with a concern for fundamental ecological processes as well as for individual

Figure 2: Vicinity Map Santa Cruz Island



species and features:

Managers and resource specialists will not attempt solely to preserve individual species (except threatened or endangered species) or individual natural processes; rather they will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity and ecological integrity of the plants and animals (NPS 2000).

Guidelines for management of species federally listed as threatened, endangered or candidates for listing are found in NPS management policies and natural resources management guidelines. National Park Service management policies (NPS 2000) and guidelines for natural resources management (1991) establish the responsibility of NPS, and the individual park, for managing both listed and candidate species. They also stress that management actions should emphasize removal of threats, but also include active recovery efforts, and that management should be done in an ecosystem context.

The Channel Islands National Park General Management Plan (1980,1985) identified the need to remove exotic animals from Santa Cruz Island.

The Endangered Species Act requires that actions authorized, funded, or carried out by federal agencies not jeopardize the continued existence of listed species. Under section 7(a)(2) of the ESA (16 USC section 1536), federal agencies are required to consult with the U.S. Fish and Wildlife Service (USFWS) on actions which may affect listed species or critical habitat. Because this Primary Restoration Plan proposes actions that could affect the 9 federally listed plant species and one proposed species on Santa Cruz Island, NPS will consult with USFWS on likely effects to those species.

National Park Service management also seeks to preserve and foster appreciation of cultural resources in NPS' custody through appropriate programs of research, treatment, protection, and interpretation (NPS 2000). Guidance for cultural resources management in NPS units is found in National Park Service Management Policies (2000) and Cultural Resource Management Guidelines (NPS-28). Management of cultural resources in NPS units is subject to the provisions of the National Historic Preservation Act (16 USC 470 et seq.), the National Environmental Policy Act (42 USC 4371 et seq.), the American Indian Religious Freedom Act (42 USC 1996), the Advisory Council on Historic Preservation's regulation regarding "Protection of Historic Properties" (36 CFR 800), the Secretary of the Interior's "Standards and Guidelines for Archeology and Historic Preservation (FR 48:44716-40) and "Federal Agency Responsibilities under Section 110 of the National Historic Preservation Act" (FR 53:4727-46).

Purpose and Need

Purpose

The purpose of the Santa Cruz Island Primary Restoration Plan is to protect the unique natural and cultural resources of the island from continued degradation and to initiate recovery of the island ecosystem by:

- Eradicating feral pigs island-wide
- Controlling fennel

Other actions are being done to restore and protect sensitive resources on Santa Cruz Island. These efforts include bald eagle re-introduction, island fox captive breeding, and golden eagle removal. These actions are ongoing and are not addressed in detail in this document. The NPS believes that the eradication of pigs is crucial for the success of these programs. These actions are discussed in greater detail in Chapter Four – Past, Present, Future Actions.

Need for Action

These actions are necessary in order to:

- Protect and initiate restoration of native plant communities
- Protect rare plant species
- Control and reduce the spread of invasive, non-native weeds, such as fennel, *Foeniculum vulgar*e.
- Protect island foxes through removal of the non-native food source (feral pigs) supporting non-native golden eagles
- Conserve archeological sites threatened by accelerated erosion and pig rooting
- Initiate conservation and restoration of soil resources

Invasions by non-native plant and animal species are generally considered to be one of the greatest threats to global biological diversity (Shafer 1990, Soule 1990). These invasions have been described as a "biological wildfire" (Federal Interagency Committee for the Management of Noxious and Exotic Weeds, 1998). Many examples exist demonstrating the negative impacts of non-native animals and plants on native biota. At the population level, native species can undergo a reduction in recruitment, distribution and abundance (Vitousek 1990), or be driven to extinction (Savidge 1987). At the community level, invasions can radically alter the structure and composition of native plant and animal communities (MacDonald and Frame 1988), and at the ecosystem level they can alter nutrient cycles, fire regimes, and other processes (D'Antonio and Vitousek 1992, Singer et al. 1984).

Ranchers and previous landowners of Santa Cruz Island have tried unsuccessfully to eradicate pigs since their introduction almost 150 years ago. Marla Daley, an expert on Santa Cruz Island history, reported (1999) that multiple efforts to eradicate feral pigs have been undertaken by previous landowners using such varied methods as roping, spearing, and the release of a swine disease, hog cholera. In addition, island scientists have unanimously called for the eradication of feral pigs at the earliest possible date (Brumbaugh 1980, Van Vuren 1981a, Van Vuren 1981b, Hochberg et al. 1980, Baber 1982, Laughrin 1982, Collins 1987, Arnold 1999, Glassow 1999) due to documented impacts to natural and cultural resources. Institutions, agencies, and individuals with long-term associations with Santa Cruz Island have indicated their support for the need of a feral pig eradication program (Coblentz 1988, Ehorn 1988, Laughrin 1988, Power 1988, Van Vuren 1988, Young 1988).

Restoration of Native Plant Communities

The Channel Islands of California are vivid examples of the pervasive impacts that non-native species can have on ecosystems. The most severe impacts to the islands have been due to exotic animals, especially cattle, feral sheep, goats, and pigs (Brumbaugh et al. 1980, Minnich 1980). In addition to the impacts from feral and domestic livestock, many species of non-native plants have become established, affecting all of the island's vegetation communities, and dominating some the island's plant communities. Non-native plants now comprise between 20-48% of the species on the islands, and between 25-80% of the ground cover (Halvorson 1992, Junak et al. 1995, and Klinger in prep).

Although to some degree non-native species, particularly plants, would remain established on Santa Cruz Island. However, it is the Park's goal to eradicate non-native species where feasible, and if not, reduce them so that they are a minor component of the island environment. There are some non-native species that cause such significant impacts to other species (feral pigs and fennel are examples) that it is imperative to eliminate or significantly control their numbers and extent in order to protect significant park resources. Fennel is the highest priority for control because

its' dense thickets are expanding rapidly, inhibit native communities from becoming established, and interfere with the eradication of feral pigs. Feral pigs significantly inhibit the regeneration of oaks, and their disturbance causes conditions that favor establishment of non-native species over native species.

Protection of Listed Plant Species

In 1997 the U.S. Fish and Wildlife Service (USFWS) listed nine plant species on Santa Cruz Island as threatened or endangered. Rooting and grazing by feral pigs was a factor in the decline of each of these species. The Recovery Plan for Thirteen Plant Taxa from the Northern Channel Islands (USFWS 2000) recommends development and implementation of an island-wide pig removal plan. The recovery plan states that the highest priority for protecting existing T&E populations on Santa Cruz Island is to remove pigs. Specifically the recovery plan states… "to prevent the continuing habitat degradation on Santa Cruz Island. The National Park Service should collaborate with The Nature Conservancy and other California Island managers to develop methods that will expedite the elimination of pigs from all of Santa Cruz Island."

Many resource scientists, including a group of 20 land management professionals convened on SCI in 1998, have made similar individual recommendations.

Reduce Spread of Non-native Weeds

The spread of many non-native weed species, such as fennel, is greatly facilitated by the transport of their seeds by animals and the presence of bare, unvegetated ground easily colonized by weeds. Feral pigs spread non-native weeds through two basic mechanisms. Pigs feed on the seed heads of annual exotic grasses, fennel, and other undesirable plants. The seeds emerge from the pig's digestive system intact and able to sprout. Pigs also carry seeds in their coats, having the ability to transport seeds many miles from the source point. Furthermore, the rooting of pigs removes vegetative cover and creates bare ground for establishment of weedy plants.

Protection of the Island Fox

The island fox (*Urocyon littoralis*) is endemic to the California Channel Islands. The fox exists as a different subspecies on each of the six islands (Wayne et al. 1991, Collins 1993). It is distributed as six island populations varying in size from less than a hundred to a few thousand individuals. Due in part to its limited distribution and small numbers, the island fox has been listed as a threatened species in California (California Department of Fish and Game 1987) and is proposed for listing as a federally endangered species.

The island fox population on San Miguel has declined sharply from levels measured in 1993 (Coonan et al. 1998, 2000) with the adult population falling from 450 in 1994 to 15 in 1999 (Coonan et al., in prep). Monitoring data from Santa Cruz Island and survey data from Santa Rosa Island indicate that island foxes are undergoing similar catastrophic declines on those islands as well.

The catastrophic decline of island foxes appears to be due to predation by non-native golden eagles (Roemer et al. 2001a). The primary year-round food source that sustains the golden eagles is the piglets produced on Santa Cruz Island. The park is currently capturing and removing golden eagles from the northern islands. However, until the food source provided by piglets is removed, golden eagles would continuously re-establish populations on the island and prey on island foxes.

Protection of Archeological Sites

Santa Cruz Island contains a rich archeological record of the Chumash culture

contained in some 3,000 sites, with the earliest dating nearly 9,000 years ago. Sites range from isolated artifacts to huge, stratified sites spanning a period of 8,000-9,000 years. The large number, diversity and relatively undisturbed nature of the island sites provide excellent research opportunities for archeological investigations into human adaptation in a context of changing environments and cultural conditions. Ninety percent of the island is listed in the National Register of Historic Places for its archeological significance. The remaining ten- percent of the island is eligible for listing in an expanded archeological district.

Feral pig rooting has damaged a large number of the island sites. Pig rooting to a depth of three feet has been noted in a number of sites. 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 prehistoric and historic period burials found in many locations on the island. Continued pig rooting of archeological sites on 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 inclusion in the National Register of Historic Places.

Conservation of Soils

The long history of grazing by non-native ungulates has greatly accelerated erosion of soils on Santa Cruz Island. Large areas have been denuded of vegetation and are eroded down to bedrock. Rooting by pigs exposes substantial sections of land to erosion by water and wind. Erosion and rooting cause disturbance to archeological sites that have long been protected by vegetation (Glassow and Arnold, pers. comm. 1999).

Scope of the Proposed Action

This document focuses on the concrete and immediate steps that must be taken to reverse the environmental degradation of Santa Cruz Island caused by feral pigs. The scope of the proposed action is to fully eradicate feral pigs from SCI and to implement significant fennel control measures. These two actions have been determined to be the two most important actions that can be implemented in order to abate on-going resource degradation and recover unique island resources.

The restoration actions proposed in this document will require a major commitment of resources. It is recognized that additional intervention would be required in the future to ensure the full protection and recovery of island resources. Additional restoration efforts including island fox captive breeding, bald eagle restoration, and golden eagle removal are currently ongoing. The implementation of these activities is not reliant on the completion of this environmental analysis. However, the environmental effects of implementing these activities have been included, where appropriate, in the cumulative effects analysis in Chapter Four.

This environmental analysis will result in a record of decision encompassing feral pig eradication and fennel control, and their associated activities. Other proposed or ongoing restoration/protection activities (such as those mentioned above) may be related or may benefit from the SCIPRP project; however, implementing these projects would require separate analysis and separate decisions.

Decisions to be Made

The official responsible for choosing the management actions for this restoration project is the National Park Service Pacific West Regional Director. Upon completion of the environmental analysis, the Regional Director can decide to:

- Select one of the alternatives analyzed within the Final EIS, including the No-Action alternative; or,
- Modify an alternative (for example, combine parts of different alternatives), as long as the environmental consequences of the modified action have been analyzed within the Final EIS.

Factors the Regional Director will take into consideration in making a decision are:

- Does the alternative meet National Park Service guidelines and policies, including the Park's General Management Plan?
- How well does the alternative meet the "Purpose and Need" for this project?
- How does the alternative respond to and/or resolve the environmental issues raised for this project?
- The nature and extent of public comment to the environmental analysis.

SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

CHAPTER TWO
ALTERNATIVES

Introduction

This chapter describes the four alternatives to be considered for implementation and identifies the significant environmental issues used to formulate these alternatives. The environmental issues were developed as a result of "scoping" conducted for this analysis. The "scoping" actions that were conducted for this analysis are described in detail in Chapter Five "Consultation and Coordination". This chapter concludes with a section that explains the rationale for dismissing other methods or alternatives from consideration, and a comparison of alternatives.

Alternative Development Process

Section 102(e) of NEPA states that all Federal agencies shall "study, develop, and describe appropriate alternatives to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources". In addition to responding to unresolved conflicts, an EIS must "rigorously explore and objectively evaluate all reasonable alternatives" [40CFR 1502.14(a)].

Taken together, these requirements determine the range of alternatives and provide the basis for the Deciding Official's informed decision, as required under NEPA. A resource analysis done by NPS and TNC resource management staff in collaboration with pig and fennel control experts resulted in the Proposed Action described in this Chapter. The proposed action identified management actions necessary to eradicate the feral pig population on the island as well as control the non-native fennel that has invaded a large portion of an area known as the isthmus.

Alternatives to the proposed action were developed to focus on the issues identified by resource specialists within the NPS and TNC, pig and fennel control experts, university and academic experts, government regulatory agencies, and the general public. Chapter Five "Consultation and Coordination" lists all individuals, agencies and organizations that provided substantive input regarding the proposed action.

Internal Scoping and Public Involvement Process

The NEPA "scoping" process [40CFR 1501.7] was used to determine the scope of the analysis and to identify potential issues and

opportunities related to the Proposed Action. A complete summary of the scoping and public involvement process for the proposed project is summarized in Chapter Five.

Environmental Issues

Through the Scoping and Public Involvement Process some significant environmental issues were identified. Significant issues are those that may require project-specific alternatives, mitigation measures or design elements to address the potential effects of the proposed activities.

For clarification, a summary statement that defines the scope of the issue for this project will accompany the identified issues. In addition, for each issue, measurement indices are given to provide a preview of how the issue will be evaluated for direct, indirect, and cumulative effects for each alternative. The "Issue" categories are as follows:

- Issue 1: Likelihood of Success
- Issue 2: Impacts to Vegetation, including Weeds and Threatened and Endangered Plant Species
- Issue 3: Impacts to Island Fauna
- Issue 4: Impacts to Physical Resources including Soils, Water and Air Quality
- Issue 5: Impacts to Social Factors including Cultural Resources and Human Use

Issue 1: Likelihood of Success

Efficacy for this analysis is defined as how well the alternative would meet the purpose and need; i.e., how well the alternative would protect the unique natural and cultural resources of Santa Cruz Island by eradicating feral pigs and controlling fennel.

Measurement Index

- Likelihood of achieving island-wide eradication of feral pigs

Issue 2: Impacts to Vegetation, including Weeds and Threatened and Endangered Plant Species

Limited impacts to vegetation would occur as a result of implementing the proposed activities. However, in the long-term, native vegetation would benefit from the eradication of feral pigs and control of fennel. The effects analysis will identify the short-term impacts as well as the expected long-term benefits of implementing the proposed activities.

Measurement Indices

- Health of threatened, endangered, rare, and endemic species
- Extent of fennel
- Extent of other weed species
- Recruitment of island oaks and other woodland species

Issue 3: Impacts to Island Fauna

Introduction of non-native flora and fauna to the Channel Islands has disrupted the ecology on all islands. The largest perturbations to Santa Cruz Island have been the introduction of sheep, pigs, and the highly invasive fennel. Sheep are no longer present on Santa Cruz Island, however abatement of feral pigs and invasive weeds would have a beneficial affect on island fauna. The environmental effects section will focus on native island fauna.

Measurement Indices

- Health of Native Island Fauna
- Non-Native Pigs

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

Livestock grazing for over 150 years on Santa Cruz Island has affected soil resources and water quality. The effects analysis will focus on watersheds of Santa Cruz Island and how loss of vegetation cover, direct soil disturbance, and

vegetation type conversion all impact runoff, soil erosion, and stream degradation and aggradation.

The prescribed fennel burn would create smoke that could result in haze and other contaminants being disseminated into the air.

Measurement Indices

- Soil Disturbance and Erosion
- Watershed level impacts
- Landtype and geomorphology (Water Quality)
- Smoke impacts (Air Quality)

Issue 5: Socioeconomic Impacts including Cultural Resources and Human Uses

Cultural resources are non-renewable resources. As such, federal regulations have been passed which prohibit the destruction of significant cultural sites. Significant cultural properties do exist on Santa Cruz Island. The effects analysis will focus on how implementation of each alternative may affect cultural resources on the island.

Visitor use of Santa Cruz Island is different depending on the landowner. Visitor use is accommodated on National Park Service owned lands and is restricted on TNC owned lands. Access by visitors, TNC personnel, park staff, and researchers may be restricted or altered in certain areas during implementation activities.

Measurement Indices

- Prehistoric Cultural Resources
- Historic Cultural Resources
- Human Uses (Human Herbicide Exposure, Visitor Use and Visitation)

Mandatory Topics and Dismissal of Issues

As required under NPS Director's Order 12, this analysis must address twelve mandatory topics. Listed below are topics that must be addressed followed by a discussion on whether they are relevant to the analysis.

a) Conflict with land use plans, policies or controls – The Park's General Management Plan, as well as the Park's Resources Management Plan identified the need to remove pigs from the Santa Cruz Island. The proposed action does not conflict with local, state, or tribal policies or regulations because no plans exist.

b) Energy requirements and conservation potential – Santa Cruz Island, like all of the Northern Channel Islands, does not have electric or gas utilities supplied to it. The Park's administration of these islands always emphasizes energy conservation. For instance all park housing on the island are totally self sufficient for electricity through the use of solar energy. Significant energy demands may be necessary to transport people, equipment, supplies, and to support the operation on the island. Transportation is accomplished mainly by boats owned and operated by the Park.

c) Natural or depletable resource requirements and conservation potential – Resource requirements for this project would be to primarily to supply the operation. Waste of resources is not an issue with operations that occur on the island, as the expense of re-supplying a remote island usually ensures conservation of available resources.

d) Urban quality, historic and cultural resources – Impacts to these resources can be found in Chapter Four - Impacts to Human Uses. Activities associated with the SCIPRP will have a negligible effect on the island's ethnographic resources. Effects on archeological sites, burials, and historic ranching properties have been analyzed in

the "Cultural Resources" section of Chapter Four. Traditional use of the island and its resources for their sacred and heritage values by descendants of the historic owners and inhabitants of the island will be accommodated fully during the course of the project.

e) Socially or economically disadvantaged populations – This proposed project would not change the local population's work, recreation, or social interactions. As such Executive Order 12898 (environmental justice) does not apply to this analysis.

f) Wetlands and floodplains – No development would be occurring in wetlands or floodplains as part of this project.

g) Prime or unique agricultural lands – Santa Cruz Island since the early 1800's has been used for rangeland for domestic livestock. Current ownership emphasizes land use conservation and protection over agricultural use. Since no current agriculture practices are occurring on the island no impacts would occur to agricultural lands. The National Park Service interprets historical land use practices to the visiting public. The alternatives would not interfere with this ongoing interpretive program.

h) Endangered, threatened, or proposed plants and animals – All plant and animal species listed under the Endangered Species Act as threatened or endangered that occur on Santa Cruz Island have been evaluated for impacts (See Chapter Four).

i) Important scientific, archaeological, and other cultural resources, including historic properties listed or eligible for the National Register of Historic Places – Impacts to cultural resources, including an assessment of impacts to properties listed or eligible for the NRHP have been evaluated in Chapter Four – Cultural Resources.

j) Ecologically critical areas, Wild and Scenic Rivers, or other unique natural resources – Although Santa Cruz Island has many unique natural resources, no resources have status as an ecologically critical area, nor are there any Wild and Scenic Rivers on the island. Impacts to unique natural resources can be found throughout Chapter Four.

Wilderness: The legislation establishing Channel Islands National Park requires the National Park Service to determine whether any federally owned parkland is suitable for wilderness designation and should be proposed to Congress for designation. This process has not yet been completed. NPS policies require that, in the interim, no actions be taken which would lessen the suitability of the federally owned lands for wilderness designation.

Achieving the goals of this plan under the proposed action would result in the portion of Santa Cruz Island better attaining the character of wilderness. Specifically, the island ecosystem and processes would be closer to the more natural state that prevailed prior to the introduction of feral pigs and non-native plants. No new permanent structures would be constructed. Temporary structures, such as fences and dog kennels, would be removed at the termination of the project. Mechanized equipment would be used, and is necessary, to achieve the eradication of feral pigs and control of fennel. The actions taken under this project would terminate when monitoring determines that all feral pigs have been eliminated from Santa Cruz Island.

k) Public heath and safety – A number of activities proposed in this analysis have the potential to harm the general public. Because of this potential the Park has proposed that portions of the island be closed to the general public during potentially harmful activities to protect public health and safety. These safety measures can be found in Chapter Four – Human Uses.

l) Sacred sites – The Park's archeologist, in consultation with the Chumash tribe, have not identified any sacred sites on Santa Cruz Island as defined by EO 13007.

Alternatives Considered in Detail

Features Common to Alternatives 2-4

Ecological Monitoring

Monitoring and assessment of key ecosystem components is an action that is included in all alternatives. Pre-eradication surveys for baseline data of pig damage, flora and fauna abundance and distribution would be conducted. Post-eradication surveys of similar components would be conducted in order to measure ecosystem responses to the eradication of feral pigs and control of invasive species, such as fennel.

Fennel Management

Fennel Control

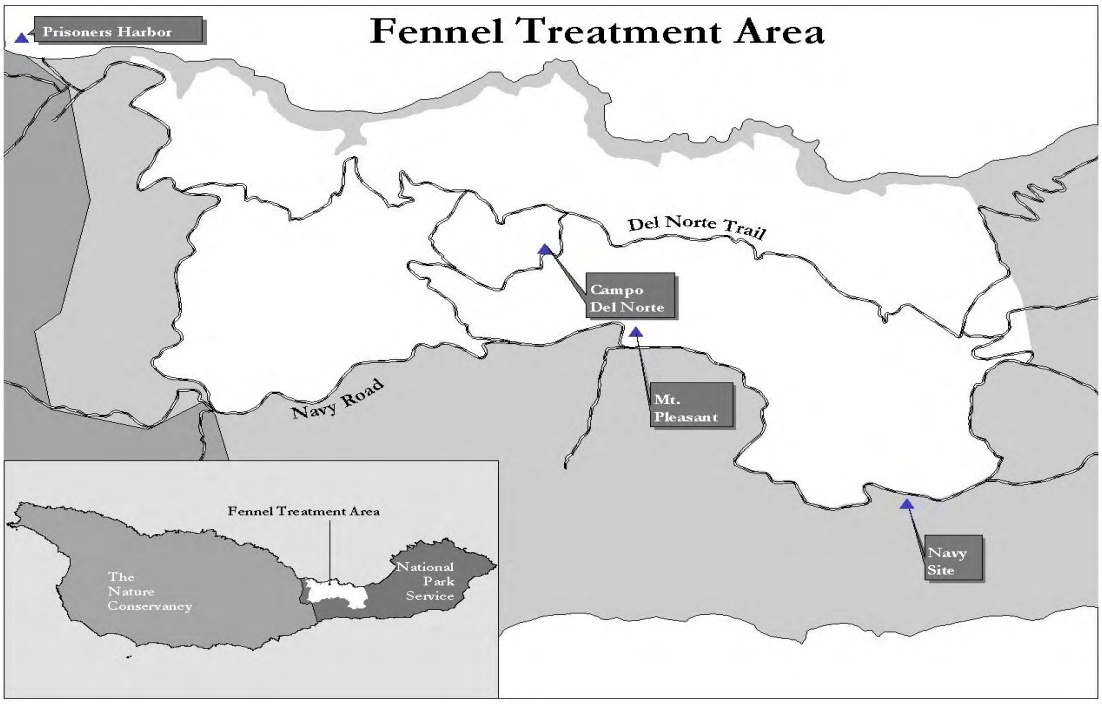
The NPS intends to take action to control invasive plants on Santa Cruz Island regardless of which alternative is chosen. The purpose of weed control is to allow native plant communities to become re-established. If funds become available, the NPS would expand its current efforts to control non-native plants. It is expected that in the long term the extent of the weed problem would be greatest under Alternative One (No Action) and least under Alternatives Two & Four (Eradicate pigs island-wide). NPS weed control efforts would focus primarily on the NPS-owned portion of Santa Cruz Island. However, the NPS plans to continue to work collaboratively with TNC to address island-wide weed problems.

Eradication of all non-native plants from Santa Cruz Island is not reasonably possible. Therefore, our goal is to reduce the density and distribution of non-native species sufficiently that they are a minor and non-dominant member of the island plant communities. The best way to control the spread of non-native plants is to eliminate non-native animals that perpetuate their establishment.

The highest priorities for treatment are highly invasive weeds, outlier populations of weeds, weeds in sensitive habitats, and new introductions. Tools that would be used include digging, mowing, flower/seed head removal, and herbicide treatment. For fennel control the herbicide that would be used is Garlon 3A at a low application rate of 1lb AI/acre. To give optimum wetting and spreading of Garlon 3a a surfactants will be used in the herbicide mix. It is expected that a non-ionic surfactant such as R-11®, methylated seed oil (MSO), or combination thereof would be the surfactants of choice. The use of an MSO's would not effect efficacy (Brenton pers. comm.) of the fennel treatment. The most efficient way to treat the large dense stands of fennel is to use aerial spraying from a helicopter. Aerial application is being considered because it is more effective, accurate, and efficient when applying herbicide over a large, inaccessible area. Aerial herbicide application would require on-board differential GPS to ensure accurate, even coverage in the specified treatment area. Garlon 3A would also be applied using backpack sprayers, ATV spray mounted units, and slip-on spray units mounted in the back of a pickup.

Dense stands of fennel would be the first priority for control. These dense fennel stands are both an impact on native vegetation and hinder feral pig eradication efforts. The Nature Conservancy has demonstrated success with fennel control by burning in the fall/winter of the year and applying Garlon 3A, a selective herbicide, to the stand in the following two

Figure 3. Fennel Treatment Area



springs. This protocol was developed by The Nature Conservancy in an extensive 600-acre program in the Central Valley of Santa Cruz Island.

Additional treatment of fennel in less dense stands and in outlying populations would be required to ensure that native plant communities are not gradually overrun by fennel. The NPS and TNC propose to treat these situations by spot burning where appropriate, followed by herbicidal control.

The prescribed burn would be conducted within the limits of a fire plan and prescription that describe both the acceptable range of weather, moisture, fuel, and fire behavior parameters, and the ignition method needed to achieve the desired effects. The prescribed burn for fennel treatment would be done in the fall/winter of the year, likely using both hand and aerial ignition.

To avoid adverse impacts, full fennel control would be deferred until the fox population has recovered to the point where it could withstand potential direct mortality from a fire (See Chapter Four "Island Fauna").

Fennel Manipulation

The fennel stand (approximately 1,800 acres) that exists on the isthmus of Santa Cruz Island is heavily utilized by pigs. Because of the fennel's density and height within this stand it is thought to comprise excellent cover for pigs. As such, it may compromise pig eradication unless the fennel is manipulated to allow for establishment of walk-in traps, bait stations, and other hunting techniques. Fennel manipulation should not be confused with fennel control. The objective of fennel manipulation is to treat portions of the stand to allow for the successful eradication of pigs within that area.

Fennel manipulation would include mowing, cutting, or flattening the fennel to allow for corridors and other openings for strategic placement of pig walk-in traps and bait stations. Burning the fennel also reduces fennel cover and may be necessary for successful pig eradication on the isthmus. In order to minimize impacts to affected resources, conducting the prescribed burn may require that certain mitigation measures be implemented. These mitigation measures can be found in Chapter Four.

Non-lead Bullet Requirement

The ingestion of lead objects such as shot, bullets, paint chips, mine wastes and fishing sinkers cause considerable harm to migratory birds such as waterfowl and raptors. In raptors, poisoning results from ingesting lead shot embedded in the flesh of prey, such as small ground birds, waterfowl, or from scavenging on large game shot with lead bullets. The lead, once ingested, is ground down in the gizzard or dissolved in the stomach by acids and absorbed into the body as a lead salt, which disrupts normal body functions, especially the digestive and nervous systems. Although this primarily comes from the ingestion of lead directly, certain raptors such as eagles can also die from secondary poisoning, or consumption of birds that have already died from lead poisoning during scavenging.

The Channel Islands is historic habitat for bald eagles, with 25 or more pairs thought to be resident on the northern Channel Islands in historic times. Because of habitat loss, harassment, and DDT poisoning, bald eagles disappeared from the northern Channel Islands by the 1950's. However, recent efforts to reintroduce bald eagles to Santa Catalina Island demonstrate the importance of restoring the avian apex predator to such tightly knit ecosystems as islands. On the northern Channel Islands, the lack of bald eagles acting as the apex avian predator has led to hyper-predation of native endemic island foxes by non-native golden eagles, nearly driving the fox to extinction.

The feasibility of restoring bald eagles to the northern Channel Islands would be studied concurrently with the implementation of the Santa Cruz Primary Restoration Plan. Using funds from the Montrose Chemical Company settlement, a consortium of agencies would begin the five-year study in 2002 with the annual release of 12 eaglets on Santa Cruz Island. Because of the high susceptibility of bald eagles and other raptors to lead poisoning, hunting activities conducted during the SCIPRP would be restricted to the use of non-lead bullets.

Alternatives to lead bullets, such as copper and tungsten bismuth, are widely available and provide accurate trajectory and distance consistent with conventional lead projectiles.

Alternatives Considered in Detail

Alternative One - No Action

Under this alternative NPS would take no action to eradicate feral pigs from Santa Cruz Island or to promote the conservation of rare species, soils, or archeological sites beyond the level of action that the NPS is currently carrying out.

Pigs would continue to occur island-wide and population numbers would fluctuate with environmental conditions. Incidental control of problem animals or focused protection of sensitive resources would occur as staff time and funding permitted.

Weed control would be restricted to current operational levels, which consists of opportunistic removal and spot spraying, but no comprehensive program. Significant fennel control would not be addressed.

There would be no specific mitigation of impacts, since this action would be a simple continuation of current operations.

Monitoring

Monitoring efforts would not change from current NPS levels and would be restricted to measures of community health, listed plant species population health, and vegetation type classifications.

Alternative Two – Simultaneous Island-wide Eradication of Pigs

Under this alternative feral pigs would be eradicated from all of Santa Cruz Island with an intensive, short duration eradication effort.

In November 1998 the NPS and TNC assembled a group of biologists and land managers on Santa Cruz Island to discuss the issue of feral pig impacts and recommended management actions. The individuals determined that eradication of feral pigs should be the highest priority for the management agencies due to the pervasive impacts of pigs on natural and cultural resources. The biologists each felt that an island-wide eradication was an achievable goal.

The National Park Service would contract with professional hunters to eradicate feral pigs under this alternative. Personnel involved in implementing this project would follow the mitigation measures described in Chapter Four for the protection of resources.

The primary tools for pig eradication would be the use of "walk-in" traps and trained hunters with dogs systematically pursuing pigs on the ground. Other techniques such as aerial hunting from a helicopter may be used when appropriate.

During the peak period of the pig eradication program it is estimated that a substantial increase in personnel, dogs, vehicles and ATV's would be on Santa Cruz Island. They would be housed, to the extent possible, in approved government housing on NPS owned property, and in TNC facilities including both Central Valley and West End Facilities. Temporary tent camps may need to be established to facilitate operations in remote areas. Horses may also be used for transportation.

Under Alternative 2 the feral pig eradication project would occur in four phases (see Table 1). The duration and success of each of the phases would depend on a number of factors, primarily: a) level of funding, b) environmental conditions, and c) pig population numbers.

Table 1: Alternative Two Pig Eradication Phases

Phase	Description
I.	*Administration and infrastructure acquisition (Approximately 1 year)*
II.	*Hunting (Approximately 2 years)*
III.	*Final Hunting (Approximately 1 year)*
IV	*Monitoring for Remnant Pigs (Five years)*

Phase I. Administration and Infrastructure Acquisition

This phase would require approximately one year to complete once funding is received and environmental compliance is met. Phase I activities include contracting the services of a professional wildlife management organization that would conduct the pig eradication, and acquiring island infrastructure necessary to conduct the pig eradication operation. Major infrastructure needs include upgrading island housing, establish adequate communication, and define monitoring protocols.

Phase II. Hunting

A simultaneous island-wide operation would require several teams of hunters and dogs repeatedly working sections of the island. Hunters would be on the island for extended periods of time. Each team would have their own transportation, which could include pick-up trucks, "Jeep" type vehicles, ATV's, and/or horses to support their operation.

On Santa Cruz Island, ground hunting with dogs is the best general technique for the eradication program (Klinger pers. comm., Lombardo pers. comm.). Helicopter hunting works well in the wet season and along ridges in

the winter. Use of walk-in traps is successful with high densities of pigs and dense vegetation cover. These could be used in areas with "pig highways", during drought periods, or in fennel stands. Hunting over bait may also be useful in selected situations.

It is expected that the hunting teams would require approximately two years of continuous hunting island-wide to eliminate the pig population on the island.

Phase III: Final hunting

The final hunting phase begins after hunting teams have made at least three visits to all sections of the island and not seen sign or pigs.

During this phase, which would last one year, a reduced number of hunters and dogs would be maintained on the island. At least two people would be dedicated to searching the island to locate pigs or pig sign. Hunters would respond to the location of pig sign to assist the monitoring team. The project would move to Phase IV after the island had no detectable pig sign.

Monitoring for pig sign would continue throughout the life of the project. The primary purpose of the monitoring is to determine the presence or absence of pigs. Water sources, which are preferred habitat for pigs, would be a focus of the monitoring efforts.

Phase IV: Monitoring

This phase would be an intensive period of combing the island to search for pig sign. Hunting teams and dogs would not be maintained on the island any longer. If pig sign is detected, hunters and dogs would be brought to the island once again. Monitoring would continue for five years following eradication of the presumed "last pig" in order to ensure that remnant pigs do not remain. Long term ecological monitoring to assess changes to the ecosystem due to pig eradication would continue into the foreseeable future.

Alternative Three - Eradicate Pigs on NPS Property; Exclude Pigs from Selected Sensitive Resources on TNC Property

Under this alternative the NPS would build and maintain a pig-proof boundary fence approximately 3 miles in length. The fence would require at least two gates at the existing road crossings. Feral pigs would be eradicated from the 14,000-acre eastern portion of the island. It is expected that pigs would regularly re-enter NPS land by going through breaks in the fence, gates left open, or by going around the ends of the fence. To address this NPS would need to have hunters regularly eliminate pigs that enter the NPS land. In addition, NPS would have an ongoing program to maintain the fence, educate staff and visitors about the need to close gates, and to hunt pigs that get through or around the fence.

The eradication of feral pigs from NPS lands would primarily involve NPS personnel and a contractor. Techniques to be used for eradication would be similar to those described in Alternative 2. Trained hunters and dogs systematically pursuing pigs on the ground and walk-in traps would be the primary methods used.

Island surveys for archeological sites and listed plant species are largely incomplete. Surveys by resource experts would need to be conducted and sites selected for protection. These selected sensitive resources would then have pig-proof fence constructed around them and pigs would be excluded from these areas. Known occurrences of federally listed plant populations would be fenced. The most important and threatened archeological sites would also be fenced. However, it is highly likely that some of the resources that fall into the category intended for protection would continue to experience degradation by pigs due to the inability to perform exhaustive inventories. Protective fencing would need to be continuously inspected and repaired to protect

the sensitive resources located within the enclosure.

Additionally, there are many natural or cultural resources of concern that may be rare and/or sensitive but do not have federal protection. These resources would remain vulnerable to impacts by pigs. Fencing all sensitive and/or rare resources on TNC property is beyond the level of what could be funded or maintained over the long term. Therefore, other efforts besides fencing to exclude pigs from selected areas or resources could be implemented.

Alternative Four – Sequential Island-Wide Eradication by Fenced Zone Hunting

Like Alternative Two, this alternative would result in the complete eradication of feral pigs from Santa Cruz Island. In close coordination with The Nature Conservancy, approximately 45 miles of fence would be constructed, thereby splitting the island into 6 distinct management units of about 12,000 acres each (Figure 3). Sequentially, hunting would occur in each of these management units. Complete eradication would be achieved in each of the units in a coordinated effort lasting approximately one year using trained professional hunters using various techniques such as walk-in traps, bait stations, and use of trained hunting dogs. The establishment of fenced zones would allow greater flexibility in the duration of the eradication activities, which is estimated to be approximately six years. Mitigation measures found in Chapter Four would be followed by all personnel involved with the project and would be applied island-wide.

The techniques and tools for achieving the eradication goal would be similar to those described under Alternative Two, and are consistent with other models of eradication such as neighboring Santa Rosa Island, Santa Catalina Island and Hawaii Volcanoes National Park. Trained hunters aided by dogs would seek out and dispatch pigs on the ground. Bait stations and walk-in-traps would be established. Pigs caught in walk-in traps would subsequently be killed. Helicopters may also be used to transport hunters or serve as a hunting platform.

This program would necessitate an increase in on-island personnel, jeep or truck style vehicles, all-terrain vehicles, and the use of hunting dogs. Other methods of transportation might also be used, such as horses or helicopters. Housing would utilize existing structures whenever possible, including government approved facilities on NPS owned property, and TNC facilities including Central Valley facilities, and Christy Ranch. Temporary tent camps might also need to be established to ensure efficient operations in remote areas, such as boat-only accessible anchorages and rough, road-less terrain.

Pig eradication would occur in four distinct phases, all similar to the phases found under Alternative Two. Each phase has discrete requirements for time to completion. Experts have indicated that for the eradication to be successful, hunting must be complete within a ten-year window. Beyond this time eradication would become much more difficult because of vegetation recovery post-sheep grazing. Factors that could influence the duration of the project include but are not limited to: a) committed levels of funding, b) environmental conditions, such as rainfall, and c) pig population numbers. The detailed description of this alternative makes the assumption that sufficient funding would be provided to ensure complete eradication.

Phase I. Administration, Infrastructure, and Acquisition

Spanning approximately one year, this phase would acquire appropriate staff to oversee, manage, direct, and carry out the project including seeking qualified fencing and hunting contractors. Additionally, attention would be given to the infrastructure requirements for project implementation, such as upgrading

Table 2: Alternative Four Pig Eradication Phases

Phase	Description
I.	*Administration and infrastructure acquisition (Approximately 1 year)*
II.	*Fencing (Approximately 2 years, overlapping with Phase III)*
III.	*Hunting (Approximately 6 years, beginning with completion of first fenced zone)*
IV	*Final Hunting and Monitoring (Five years)*

housing facilities to accommodate long-term use, and establishing additional communications on the TNC lands to facilitate a safe and efficient operation. Necessary equipment and supplies would also be secured at this time.

Two TNC facilities would be used to support the operation; bunk cabins in the Central Valley, and the west end Christy Ranch facilities. Upgrades necessary for long-term use at the bunk cabins include: Repair septic tank; expand toilet building to include a waterless urinal & low-flush toilet; replace the hot water tank; upgrade the kitchen cabin including replacing cabinets, shelving, and countertops; and install a 2.5 kW photovoltaic system. Christy Ranch upgrades necessary for long-term use include: install water storage tank near the ranch house; install temporary bunk structures; install a 2.5 kW photovoltaic system.

Phase II. Fencing

Fencing all zones would require approximately 2 years to complete. The island would be fenced off into 6 distinct management units. Five zones average roughly 12,000 acres in size, and one smaller zone (Central Valley Zone) is approximately 3,000 acres. Most pigs are expected to be eradicated within the zones within a one-year time frame, barring factors listed above.

Fences would be constructed of either triple-galvanized steel or special alloy metals to resist corrosion in the heavy marine environment of Santa Cruz Island. Fence construction requires heavy-duty fence posts spaced approximately 8 ft. apart to be pounded into the ground. Mesh wire fence would be strung along the posts, secured to both the posts and the ground. Securing the fence to the ground is vitally important part of the fence construction to ensure pigs cannot get under the fence. Fence integrity is critical to the success of this alternative. This type of fence has been demonstrated to be effective and durable in Hawaii Volcanoes National Park's and Santa Catalina pig eradication efforts.

It is estimated that fencing would be completed across all zones within two years of the start of construction. Hunting and establishing walk-in traps in a zone may begin as soon as the zone fence is completed. Eradication activities may be occurring in one or more zones simultaneously.

Phase III. Hunting

Eradication activities would begin shortly after the first pig zone is complete. The fencing of hunting zones would be completed in the same sequential order that the eradication activities would follow. This would allow for eradication activities to occur in one or more zones at the same time during the first two years of the operation. While fence construction is occurring, eradication activities and fencing activities would be occurring concurrently.

Generally, techniques such as walk-in traps and bait stations, as well as ground hunting with dogs have been shown to have the highest efficiency rate for eradication on SCI (Sterner, 1990). Following that model, to increase efficiency, establishing walk-in traps and bait stations could precede fence completion and ground hunting in each of the zones.

Hunting by zones would require teams of hunters and dogs repeatedly working a zone. Hunters would be on the island for extended periods of time. Each team would have their own transportation, which could include pick-up trucks, "Jeep" type vehicles, ATV's, and/or horses to support their operation.

The sequential order of fencing and hunting/trapping for the zones has yet to be determined. The factors that would be considered in determining the order of zone eradication activities include: a) risk of failure over time because of vegetation recovery, b) length and separation of defendable perimeter, and c) evaluation of the island fox population viability in conducting certain activities, such as the fennel control burn. Continued monitoring of established pig-free zones would occur concurrently with the hunting efforts. Fence patrol for breaks and openings caused by pigs and weather would also be an ongoing task during this phase.

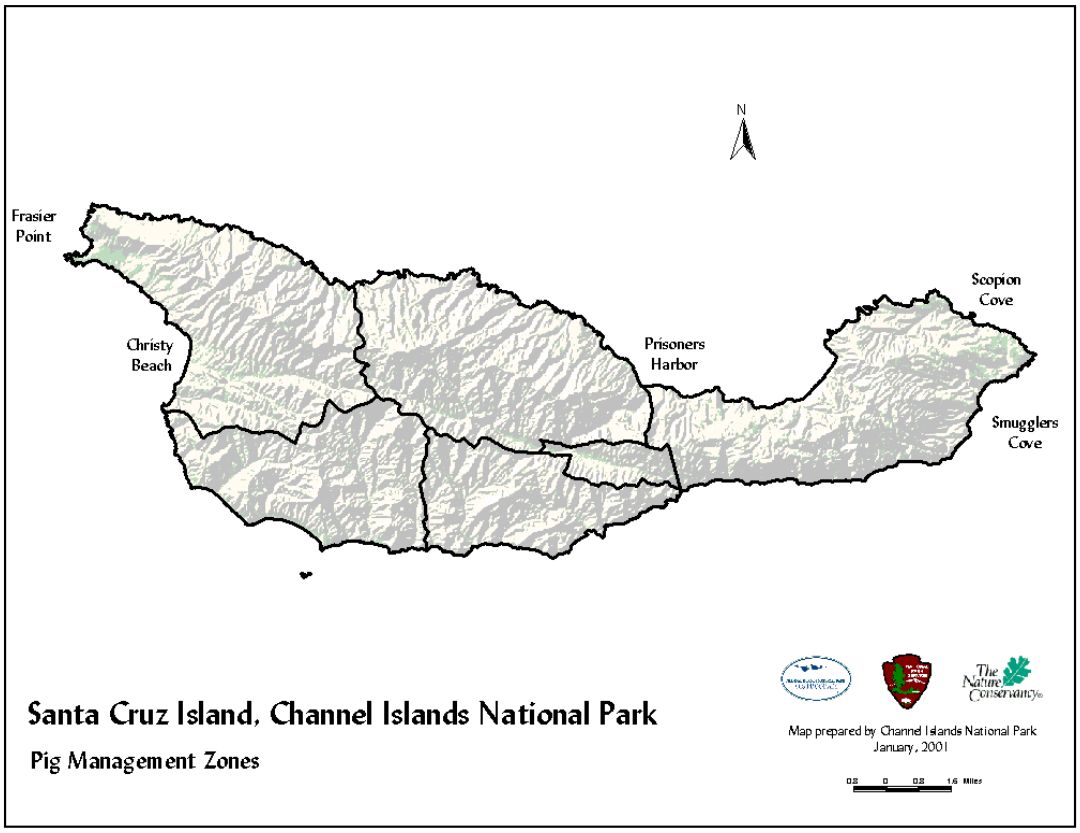
It is expected that the hunting team could achieve a nearly complete eradication status island-wide within a six-year period.

Phase IV. Final Hunting and Monitoring

Under the final phase of the program NPS, TNC, and hunting contractors (to a limited extent) would exhaustively search the island for remnant pigs and pig sign. Hunting teams would no longer be maintained on the island, but would be dispatched to areas if sign or animals were detected. A systematic protocol for detecting remnant feral pigs would be implemented for the island. Detection protocols would include, but not be limited to: systematic and random transects, indicator stations, baiting, aerial detection, and other pig detection techniques.

Island-wide remnant pig monitoring would continue for five years after elimination of what is thought to be the "last pig". Under the

Figure 4. Alternative Four Hunting Zones for Pig Eradication



direction of the park, long term ecological monitoring to assess ecosystem changes due to pig eradication would continue into the foreseeable future.

The decision to remove fence would only be made after a deliberate and collaborative process between TNC and NPS. Consultation with other pig eradication experts that have other similar projects (i.e. Catalina Island Conservancy and Hawaii Volcanoes NP) may be done. Decisions to rehabilitate areas disturbed as a result of the eradication activities would also be done under NPS and TNC collaboration.

Alternatives Considered But Dismissed from Detailed Study

Dismissed Alternatives and Techniques for Feral Pig Eradication

Live capture of feral pigs and relocation to the mainland

Feral swine, like all animals wild or domestic, are susceptible to a wide range of infectious and parasitic diseases. While some of these diseases are specific only to pigs, others are shared with other animals, including some that are shared with humans.

California is among the top states in the country for numbers of feral pigs. Currently, 52 of California's 58 counties are known to have feral pigs. As a statewide population, the number is great enough to cause substantial ecological impact, property damage, and further the spread of disease. As the numbers and distribution of feral pigs continue to increase, the contact between feral swine and domestic livestock, wild animals, and humans would also increase. This direct or indirect exposure to feral pigs brings with it a greater potential for transmission of both zoonotic (animal to human) and epizootic (animal to animal) diseases. To date, little information exists regarding diseases of feral swine, or the mechanisms or rates of transmission into domestic animals or humans.

Brucellosis and pseudorabies are the primary diseases carried by feral pigs nationwide and perhaps on Santa Cruz Island.

Brucellosis is a bacterial infectious disease of animals and humans that causes abortion and reproductive organ failure in the primary host, which in this case is the feral pig. In secondary hosts, such as humans, it can cause chronic flu-like symptoms, crippling arthritis, or meningitis. There is no cure for brucellosis for animals, while humans are treated with extremely high doses of antibiotics with the hope of clearing the infection. Brucellosis is transmitted via contact with fluids discharged from the infected animal (nasal mucous, semen, vaginal mucous, etc.).

Pseudorabies virus is a herpes simplex epizootic disease that largely affects domestic livestock, cats, and dogs. The disease is spread primarily by direct contact and ingestion of infected tissues or carcasses. The symptoms of pseudorabies virus vary widely among species, but can include anorexia, excessive salivation, spasms and convulsions, as well as "mad itch". Pseudorabies virus is almost always fatal.

Millions of dollars have been spent in a nation-wide effort to rid the United States of brucellosis and pseudorabies virus. Federal and state agencies responsible for these programs strongly forbid actions that may transmit these diseases. Therefore, both the State of California (1999) and the County of Ventura (1999) oppose transport of any live feral pigs from the island to the mainland. The California Department of Fish and Game stated "The Department would not approve a request to translocate wild pigs from Santa Cruz Island to the mainland. Our reasons for objecting to any plans to translocate wild pigs are two-fold: 1) potential spread of disease to other wild pigs or domestic swine, and 2) increasing the distribution and abundance of

an exotic species with great potential of causing damage."

The County of Ventura (Jenks 1999) has stated that it would be "irresponsible to risk the health and welfare" of mainland domestic livestock and pets by attempting to bring feral pigs from the island to the mainland.

The NPS concurs with this decision, opting to not risk transmission of potentially dangerous and fatal diseases to the mainland populations of domestic livestock, pets, and people.

Use of Poison

There are a number of toxicants which can be effective as part of an eradication program. However, each of the potential poisons could negatively affect non-target species. It would be very difficult to protect non-targets from incidental poisoning. Additionally, there are rare, endemic species, such as the island fox and spotted skunk, on Santa Cruz Island that could be impacted by the use of poisons. For these reasons, and because hunting can achieve the park goal without the secondary impact, poison would not be used as a tool in the eradication of feral pigs from Santa Cruz Island.

Use of Snares

Snares are an effective and inexpensive method of trapping pigs; however the use of snares on Santa Cruz Island could capture non-target animals such as the island fox or spotted skunk. Imperiling the island fox to this hazard is unacceptable to the NPS. Hunting and walk-in traps can achieve the park goal of eradication of pigs. Therefore, snares would not be used in this project.

Use of Contraceptives or Sterilization

Contraception and/or sterilization could be a relatively benign way of eliminating feral pigs from an area under controlled conditions. However, birth control technology is not yet adequate to achieve eradication, or even control, of feral pig populations. The NPS is not aware of a Food and Drug Administration (FDA) approved contraceptive or sterilant that could be used for feral pig eradication.

Contraceptives

Contraceptives are a tool that may work adequately in species with low reproductive rates or in animals that can be reliably and consistently treated with the contraceptive and booster at the required times and doses. Feral pigs do not meet either of these criteria.

Reproductive Rate: The primary reason why birth control is ineffective with pigs is their high reproductive rate. Sows can produce 2 litters of pigs per year and average 5.6 pigs/litter on Santa Cruz Island. Sows begin breeding in their first year. With such a high reproductive rate, even the smallest failure of the contraceptive (contraceptives can have failure rates as high as 20%) or failure to deliver the contraceptive and subsequent booster to every sow would result in production of a large new generation.

Consistent and Reliable Treatment: Treating every feral pig on Santa Cruz Island would be impossible. Considerations such as knowing which pigs have been treated, efficacy of the contraceptive on treated animals, the need for booster inoculations, accessing every pig in difficult terrain would all contribute to making the operation overly complex, expensive, and ultimately unreliable.

Sterilization

Sterilants in general cannot be used for this project because: 1) use of a sterilant would require injecting and marking each pig on the island; and 2) they are unproven for an eradication program.

Requires Injecting and Marking Each Pig on the Island: The logistics of delivering the sterilant to all pigs on the island comprises an insurmountable obstacle. Because pigs are nocturnal, secretive, and widespread, delivering injections to all pigs would be impossible, even if the injection was delivered remotely (by rifle).

The annual effort required would exceed the capabilities of NPS and TNC. And unless treated animals were marked, it would be impossible to distinguish treated pigs from untreated pigs.

Unproven for an Eradication Program: Sterilants are unproven for any mammal eradication program. Use of any sterilant on Santa Cruz Island feral pigs would be a waste of money and would not achieve the purpose of this plan, which is to eradicate feral pigs island-wide. Use of any sterilant would, at best, control pig populations, but cannot eradicate them. Mere control of the pig population is not acceptable, because pigs left on the island would continue to impact natural and cultural resources.

Public hunting on NPS property

Allowing hunting by members of the public, similar to hunting in National Forests or on certain state lands has been suggested as an inexpensive way to eradicate pigs while raising revenues for the park. The primary reasons why this tool cannot be used as part of the eradication program are: A) there is no legal authority that could allow public hunting to occur in CINP, and B) public hunting, regardless of guide or not, cannot achieve total eradication of feral pigs on the island, a stated goal of this plan.

Recreational hunting can achieve significant control or eradication of animals that have a relatively low reproductive potential. However, animals with high reproductive potentials, such as pigs and rabbits, are much more difficult to eradicate and require a very focused and sustained effort by skilled workers.

Through recreational hunting, the former owners of eastern Santa Cruz Island attempted, but failed, to control feral sheep numbers low enough to avoid extensive degradation of soils, vegetation and archeological sites on eastern Santa Cruz. Thousands of sheep remained on East Santa Cruz Island at the time of acquisition by NPS in spite of extensive sport hunting. Sheep have a much lower reproductive potential than pigs.

The decision by Channel Islands National Park not to use recreational hunting as a part of its plan to eradicate pigs does not preclude The Nature Conservancy from allowing public hunting on its property prior to the start of the eradication program. Extensive hunting by recreational hunters may make hunting associated with the eradication program more difficult because the pigs may become more reclusive with the increased hunting pressure.

Use of Swine Diseases

Diseases, such as hog cholera, can be very effective in the reduction of pig populations. Hog cholera was introduced to Santa Cruz Island in the 1950's. It is thought that this resulted in a reduction of pig numbers on Santa Cruz Island by 75% or more. A survey conducted in the late 1980's confirmed that there is no remnant hog cholera left within the population of feral pigs on Santa Cruz Island.

Hog cholera has been successfully eliminated from the United States and is now classified as a foreign pathogen and disease. As such, hog cholera is not permitted for use in any capacity in the United States.

This alternative was also rejected from further consideration because of the possibility of transmission of the pathogen to the domestic livestock, wild animals, or humans on the mainland or on the island.

Dismissed Alternatives for Fennel Control

Mechanical Fennel Control (Exclusive)

Mechanical control has been proposed as an alternative way of controlling fennel on the isthmus. Mechanical control would consist of mowing the fennel annually with the goal of preventing the fennel plants from producing seed during the growing season. The objective would be to continue a mowing program until the seed bank in the soil is depleted. It is

estimated that fennel seeds remain viable in the soil for at least 5-7 years.

Controlling fennel in this manner was rejected as a viable option for a number of reasons. First, because fennel is an indiscriminate seeder (sets seed from May through October) it would not be possible to conduct a single-pass mowing program and ensure that the fennel plants would not produce seed during the growing season. Second, it would be impossible, and possibly unsafe, to mow substantial amounts of the fennel given the difficult terrain. Third, mowing such a large area would require multiple passes by a tractor mower, which would cause significant soil disturbance. Lastly, although fennel generally reproduces by seed, it does have the ability to resprout from the crown of the plant's root system after mowing. So despite an aggressive effort to mow the fennel stand, the fennel would still have the ability to produce seeds later in the same season. However, until fennel control is achieved, mowing would still continue along roads and trails.

Mechanical Fennel Control (Hand Application of Herbicide)

Mechanical control of fennel would be done as described above e.g. tractor mowing. Following mowing, herbicide would be applied using backpack sprayers, ATV mounted spray units, and truck mounted slip-on spray units.

This method was rejected as a viable alternative because of concerns regarding efficiency, safety, and soil disturbance.

Efficiency: It is estimated that to apply herbicide to approximately 1,800 acres of fennel by these means would require at least a six-person crew working from May through September. Because seeds remain viable in the soil for at least 5-7 years, the spray crew would have to apply herbicide annually in multiple consecutive years. The cost of hiring such a crew (including vehicles, equipment, and herbicide), the limited housing availability on the island and transportation logistics makes this alternative too expensive and inefficient when compared to aerial broadcast application.

Safety: Although the crew would follow all state and federal safety measures, the crew would be required to handle herbicide frequently, increasing exposure and the chance for spills. In addition, the difficult terrain within the fennel patch would require the crews to operate mechanized equipment on uneven steep terrain. Much of the area would be in areas inaccessible to mechanized spray units. Such areas would require crewmembers to carry heavy backpack sprayers. Carrying heavy backpack spray units over steep, uneven terrain can be hazardous.

Disturbance: As mentioned previously, mowing would cause significant soil disturbance. In addition to the disturbance caused by mowing, 4-wheel drive pickups and ATV's would be used in accessible areas causing additional soil disturbance and soil compaction.

Burn Fennel (Hand Application of Herbicide – no aerial spraying)

This dismissed alternative would pre-treat the fennel with fire as outlined, then only use hand application of herbicide (i.e. exclude use of aerial herbicide application). Rationale for dismissing exclusive use of hand application of herbicide is given above.

Preferred Alternatives

This section provides a discussion regarding the "Environmentally" and "Agency" preferred alternative. The environmentally preferred alternative is the alternative that causes the least damage to the biological and physical environment. Identification of the agency-preferred alternative allows the public to

understand what actions the agency would like to implement.

The decision maker is under no obligation to choose either the "environmentally" or "agency' preferred alternatives. In many cases the "environmentally preferred" and "agency preferred" alternatives are the same, however, for this analysis the "agency" preferred alternative is different.

Environmentally Preferred Alternative

To be considered environmentally preferred the alternative would have to eliminate feral pig impacts island-wide. Without island-wide pig eradication significant natural and cultural resources impacts would be ongoing and would lead to a more degraded environment. Since Alternative One and Three allow pig impacts to continue, they cannot be considered "environmentally preferred".

In considering which alternative is the environmentally preferred among the remaining Alternatives (Two and Four), a comparison was made regarding duration and severity of effects associated with the implementation of each alternative. For this comparison it is assumed that these alternatives meet their objective within the predicted timeline (100% efficacy).

The activities associated with fence construction and fennel control are considered to have the severest short-term environmental impacts. Since fennel control is identical for these alternatives, comparing miles of fence construction would give an indication of which alternative would have the most severe environmental effects. Alternative Two does not require building fence to eradicate pigs from the island, whereas, Alternative Four would require approximately 45 miles of fence.

There are similarities in the effects on biological resources from implementation of Alternatives Two and Four; however, the duration of these effects is different among these alternatives. Comparing the duration of effects to biologic resources, Alternative Two would complete pig eradication in approximately three years with the bulk of biological effects occurring during these years. Alternative Four would have biological effects persisting for a minimum of six years, the length of time estimated to eradicate pigs from the island. However, when compared to Alternative Two and its two year eradication timeline, Alternative Four would have nearly 50% of the island mostly pig free within the same timeline. Post-eradication activities, such as fence removal, fence maintenance, and monitoring would extend disturbance-causing activities beyond the eradication activities.

Because Alternative Two has less physical disturbance (least severity) and would be completed in the shortest amount of time (least duration of biological effects) it is determined to be the "Environmentally Preferred Alternative." However, if both Alternatives meet the 100% eradication objective, the long-term (5+ years post-eradication) beneficial effects would be similar.

Agency Preferred Alternative

For reasons given in the efficacy discussion (*Issue 1: Likelihood of Success*) in Chapter Four, the agency preferred alternative is Alternative Four.

The efficacy discussion for Alternative Two points out concerns the agency has with regards to implementing a high intensity/short duration implementation strategy. The analysis concludes that if the Park was unable to implement such a strategy, for whatever reasons, the probability of success decreases.

The Park is more confident that the deliberate longer term eradication strategy identified in Alternative Four can be implemented more easily given the logistical and financial challenges of supporting a complex program on an offshore island.

Comparison of Alternatives

**See Table 3 below.

Table 3. Comparison of Alternatives

	Alternative One	Alternative Two	Alternative Three	Alternative Four
Pig Eradication Strategy	No Eradication Strategy would be implemented	Hunt all areas simultaneously until all pigs are eradicated	Create two pig zones: eradicate pigs in NPS zone; exclude pigs from selected resources on TNC property	Hunt and establish walk-in traps by zone until all pigs are eradicated
Fence construction (miles)	None	None	Minimum of 3 miles (NPS property boundary); 3-20 miles to protect sensitive resources on TNC property	~45
Duration of Project	0	Estimated 2 years of eradication, 5 years inspect and monitor	2 years of eradication on NPS lands; defend exclusion areas until mgmt strategy changes	6 years of eradication, 5 years inspect and monitor
Fennel Control	None	Prior to pig eradication - Burn Fennel in the fall; aerially spray with herbicide two consecutive springs	Same as Alt. 2	Same as Alt. 2
Likelihood of Success	None	High	Low	High

SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

CHAPTER THREE
AFFECTED ENVIRONMENT

Introduction

This chapter focuses on portions of the environment that are directly related to conditions addressed in the alternatives. The description of the affected environment is not meant to be a complete description of the project area. Rather, it is intended to portray the significant conditions and trends of the resources that may be affected by the proposed project or its alternatives. Information in this chapter is based primarily on inventory and monitoring data from the Park's resource management staff, information provided by The Nature Conservancy, U.S. Fish and Wildlife draft recovery plan for 13 plant taxa of the northern channel islands, independent academic research studies, and studies conducted as part of this proposed action. Other sources are noted where applicable.

This chapter is organized into four sections, which when taken together provide the most complete description of the island resources, including the human element. The four major components of this chapter are:

- Physical Environment
- Terrestrial Environment
- Cultural Resources
- Human Uses and Values

For the most part, geologic and climatological conditions, processes, and disturbances cannot be altered by management activities. Watershed, soil, and atmospheric conditions and processes, also part of the physiographic setting, can be modified by certain management activities, and such impacts are outlined in Chapter Four, Environmental Consequences.

Physical Environment

Setting

Off the coast of southern California, eight ridges in the continental shelf rise above sea level, forming a series of islands. The four northern islands are located in the Santa Barbara Channel parallel to the coast south of Point Conception; the four southern islands are scattered offshore between Los Angeles and the Mexican border.

The Channel Islands vary greatly in size, distance from each other, and distance from the mainland, creating an immense natural laboratory of isolation and evolution. Because the islands have escaped much of the historical human impact on coastal California, they provide an ideal place for field scientists to perform work no longer possible on the mainland.

Of all the Channel Islands, the largest and most diverse is Santa Cruz. Totaling 60,784 acres, Santa Cruz Island is almost three times the size of Manhattan. One of the northern Channel Islands, it lies southwest of the City of Ventura, 19 miles across the Santa Barbara Channel from the nearest mainland point.

The National Park Service owns the eastern end of Santa Cruz Island, including the area known as the "isthmus". The Nature Conservancy owns the remainder of the island (Figure 1).

Like the state of California in miniature, SCI has two major mountain systems flanking a fault-dominated central valley. SCI's valley divides the island into two very different geologic terraines. To the north, a purple-brown ridge of young volcanic rocks rises to Mt. Diablo, then plunges abruptly into the Santa Barbara Channel. At 2,432 feet, Mt. Diablo is the highest point on all the Channel Islands. South of the Central Valley is a weathered ridge of reddish metamorphic rocks that reaches an elevation of 1,523 feet. At its seaward base, a submerged shelf extends several miles southward before falling off into the Santa Cruz Basin, which is more than a mile deep. Cutting through both ridge systems is a series of steep-sided canyons, many with freshwater springs and intermittent streams. Some of these creeks expire on gravel beaches at canyon mouths; others plunge from ocean cliffs directly into the sea. The island's main watershed has an interesting drainage pattern: Its primary stream flows southeast along the central valley, then turns abruptly northeast to drain through a steep gorge in the northern range to its mouth at Prisoners' Harbor.

The island's coastline includes a variety of exposures, from protected coves and sandy beaches to vertical cliff faces, hidden sea caves, and dissected marine terraces. Offshore, warm southern waters mingle with cold currents from the north, creating a major transition zone for marine life.

The diversity of the island's topography and microclimates gives rise to a wide array of habitats, from rocky intertidal to chaparral to pine forests. Its size and complexity make the island biologically similar to undisturbed areas on the adjacent mainland. But because of SCI's geographic isolation, its ecosystems exhibit subtle and not-so-subtle differences from their mainland counterparts, inviting comparative studies.

The island's biota includes many organisms endemic to the Channel Islands, some found only on Santa Cruz Island. Scientists believe most plants and animals reached the island by chance after swimming, flying, or floating on debris, especially during periods of low sea level.

Considering that it was colonized by overwater dispersal, Santa Cruz Island supports a remarkably rich biota. Some groups, however, are decidedly depauperate, and certain organisms, lacking the usual competitors or predators, have taken on different forms or have invaded niches unavailable to them on the mainland.

Aboriginal people, who traveled extensively between the mainland and the islands, may have introduced some organisms. SCI's abundant, well-preserved archaeological sites provide insight into past cultures and environmental conditions. The island's seclusion, ruggedness, and history of conscientious private stewardship have protected the island from many of the usual impacts of heavy exploitation following European contact.

Exotic plants and animals have affected the vegetation and soils of SCI. Efforts are underway by all stewards of the island to deal with non-native organisms. The most recent

successful effort was the removal of over 9000 sheep from the island ending in December 2000.

Climate

Precipitation and Temperature

The Channel Islands enjoy the Mediterranean climate typical of the central California coast. Rain pelts the islands off and on from November to March, but is scarce from late May to October, when a stable pacific high-pressure system settles off the coast. A shallow coastal marine layer helps lessen the impact of the common summer drought conditions on the islands.

Northwesterly winds blow throughout the year, picking up speed most afternoons and dropping off at night. These winds drive fog against the islands' northwestern slopes, which provide very different climatic conditions than the south-facing coastal slopes of the mainland. Santa Ana winds occasionally disrupt this pattern, particularly in the fall and early winter. These hot dry winds blow from the east when high-pressure systems are present in the interior mainland.

Drought

Drought is an important process that affects ecosystems. Drought is defined as an absence of usual precipitation (less than 75 percent of normal), for a long enough period that there is decreased soil moisture and stream flow, thereby affecting ecological processes and human activities. Typical of Mediterranean climates, the islands have their dry season during the summer months.

Geology

Much of the tumultuous geologic history of the Channel Islands can be read in the rocks of SCI (Gustafson, 1999). Cleaving the island in two is the Santa Cruz Island Fault, which juxtaposes 150 million-year-old metamorphic rocks with volcanics less than 20 million years old. Ongoing research suggests this fault has been very active recently, causing as much as 200-300 meters of movement in the last 30,000 years. This displacement can be seen in several areas where streambeds jog markedly as they cross the fault.

A pronounced but discontinuous central valley, formed by stream erosion along the fault zone, runs the length of the island from east to west separating two major ridge systems.

Other features of geologic interest on SCI include sheep-induced erosion, diverse soils, unusual drainage patterns, and Pleistocene fossils of dwarf mammoths and Douglas fir.

Air Quality

Though very little historic record exists with respect to air quality around the Channel Islands, it is probable that the combination of prevailing wind patterns, a low natural fire history, and small human populations allowed for generally good air quality. Since the population and development boom along coastal southern California, however, poor air quality is widespread, and smog often mars the visibility from and around the islands.

Channel Islands National Park is classified as a Class II area under the Federal Clean Air Act (42 USC 7401 et seq.). Class II areas are protected under the Clean Air Act, but have somewhat less stringent protection from air pollution damage than class I areas. The Act gives federal land managers the responsibility for protecting air quality and related values, including visibility, plants, animals, soils, water quality, cultural and historic structures and objects, and visitor health from adverse air pollution impacts.

Channel Islands NP Headquarters/Visitor Center and Anacapa Island are located in Ventura County, CA, and Santa Cruz, San

Miguel, Santa Rosa, and Santa Barbara Islands are located in Santa Barbara County, CA. Both counties are part of the South Central Coast Air Basin. The Ventura County Air Pollution Control District and the Santa Barbara County Air Pollution Control District are the governing authorities that have primary responsibility for controlling air pollution from stationary sources in Ventura County and Santa Barbara County, respectively. Table 4 summarizes the air quality designation of these counties.

Table 4. Ambient Air Quality Designations

Pollutants	Ventura County, CA		Santa Barbara County, CA	
	CA	National	CA	National
Ozone (one-hour)	N	N[1]	N	N[1]
Carbon monoxide	A	U/A	A	U/A
Nitrogen dioxide	A	A	A	A
Sulfur dioxide	A	A[2]	A	U
Particulate matter	N	U	N	U
Lead[3]	A		A	

A = Attainment N = Nonattainment T =Transitional U = Unclassified

[1] Although Ventura and Santa Barbara Counties are designated as nonattainment for the federal ozone standard, the Channel Islands are designated as unclassified/attainment

[2] Although Ventura County is designated as attainment for the federal SO_2 standard, the Channel Islands are designated as unclassified

[3] There are no areas in California that exceed the National standard for lead

Although there is no ozone monitoring station on Santa Cruz Island, neighboring Santa Rosa Island contains a continuous ozone monitoring station. This station is operated through a cooperative agreement between the NPS and the Santa Barbara County Air Pollution Control District. A summary of ozone emissions from this station is summarized in Table 5.

Standards for Prescribed Fire

The California Air Resources Board (ARB) is responsible for promulgating regulations pertaining to a variety of areas, including state ambient air quality standards and area designations, emissions from motor vehicles, fuels and consumer products, and airborne toxic control measures. Title 17 of the California Code of Regulations, titled Smoke Management Guidelines for Agricultural and Prescribed Burning, provides direction to air pollution control and air quality management districts (air districts) for the regulation and control of agricultural burning, including prescribed burning. The Guidelines are intended to provide for the continuation of prescribed burning as a resource management tool, while minimizing smoke impacts on the public. Local and regional authorities have the primary responsibility for control of air pollution from prescribed burning.

The Santa Barbara Air Pollution Control District requires that NPS prepare and submit a smoke management plan for the fennel burn. As a minimum the plan would include: 1) location and specific objectives of the burn project; 2) acreage or tonnage, type, and arrangement of vegetation to be burned; 3) directions and distances to nearby sensitive receptor areas; 4) fuel condition, combustion, and meteorological prescription elements developed for the project; 5) projected schedule and duration of project ignition, combustion and burndown; 6) specifications for monitoring and verifying critical project parameters and 7) specifications for disseminating project information.

Table 5. Santa Rosa Island 3-year average fourth highest daily max 8-hr ozone concentration based on data collected during the reported year and the two previous years.

Year	3-Year Avg 4th High Daily Max 8-hr Ozone (ppb)	3-Year Avg Data Complete	Data Complete % Met?	Annual 1st High Daily Max 8-hr Ozond (ppb)	Annual 2nd High Daily Max 8-hr Ozone (ppb)	Annual 3rd High Daily Max 8-hr Ozone (ppb)	Annual 4th High Daily Max 8-hr Ozone (ppb)	Annual 5th High Daily Max 8-hr Ozone (ppb)
2001 (a)	NA	NA	NA	NA	NA	NA	NA	NA
2000	66	87%	No	76	71	68	65	64
1999	67	93%	Yes	77	76	74	70	69
1998 (b)	*	*	*	*	*	*	*	*

a. 2001 data is not yet available

b. Data Completeness was not met. Summary data indicates that the highest ozone daily 1-hr average maximum concentration was 82 ppb recorded on 10/6/98. There were no episodes of 8-hr avg ozone concentrations greater than 84 ppb.

Soils/Water Quality

This section will describe the current condition and trend of soil resources and water quality on Santa Cruz Island. However, because there has not been a soil survey or permanent water quality stations established on Santa Cruz Island, information on these two subjects is not well documented. In cooperation with the Natural Resource Conservation Service, Channel Islands National Park has begun a soil survey for all Park islands, including Santa Cruz Island. This survey is expected to be complete within three years.

Geology and its Relation to Soil Erosion

Disturbance factors such as heavy past livestock grazing, pig rooting, and extensive vegetation type changes, when acting on steep landform features and erosion prone sedimentary geologic types, have caused localized downward trends in soil resources.

Gully and sheet erosion is still actively occurring throughout the island, especially within the sedimentary Monterey formations found on the isthmus and east end of the island. The El Niño winter storm events of 1997-98 caused hundreds of small and large landslides throughout the island. This was particularly noticeable in the Scorpion watershed, one of the most disturbed watersheds on the island, which is extremely vulnerable to erosion due to past heavy sheep grazing, pig rooting, steep landforms, and geologic type (half of the watershed is in the Monterey formation).

The volcanic geologic types found on the northwestern part of the island and on the higher elevations of the island's east-end are less prone to erosion. However, because this geologic type supports many of the tree-dominated community types, they have been a natural resting area for feral sheep, as well as preferred habitat for pigs foraging for acorns. Even though they may be less prone to erosion, the feral animal activity has impacted them dramatically in localized areas.

Watershed Features

Watersheds on Santa Cruz Island vary greatly in size. The largest watershed is the Central Valley, which runs east/west and drains out to the north shore at the base of the isthmus. Landforms within the watersheds vary, however almost all of them have steep slopes with highly dissected drainages.

Typical Santa Cruz Island watersheds are characterized by steep, highly dissected subdrainages. Most of the steep slopes show many mass slope failures that result in high erosion and sedimentation in the valleys. Most of the major watersheds have a mix of vegetation community types, with coastal sage scrub on south facing slopes, chaparral on north facing slopes on volcanic substrates, and woodland communities in the higher elevations with steeper slopes. Incised gullies are commonplace throughout the drainages, a situation that was exacerbated by the overgrazing of sheep. Slope failures of all sizes are also very evident throughout the watershed, although fewer slope failures are evident in watersheds that are in the volcanic geologic types.

Valley-bottom Characteristics

The highly dissected drainages typically have V-shaped valley-bottoms. These drainages are highly efficient at delivering sediment. These valley-bottom types, when coupled with low vegetation cover are capable of causing "flash flood" events. This situation contributed to the December, 1997 Scorpion Flood. Near the ocean confluence, the larger drainages are typically low gradient and U-shaped and may contain estuary habitat.

Streamflow and Water Quality

Most drainages have only intermittent above ground stream flow. However, the larger watersheds have perennial flow in normal precipitation years. Drought conditions play a major role in extent of above surface streamflow. Even the largest watershed on the island (Central Valley) has intermittent flow, where stream flow alternates above and below ground throughout its length. Junak et. al. (1995) notes that there are many freshwater seeps and springs throughout the island. One of the largest springs on the island is located in Aguaje Canyon near Yellowbanks Anchorage. Minimal documentation exists as to water chemistry (nutrients or animal waste) monitoring within the streams of Santa Cruz Island, so presence of microbes or nutrients is unknown. Given the island's ranching history, and the resultant declining vegetation conditions, sedimentation above natural sediment rates is a concern for water quality.

Terrestrial Environment

Introduction

This section provides a description of the terrestrial component of Santa Cruz Island that is directly related to conditions addressed in the alternatives. As such, it is not a complete description of the entire terrestrial environment; rather it is a description of the significant conditions and trends of resources that may be affected by the proposed project or its alternatives. Listed below are the three terrestrial components that will be described in this section:

- Wildlife
- Native Vegetation, including Threatened and Endangered plant species
- Fennel and other weeds

Wildlife

Introduction

Santa Cruz harbors fewer species than comparable mainland areas, because only a subset of the mainland species pool successfully colonized the island. This is typical of island faunas. On the other hand, evolution of island forms in relative isolation from their mainland ancestors has resulted in a high degree of endemism in the fauna of Santa Cruz Island, and

for the fauna of islands as a whole. Endemic taxa (species or subspecies) are those that are restricted to a particular geographic locale.

Non-avian Vertebrates

Eight species of reptiles and amphibians have been recorded for Santa Cruz Island (Table 4), of which 3 are endemic to the island or archipelago. One reptile, the Santa Cruz gopher snake, occurs only on Santa Cruz and Santa Rosa Islands. Fifteen species of mammals, including 11species of bats, have been recorded on Santa Cruz (Table 6). Three of the 4 non-bat mammals occur only on Santa Cruz, and the other (the island spotted skunk) occurs only on Santa Cruz and Santa Rosa Islands.

Because of their unique taxonomic status and questionable population status, several species are treated in greater detail.

Island Spotted Skunk

Island spotted skunks (*Spilogale gracillis amphiala*) occur only on Santa Cruz and Santa Rosa Islands, having possibly been extirpated from San Miguel Island (Walker 1980). Very little is known about the ecology of the Channel Islands spotted skunk. Difficulty in trapping skunks has plagued the few investigations that have been attempted. Crooks (1994) studied the comparative ecology of the spotted skunk on

Table 6. Santa Cruz Island Fauna

Common Name	Scientific Name [1]	Legal Status[2]	Endemic Status
AMPHIBIANS			
Blackbelly slender salamander	*Batrachoseps nigriventris*		
Channel Islands slender salamander	*B. pacificus pacificus*	FSC	Channel Islands
Pacific tree frog	*Pseudacris regilla*		
REPTILES			
Southern alligator lizard	*Elgaria multicarinata*		
Island fence lizard	*Sceloporus occidentalis beckii*		Channel Islands
Side-blotched lizard	*Uta stansburnia*		
Santa Cruz gopher snake	*Pituophis catenifer pumilus*	FSC, CSC	SCI, SRI
Western yellowbelly racer	*Coluber constrictor mormon*		
MAMMALS			
California myotis	*Myotis californicus caurinus*		
Big-eared myotis	*M. evotis*	FSC	
Fringed myotis	*M. thysanodes*	FSC	
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*	FSC, CSC	
Big brown bat	*Eptesicus fuscus*		
Pallid bat	*Antrozous pallidus pacificus*	CSC	
Silver-haired bat	*Lasionycteris noctivagans*		
Hoary bat	*Lasiurus cinereus*		
Red bat	*L.borealis*		
Mexican free-tailed bat	*Tadarida brasiliensis*		
Western mastiff bat	*Eumops perotis californicus*	FSC, CSC	
Santa Cruz Island deer mouse	*Peromyscus maniculatus santacruzae*		Island
Santa Cruz Island harvest mouse	*Reithrodontomys megalotis santacruzae*	FSC	Island
Santa Cruz Island fox	*Urocyon littoralis santacruzae*	ST, FPE	Island
Island spotted skunk	*Spilogale gracilis amphiala*	FSC, CSC	SCI, SRI

[1]Nomenclature for reptiles and amphibians is from Collins (1990).
[2]FSC = Federal Species of Special Concern; CSC = California Species of Special Concern; ST = State-listed as Threatened. Data on legal status is from California Department of Fish and Game (1998).

Santa Cruz Island in relation to the island fox. He found that skunks were rare and difficult to capture; that they were habitat specialists, preferring ravines, and to a lesser extent, chaparral-grasslands; and that they were entirely carnivorous and nocturnal. Crooks concluded that the low population size and relatively narrow geographic range of the skunk made the species vulnerable to extinction.

The skunk is listed as a "Species of Special Concern" by the State of California and the National Park Service. According to von Bloeker (1967), spotted skunks were once very common on Santa Cruz and Santa Rosa Islands, but by 1967 they were rarely found on either island, at least near human dwellings. The apparent rarity of spotted skunks may reflect normal population fluctuations, or it may reflect a real decline in numbers (Williams, 1986).

Recent observations from Santa Cruz Island and Santa Rosa Island indicate that island spotted skunks have increased in numbers, at the same time that island foxes have decreased (G. Roemer, Institute for Wildlife Studies, unpublished data; K. Crooks, University of California, Santa Cruz, pers. comm., T.Coonan, NPS, unpublished data).

Landbirds

Fifty-one species of landbirds are known to breed on Santa Cruz Island (Diamond and Jones 1980). Eight of those taxa are subspecies endemic to two or more of the northern Channel Islands, while one, the island scrub-jay, is a species endemic to Santa Cruz Island. Three of the endemics (horned lark, rufous-crowned sparrow, and loggerhead shrike) exist at low population levels (H. Walter, University of California, Los Angeles, unpublished data).

Several pairs of peregrine falcons, a species formerly listed as endangered, breed annually on the island. Bald eagles are currently listed as threatened under the Endangered Species Act, but have been proposed for de-listing. They formerly bred on Santa Cruz Island, and on all other Channel Islands, but were extirpated in the mid-20th century due to persecution and effects of DDT and other related compounds (Kiff 1980).

Invertebrates

The invertebrate fauna of Santa Cruz Island is much less well known than the vertebrate fauna, due to greater traditional interest in the latter, and the far greater number of taxa in the former. Powell (1994) estimated that lepidopteran fauna of Santa Cruz Island was about 70-75% known. In contrast he estimated that at that time, San Miguel and Santa Rosa lepidopteran fauna was only 50% known. About 750 species of lepidopterans are known from the Channel Islands, about 550 of them from Santa Cruz Island. Fourteen lepidopteran species known from Santa Cruz are endemic to one or more of the Channel Islands (Powell 1994). The butterfly and moth fauna of Santa Cruz Island is depauperate for the same reasons that island vertebrate species are typically depauperate: absence at time of island genesis, subsequent extinction, and failure to colonize (Powell and Wagner 1993).

The native bee fauna of Santa Cruz Island is well known, due to research on the effects of non-native European honeybees (*Apis mellifera*) on native bees (Thorp et al. 1994). The bee fauna of Santa Cruz is more diverse than that on other Channel Islands, due to the island's size, elevations, topographical diversity, and habitat variability. European honey bees have been all but eradicated from the island (Wenner et al., in press).

Threatened or Endangered Animal Species

Two listed animal species, the Western snowy plover (*Charadrius alexandrinus nivosus*) and the California brown pelican (*Pelecanus occidentalis californicus*), occur on Santa Cruz Island. One listed species, the bald eagle (*Haliaeetus leucocephalus*), will be

experimentally reintroduced to Santa Cruz Island in 2002.

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 in December 2002.

Island Foxes

The island fox, a diminutive relative of the gray fox (*U. cinereoargenteus*), is endemic to the California Channel Islands. It is distributed as six island populations, each varying in size from fewer than a hundred, to a few thousand individuals. The fox exists as a different subspecies on each of the six islands, a distinction upheld by morphological and genetic work (Wayne et al. 1991, Collins 1993). The subspecies on Santa Cruz Island is *U. l. santacruzae*. Due in part to its limited distribution and small numbers, it was been listed as a threatened species in California (California Department of Fish and Game 1987). A substantial amount is known about this species' population ecology and evolutionary history due to recent work on island fox genetic variability (Gilbert et al. 1990), evolution (Wayne et al. 1991), disease incidence (Garcelon et al. 1992), and population status and conservation (Roemer et al. 1994, Roemer 1999). Channel Islands National Park encompasses five of the eight California Channel Islands and includes three islands that harbor different island fox subspecies.

Island foxes occur in virtually every habitat on the Channel Islands and feed on a wide variety of prey (Moore and Collins 1995). They occur in valley and foothill grasslands, southern coastal dune, coastal bluff, coastal sage scrub, maritime cactus scrub, island chaparral, southern coastal oak woodland, southern riparian woodland, Bishop and Torrey pine forests, and coastal marsh habitat types. Island fox home range size varies by habitat type, season, and sex of the animal (Fausett 1982, Laughrin 1977, Crooks and Van Vuren 1995, Thompson et al. 1998, Roemer 1999). The island fox diet includes a wide variety of plant and animal materials (Laughrin 1973, 1977, Crooks and VanVuren 1995; Moore and Collins 1995). Island foxes forage opportunistically on any food items encountered within their home range. Selection of food items is determined largely by availability, which varies by habitat and island, as well as seasonally and annually. Principal foods eaten include mice, ground nesting birds, arthropods, and fruits.

Island fox populations were annually monitored on San Miguel Island from 1993 to 1999, and on Santa Cruz Island from 1993 to present. The island fox population on San Miguel declined beginning in 1994 (Coonan et al. 1998) with the adult population falling from 450 in 1994 to 15 in 1999. The Santa Cruz population declined from approximately 2,000 adults in 1994 to perhaps less than 135 in 2000 (Roemer 1999), and the current population is probably 50-60 adults (Dennis et al. 2001; D. Garcelon, Institute for Wildlife Studies, unpubl. data). Survey data from Santa Rosa Island (G. Roemer, Institute for Wildlife Studies, unpublished data) indicate that island foxes experienced a similar catastrophic decline on that island as well. Foxes on Santa Rosa may have numbered more than 1,500 in 1994 (Roemer et al. 1995) but have since declined to 31 animals, all in captivity (Coonan and Rutz 2001).

Using population viability analysis, Roemer (1999) estimated time to extinction at five years for island foxes on San Miguel and 12 years for island foxes on Santa Cruz.

Predation by non-native golden eagles (*Aquila chrysaetos*) is the primary mortality factor now acting upon island foxes on the northern Channel Islands, and is likely responsible for the massive decline of the past five years (Roemer 1999, Roemer et al. 2001). Golden eagle predation was identified as cause of death for 19 of 21 island fox carcasses found

on Santa Cruz Island from 1993 to 1995. On San Miguel Island in 1998-1999, four of eight radiocollared island foxes were killed by golden eagles in a four-month period, and another two died of unknown causes. In 2001, nine of 27 radiocollared island foxes died from golden eagle predation (Dennis et al. 2001; D. Garcelon, Institute for Wildlife Studies, unpubl. data). This level of golden eagle predation is unnatural. Until recently, golden eagles have never bred on the Channel Islands and their recent appearance is due to a prey base, feral pigs (*Sus scrofa*), that was not present prehistorically.

In a recent study to determine distribution and abundance of island foxes on Santa Cruz Island, most foxes were found in the Central Valley and in the Isthmus area (Dennis et al. 2001; D. Garcelon, Institute for Wildlife Studies, unpubl. data). Of the 82 individual foxes trapped during the study, 22 were trapped in the thick fennel stands on the Isthmus, which may provide foxes with more cover from golden eagles than do other habitat types on Santa Cruz Island. Crooks and Van Vuren (1995) found foxes in the isthmus of Santa Cruz Island to prefer fennel grasslands over ravines and patches of scrub oak.

The absence of bald eagles (*Haliaeetus leucocephalus*), which bred historically on the islands and whose presence may have kept golden eagles away, is another contributing factor driving increased golden eagle predation. Moreover, on much of the northern Channel Islands, historic sheep grazing changed the predominant vegetation from shrub to non-native grasslands, which offer much less cover from aerial predators.

Concerned about the potential loss of three subspecies of island foxes from its lands, the Park convened an island fox recovery team in April 1999 to consider the available information and develop strategies to recover island fox populations to viable levels. The team concluded that:

- predation by golden eagles is the primary mortality factor now acting on the population
- disease or parasites may be compounding the effects of predation
- natural recruitment is low
- the most effective conservation measure that could be taken right now is to increase survival of pups, juveniles and adults by reducing or eliminating golden eagle predation

The team recommended that the Park implement the following emergency measures to safeguard island foxes and to recover fox populations on the northern Channel Islands:

- Relocate golden eagles from the northern Channel Islands
- Establish fox sanctuary/captive breeding programs on Santa Rosa and San Miguel Islands
- Eradicate feral pigs
- Reintroduce bald eagles

Upon receiving these recommendations, the Park began taking emergency recovery actions in 1999. In summer 1999 the Park constructed pens on San Miguel and began capture of wild island foxes. By January 2000, 14 island foxes had been captured and placed in the pens. Only four of those were males, and so eight San Miguel Island foxes were paired for breeding purposes. The captive population increased from 14 to 21 animals after two years of reproduction. There is only one fox left in the wild on San Miguel Island. A captive breeding program was initiated for Santa Rosa Island in 2000. The captive population on Santa Rosa increased from 14 to 32 foxes after two years of captive breeding, and there are none left in the wild on that island.

The Park established a cooperative agreement with the Santa Cruz Predatory Bird Research Group (SCPBRG) in 1999 for the purpose of relocating golden eagles from the northern Channel Islands. Personnel from the

SCPBRG began eagle surveys on Santa Cruz Island, the island with the most recent sightings, in late summer 1999. During that time period a helicopter crew working on East Santa Cruz Island noted a large stick nest in a canyon. Biologists from SCPBRG rappelled into the nest and confirmed that it was an active golden eagle nest, the first confirmed nesting by golden eagles on the northern Channel Islands. Among the prey remains found in the nest were two adult island foxes, piglets, and ravens. To date 19 golden eagles have been removed from Santa Cruz Island with NPS and TNC support. Captured birds were released in northeastern California, and satellite telemetry indicates none have attempted to return to the islands. Three golden eagles remained on the island as of January 2002. However, other golden eagles may disperse from the mainland to the islands, and eagle monitoring and removal may be necessary until feral pigs are removed from the island, or bald eagles re-established.

The current status of eagles and foxes on Santa Cruz Island indicates that captive breeding is warranted for that island fox population. To date ten radiocollared 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. .

In March 2001, the Park released to the public a draft recovery plan for island foxes on the northern Channel Islands (Coonan 2001). The recovery plan is in the format of U.S. Fish and Wildlife Service recovery plans, stating the threats to the species, delineating goals, objectives and recovery criteria, and presenting a schedule and cost estimates for recovery actions. Appropriate recovery goals for each of the three island fox subspecies in the northern Channel Islands were set with the assistance of demographic modeling. Population viability analysis was used to identify target population levels that would minimize the chance of extinction. Modeling was then used to set an augmentation (captive breeding and release) schedule that would achieve those targeted goals in a reasonable timeframe.

The island recovery plan calls for a continuation of the emergency actions of island fox captive breeding and golden eagle removal, as well as the separately funded actions of feral pig removal and reintroduction of bald eagles to the northern Channel Islands. Full recovery of the San Miguel subspecies may take as long as a decade, although recovery on Santa Rosa and Santa Cruz may occur sooner. The plan was developed with input from U.S. Fish and Wildlife Service, and is likely to be adopted as part of a FWS recovery plan for the species, should the species be listed.

Bald Eagles

Bald eagles are currently listed as threatened under the Endangered Species Act, but have been proposed for de-listing. They formerly bred on Santa Cruz Island, and on all other Channel Islands, but were extirpated in the mid-20th century due to persecution and effects of DDT and other related compounds (Kiff 1980). Santa Cruz Island regularly supported at least five pairs of bald eagles, which nested in niches and potholes on the sea cliffs. Known nesting areas included Pelican Bay, San Pedro Point, Blue Banks, Valley Anchorage, Chinese Harbor, Potato Harbor, and Middle Grounds. Nearby Anacapa Island had as many as three nesting pairs in some years. Kiff estimates that the northern Channel Islands supported at least 10 nests, and probably more, at any one time.

The NPS is working with other agencies to restore bald eagles to the northern Channel Islands. In 2002, a consortium of agencies will implement a feasibility study for reintroduction of bald eagles, funded by the Montrose Chemical Company contaminant case settlement. Up to 12 bald eagle chicks will be hacked back on Santa Cruz Island annually for three to five years. Released birds and their prey items will be monitored to determine whether a breeding population can be established. The

primary factor limiting reestablishment may be levels of DDE in the environment. Since bald eagles do not mature and breed until four to five years of age, it may be some time before a breeding population is established.

Brown Pelicans

The California subspecies of the brown pelican was classified as endangered under the Federal Endangered Species Act in 1970, and was designated as endangered by the State of California in 1971. On the west coast of North America, pelican breeding colonies are located on West Anacapa Island, on Santa Barbara Island and on islands off the coast of Baja California. Pelicans also breed sporadically on Scorpion Rock off Santa Cruz Island. These colonies almost disappeared in the 1970's, due to egg-shell thinning caused by organochlorine pesticides in the environment (Carter et al. 1992). In 1971, only one chick successfully fledged.

The pelican breeding colonies have subsequently recovered. The number of birds in the breeding colony at West Anacapa Island has steadily increased to between 4,000 and 6,000 annual nesting attempts. This is in sharp contrast to the early 1970's in which there were only about 100 annual nesting attempts. On Santa Barbara Island, the once-ephemeral colony produces 400-700 nests every year. Pelican populations are now primarily affected by availability of their primary prey, northern anchovies (*Engraulis mordax*) (Carter et al. 1992).

Snowy Plovers

The Pacific coast population of the western snowy plover is federally listed as threatened. Western snowy plovers breed from Washington to Baja California, and winter in coastal areas from southern Washington to Central America. Western Snowy plovers breed primarily above the mean high tide line on coastal beaches, dunes, estuaries and lagoons. In southern California, snowy plovers are primarily found on San Miguel, Santa Rosa, and San Nicolas Islands, as well as in San Diego County and on Vandenburg Air Force Base in Santa Barbara County (Baird 1993). Counts of snowy plovers at Channel Islands National Park have declined since 1991. This decline in the park breeding population occurred concurrently with a decline in the breeding population in southern California.

Non-Native Pigs

Feral or domestic pigs (*Sus scrofa*) are an ungulate species not native to North America. Domestic pigs were brought to California by Spanish settlers in 1769 (Barrett 1999) and were introduced to Santa Cruz Island in 1852 (Schuyler 1988). The term "feral pig" refers to a wild pig that comes from domestic genetic stock, such as domestic livestock that escape to survive in the wild, as well as their progeny. By 1857 pigs had escaped and become feral on Santa Cruz Island. Wild pigs now occur in 52 of 58 California counties and are most abundant in forests, oak woodlands and chaparral.

Feral pigs are generalist omnivores with a diet that changes seasonally according to abundance of foods. Mast foods, such as acorns and berries, are important food items in the fall. Winter diets typically comprise roots, bulbs and invertebrates that pigs find by rooting in seasonally moistened soil. As soil dries during spring and summer, pig diets shift to green plants.

Feral pigs have high reproductive potential, and are considered the most prolific ungulate in the U.S. Sows can breed at six or seven months of age, and can produce up to two litters per year with as many as 10 piglets in each litter. Pig populations can more than double annually if not limited by food or water availability. Pig populations respond to changes in food availability and weather. Drought years can cause significant declines in population numbers due to starvation and reduced reproduction, whereas heavy mast crops following winters of high precipitation can allow pig populations to

increase significantly (Baber and Coblentz 1987, Sterner 1990). Pigs generally require access to permanent water, and abundant cover.

Feral Pigs on Santa Cruz Island

Most information about pig distribution and abundance on Santa Cruz Island comes from studies initiated in the 1980's. Feral pigs are found in all locations and habitat types on Santa Cruz Island (Schuyler 1988). As in other areas, they favor oak woodland throughout the year, but especially during the fall when the acorn crop is available. Pig utilization of chaparral and grassland habitat types increases during the winter and spring when grasses and forbs are emerging. Coastal areas are the least utilized, year-round. Ridge tops and higher slopes are utilized primarily during the wetter, cooler months. During the dry months pigs are typically found in canyon bottoms or on middle or lower slopes.

Reasonable pig population estimates for Santa Cruz Island were not available until the 1980's, although it is generally accepted that the removal of feral sheep from the island increased both vegetative cover and the carrying capacity for feral pigs (Baber 1982, Sterner 1990). Annual estimates of the island's pig population have ranged from 1,500 to over 4,000.

As an example of the large population swings that Santa Cruz Island pigs endure, a study by Sterner (1990) estimated the island population at 1261 in 1987, based upon island wide aerial and ground censuses. Because the censuses occurred after drought and hunting-induced mortality, the actual spring-summer pig population was thought to be higher than this. The pig population apparently doubled from 1987 to 1988, due to an increase in mast production, which included scrub oak (*Quercus dumosa*), island manzanita (*Arctostaphylos insularis*) and Catalina cherry (*Prunus ilicifolia lyonii*) (Sterner 1990). An aerial census in 1988 yielded an island pig population estimate of 3,165 ± 1,157. Pig densities were estimated at 15 – 24 pigs per km^2. Average litter size increased from 1.1 piglets per sow in 1987 to 3.2 in 1988.

Santa Cruz Island pig densities were found to be higher than densities reported from mainland sites in California (Sterner 1990). One reason for this may be lack of predators on the island; another is the smaller size of Santa Cruz Island pigs. Sterner (1990) reported that adult pigs on Santa Cruz Island weighed about half as much as mainland pigs.

Sterner (1990) also conducted a radiotelemetry study of feral pigs in the Willows pasture of Santa Cruz Island to determine home ranges and habitat utilization. He found pigs to prefer drainage bottoms, which pigs used as travel corridors, to ridge tops. Pigs selected areas close to cover and water sources. The Willows pasture was sufficiently heterogeneous that pigs did not prefer one habitat type over another.

All pigs were removed from a 4,500 ha exclosure in the Willows Pasture on Santa Cruz Island from 1989-1990, to evaluate the feasibility of eradication (Sterner and Barrett 1991). Pigs later breached the fence and recolonized the area.

Diseases of Feral Pigs

Wild and feral pigs can harbor various diseases, including pseudorabies, hog cholera, brucellosis, vesicular exanthema of swine (also known as San Miguel sea lion virus), trichinosis, and leptospirosis. Most of these diseases have been eradicated, or are highly limited in extent, on the California mainland through extensive inoculation programs. Recent sampling of the population indicates very low incidences of disease, if any, to occur. However, disease sampling can only provide guidance for trends, not comprehensive prevalence for disease within a population. Clearly, the potential for disease within the wild population of pigs is still quite large, especially within the context of high incidences of disease in the past.

Hog cholera is the most destructive and costly swine disease ever to occur in the U.S., but was eradicated by 1978. Hog cholera was introduced into both Santa Cruz and Santa Rosa Island pig populations earlier in the century in an attempt at eradication, but serologic testing of blood from island pigs in 1987 revealed no antibodies to hog cholera in that sample (APHIS 1988).

Pseudorabies virus is a herpes virus that causes pseudorabies infection (also known as Aujesky's disease, mad itch, and infectious bulbar paralysis). Most mammalian species are susceptible to infection, but pigs, which are the only reservoir for the virus, are most susceptible (Vandevelde 1990). The virus does apparently not affect humans. Transmission among pigs is direct, and can be venereal, since the boar sheds the virus in his semen. Transmission among pigs is also density dependent, with more transmission and higher prevalence of the disease at higher pig densities (Timm et al. 1994). Consuming contaminated raw pork can infect other mammals, particularly fur-bearing mammals, dogs, and cats. Pseudorabies is nearly always fatal in dogs. Pseudorabies can become enzootic in some pig populations, with few adverse effects at the population level. Alternatively, pseudorabies can cause up to 100% mortality in suckling pigs (Gustafson 1986, as cited in Timm et al. 1994). Mortality is much less in adult pigs, but effects include anorexia, weight loss and reproductive failure.

Antibodies to pseudorabies virus were detected in pig blood samples from both Santa Cruz and Santa Rosa Islands in the 1980's, prompting the Secretary's Advisory Committee on Foreign Animals and Poultry Diseases to recommend against live removal of pigs from those islands to the mainland (Glosser 1988). On Santa Catalina Island, 25% of 366 pigs tested positive for antibodies to pseudorabies (Timm et al. 1994), with adults having higher seroprevalence than juveniles. Effects of the disease on individuals and the population were not apparent. Seroprevalence (the presence of antibodies) indicates exposure to a disease, but does not necessarily equate to infections.

Brucellosis is a disease caused by bacteria of the genus *Brucella* that can cause reproductive failure in the form of abortions and reproductive organ infections (Davis 1999). The disease is zoonotic, or capable of being transmitted to humans, in whom it can mimic severe flu and may lead to crippling arthritis or meningitis. Animals and humans are exposed to the *Brucella* bacterium by handling or contact with infected placentas, amniotic fluids, vaginal discharges, milk, semen, reproductive tissues, and exudates from infected animals usually just prior to and after an abortion. *Brucella suis* specifically affects pig populations. Other species include *B. canis*, which causes canine brucellosis, and *B. abortus*, which affects large ungulates such as bison and elk. It is not known whether feral pigs on Santa Cruz are infected with brucellosis. Timm et al. (1994) found no antibodies to brucellosis in Santa Catalina Island pig blood samples. In a survey of feral swine in California, 3.8% of 611 pigs were seropositive for brucellosis (Drew et al. 1992), but 90% of those positive animals were from only two counties. Brucellosis is thus locally influential in several pig populations in California.

San Miguel sea lion virus is a calicivirus which, in pigs, results in lesions identical to those produced by vesicular exanthema of swine disease. Antibodies for San Miguel Sea lion virus have been found in serum from both feral pigs and island foxes on Santa Cruz Island (Prato et al. 1974, 1977), and in pigs on Santa Catalina Island (Timm et al. 1994). Vesicular exanthema of swine and San Miguel sea lion virus in foxes may have a marine origin on Santa Cruz Island (Prato et al. 1974, 1977), since pigs and foxes forage at pinniped haul-out sites.

Trichinosis is a zoonotic disease caused by the parasite *Trichinella spiralis* and passed to humans by the consumption of infected, undercooked meat. It is very rare in wild pigs in California, with only a 1% occurrence (Jessup and Swift 1993). It is not known if Santa Cruz

Island pigs have significant infection with *Trichinella*.

Leptospirosis is a zoonotic disease caused by a bacterium, *Leptospira interrogans*. The bacteria are shed in pig urine, and can be transmitted to other animals at watering holes in which pigs have wallowed. The period of active infection is brief and *Leptospira* is only viable in water for a short time (Jessup and Swift 1993). However, antibodies to *Leptospira* are common (83%) in California pigs.

Pig Management in the State of California

The California Fish and Game Commission in 1956 declared wild pigs a game mammal, and since that time pig range, hunter interest and annual kill have expanded (Barrett 1999). With current wild pig numbers in California estimated at 70-80,000, the species is nearly as important a big game species as deer. However, problems with pig depredation exist statewide, and the state of California must balance its management of the pig as a game animal with the need to control pig damage on public and private lands (Updike and Waithman 1996).

Based upon his observation of pig distribution and abundance on Santa Cruz Island, Sterner (1990) stated it was unlikely that sport hunting could control pig populations, unless the annual take was more than 50% of the pig population. Barrett (1999 pers. comm.) later stated that it was likely that 70% of the population would need to be removed on an annual basis to maintain a low and stable number of pigs on the island.

Pig Eradication Efforts

Feral pigs have been successfully eradicated from areas using a variety of methods, including traps, hunting, and hunting with dogs, and with boundary fencing to limit future incursions of pigs (Barrett et al. 1988; Sterner and Barret 1991). These are the primary tools used in the successful eradication campaign underway on neighboring Santa Catalina Island, as well as the model being used in Hawaii Volcanoes National Park.

Native Vegetation

Introduction

The vegetation communities on Santa Cruz Island, like those of the other Channel Islands, developed in relative isolation from the mainland. Although many species on the islands are the same as those found on the mainland, almost 50 are unique to the Channel Islands. These endemic species can be confined to one or more of the islands. Some of these endemic species are believed to have developed on the islands through adaptive radiation (Sauer, 1988). Other Channel island endemic species are remnants from more widespread populations that once occurred on the mainland. Aside from long-term climatic changes these vegetation communities developed in the absence of major disturbance pressures from the end of the Pleistocene (approximately 12,500 years ago) until European settlement of the island in the mid- 1800's. That is not to say however that disturbance pressures were completely absent from the island during this period. Humans have probably been present on the island since approximately 10,000 – 11,500 years ago. The first human inhabitants were probably Native Americans who reached the islands from the mainland. Archeological evidence indicates that sizable human populations were present on all of the larger Channel Islands by about 7000 B.P. There is little doubt that these first inhabitants altered the vegetation on the islands in some fashion. It is likely that they exerted an impact on island vegetation through food-gathering activities. They may have deliberately set fires to encourage certain plants to grow and for easier access through and to certain areas. They may have also cut down trees or shrubs for

shelter, for fuel, and to make baskets. Because these early inhabitants were mobile and likely moved from island to island, and to and from the mainland, they may have also, inadvertently or deliberately, introduced new plants and animals to the islands.

Even with the impacts associated with early Native American habitation of the islands, it probably wasn't until the arrival of European traders around the mid-eighteenth century that the island vegetation became seriously altered. It was during this era that goats, pigs, rabbits, and sheep were variously released on some or all of the islands. Left alone, these animals became feral and the lack of predators on the islands allowed them to quickly reproduce. As their numbers grew, these alien herbivores severely impacted the native vegetation and probably extirpated many plant species, which had developed for thousands of years isolated from grazing. By the 1830's settlers had moved on the islands to farm and raise livestock. Rabbits were released on some of the islands to be followed by cattle and more sheep. These settlers also brought with them non-native plant species, many of which were adapted to the pressures of grazing and consequently thrived at the expense of the native vegetation in the presence of the introduced herbivores.

Santa Cruz Island Vegetation

Sheep were first introduced to Santa Cruz Island around 1850. Their numbers on the island were allowed to grow fairly unchecked with periodic round-ups to shear and slaughter some of the stock. By 1875 there were an estimated 60,000 sheep on the island, only half of which could be rounded up for shearing annually (Sauer, 1988). During drought years tens of thousands were slaughtered to forestall starvation. Attempts at management of the stock continued until 1939 when the Stanton Ranch, who had acquired 90% of SCI in 1937, began a concerted effort to install fencing and to round up all the sheep. By the 1970's over 263,000 sheep had been captured and sent to market or slaughtered (Warren, ca 1954; Santa Cruz Island Company Records). Due to the severe grazing that had occurred, coastal prickly pear (*Opuntia littoralis*), a native cactus and component of island coastal bluff scrub, began to expand. By 1939 the Stanton Ranch estimated that 40% of the rangeland on the island was useless because of dense *O. littoralis* stands. The ranch then enlisted the help of entomologists from the University of California, Riverside and began releasing biological controls to control the Opuntia. Although several insects were released, the most successful was a cochineal scale insect, *Dactylopius opuntiae*, which since 1951 has destroyed most of the dense *Opuntia* populations on the island (Sauer, 1988).

In 1978, The Nature Conservancy secured permanent protection for the Stanton holdings and began a more intensive program of fencing, trapping, and hunting to remove the remaining feral sheep on the Stanton portion of the island. In early 1987 Nature Conservancy became the sole owner and manager of 90% of Santa Cruz Island. In this same year The Nature Conservancy had completed its sheep eradication program. The Nature Conservancy then ceased what had been the Stanton ranching operation and removed all of the cattle from the island. At this juncture, the remaining herbivores on the island were feral pigs and sheep. The feral sheep were, for the most part, confined to the eastern 10% of Santa Cruz Island. In 1997 the National Park Service fully acquired the eastern 10% of Santa Cruz Island (ESCI). ESCI was incorporated into Channel Islands National Park, which began removing the estimated remaining 9,000 sheep within its boundary. The National Park Service concluded an intensive 3-year effort to remove sheep from Santa Cruz Island. This effort has successfully removed approximately 9,270 sheep from the island. At publishing time of this document it is believed that Santa Cruz Island is sheep-free, however, vigilant monitoring for remaining sheep is on-going.

The severe grazing pressure that has occurred on SCI over the past 150 years has

adversely affected most of the island's plant communities by altering their population structure, the natural size and stature of dominant species, as well as species diversity and composition (Hochberg et al., 1980; Sauer, 1988; Van Vuren and Coblentz, 1987). Grazing of selected plant species has reduced the range of many native species (e.g. *Coreopsis gigantea, Hazardia detonsa*, *Lupinus albifrons*, and *Mimulus flemingii*) and increased the range and abundance of other taxa (e.g. *Eremocarpus setigerus*, *Opuntia littoralis*, *O. oricola*, *Senecio flaccidus*) (Junak et al., 1995). The adverse effects of feral sheep and pigs on Santa Cruz Island have been well documented (Hochberg et al., 1980; Van Vuren and Coblentz, 1987). At the east end of the island, adverse impacts to vegetation were noted by Brumbaugh (1980b) by comparing maps drawn in 1856 with aerial photographs taken in 1929. The vegetation on SCI is to a large degree determined by the island's topographic and geologic factors. The underlying geology of SCI is dominated by Santa Cruz Island Volcanics overlain with eroded Pleistocene terrace deposits. ESCI for the most part rises abruptly out of the ocean and its interface with the ocean is dominated by steep cliffs, covered by coastal bluff scrub. Away from the cliffs the topography flattens out and annual grasslands dominate on these coastal terraces. The coastal terraces are beginning to recover from over a century of grazing. These grasslands are currently a complex of native grasses, annual grasses, and re-colonizing shrubs such as coastal sage and chaparral species. As one moves towards the isthmus, which links ESCI with the main portion of Santa Cruz Island, the topography becomes quite steep and patches of island chaparral, oak woodland, and ironwood groves occur. Originating from these steep slopes are riparian drainages which have cut through the coastal terraces as they outlet to the sea. To the west of these steep slopes lies the isthmus. Here most of the bedrock is composed of sandstones, cherts and diatom-rich shales from the Monterey Formation. This material erodes readily into a reddish, clay-like soil (Schoenherr et al. 1999). Island chaparral and oak woodland are the dominant vegetation communities on the isthmus. The rest of SCI is characterized by a large central valley, which cleaves the main part of the island on a diagonal. The valley is actually a fault, the Santa Cruz Island Fault. The valley is bordered by gentle to steep slopes to the north and south. This topography is overlain with a mosaic of plant communities.

Different authors have variously described the vegetation communities on SCI. Philbrick and Haller (1977) noted eight upland plant communities and two wetland vegetation types. Minnich (1980) in turn reduced the island's vegetation communities into six physiognomic categories by combining some categories and discarding others. In contrast, Holland (1986), expanded the island plant communities into 14 different types: southern foredune, southern dune scrub, southern coastal-bluff scrub, Venturan coastal-sage scrub, valley needlegrass grassland, non-native grassland, island chaparral, island-oak woodland, southern Bishop-pine forest, coastal and valley freshwater marsh, freshwater seep, southern coast-live-oak riparian forest, and mule-fat scrub. For the purposes of this document we will use the vegetation as described in, "A Flora of Santa Cruz Island" (Junak et al. 1995) which is based on the Philbrick and Haller (1977) and Holland (1986) classifications. There are 16 vegetation communities described under that Flora, southern beach and dune, valley and foothill grassland, coastal-bluff scrub, coastal-sage scrub, coyote-brush scrub, island chaparral, island woodland, southern coastal oak woodland, Bishop pine forest, intertidal and subtidal marine community, coastal marsh and estuary, freshwater seeps and springs, vernal ponds, riparian herbaceous vegetation, mule-fat scrub, and southern riparian woodland.

Coastal Bluff Scrub

This vegetation community is confined to the steep cliffs that surround much of Santa Cruz Island and on steep canyon walls and outcrops in

the interior (Junak 1995). Due to the inaccessibility of these bluffs this community has remained largely intact and unaffected by the grazing impacts felt on other parts of the island. This plant community has been called a refugium for some plant species. It is thought that many plant taxa now confined to the coastal bluffs will spread out into other areas of the island now that the sheep have been removed. On the north side of the island, plant taxa which are found in this community include: *Artemisia californica, Astragalus miguelensis, Achillea millefolium, Adiantum jordanii, Antirrhinum nutallianum, Coreopsis gigantea, Dudleya greenei, Eriogonum arborescens, Eriogonum grande var. grande, Erigeron glaucus*, and *Hazardia detonsa* among others. On the south side of the island, common coastal bluff species are similar to those on the north side but also include *Salvia mellifera, Encelia californica,* and *Mimulus longiflorus* as well as other plant taxa. There are also two federally listed plant species, *Arabis hoffmanii* and *Malacothrix indecora*, which are presently confined to coastal bluff scrub.

Grassland

This is a widespread plant community and may be the most dominant vegetation type on SCI. Introduced annual grasses are the most common types of plant species within this community, although extensive patches of native perennial bunchgrasses, which are dominant in some areas, do occur. This community can be found on the coastal terraces and all slopes where heavy grazing has occurred. It is believed that the current extent of the annual grassland community has been created and artificially maintained by historic grazing practices and the feral herbivores on the island. Occasionally, solitary native shrubs such as lemonade berry *(Rhus integrifolia*), manzanita (*Arctostaphylos* sp.), and oaks (*Quercus* spp.), and others are found in the middle of these large annual grasslands indicating that native shrub communities may have previously existed there. With the removal of the feral sheep it is expected that these native shrubs will begin to expand and change what is now annual grassland back to other communities such as coastal sage scrub and island chaparral. The more prevalent exotic annual grasses include: *Bromus diandrus, Bromus hordeaceus, Avena fatua, Avena barbata, Lolium multiflorum, Bromus madritensis*, and *Hordeum murinum*. Native forbs and perennial bunchgrasses also occur within this community and these species include: *Bloomeria crocea, Dichelostemma capitatum, Lasthenia californica, Layia platyglossa, Ranunculus californicus, Sisyrinchium bellum, Nassella pulchra, and Hordeum brachyantherum* ssp. *californicum.* Within this community, native plants such as *B.crocea* and *D. capitatum,* which store energy reserves in underground bulbs, tubers, or corms, are often the hardest hit by the feral island pigs.

Island Chaparral

Island chaparral is found throughout SCI, primarily on the north-facing slopes. Although similar to chaparral found on the mainland, there are some differences both structurally and floristically. Structurally, the dominant island chaparral species are taller and more arborescent resulting in a more open woodland appearance. This may be due in part to climatic differences, a lower fire frequency, or the effects of long-term, intensive grazing. Floristically, island chaparral differs from mainland chaparral in that there is a heavy component of endemic manzanitas and oaks. Within the Central Valley and in Islay Canyon this community is dominated by chamise (*Adenostoma fasciculatum* var. *fasciculatum*), Santa Cruz Island manzanita (*Arctostaphylos insularis*), island ceanothus (*Ceanothus arboreus*), toyon (*Heteromeles arbutifolia*), and mountain mahogany (*Cercocarpus betuloides* var. *blancheae*). On the Monterey Shale bedrock of the isthmus, island chaparral is dominated by a prostrate variety of chamise (*Adenostoma fasciculatum* var. *prostratum*), McMinn's manzanita

(*Arctostaphylos viridissima*), toyon (*Heteromeles arbutifolia*), and island scrub oak (*Quercus pacifica*). Island scrub oak can be the dominant plant species within this community and its dense, shrubby form and the abundant acorn production provides an almost perfect haven for the island feral pigs.

Coastal Sage Scrub

The coastal sage scrub community occurs on dry, rocky slopes throughout Santa Cruz Island. It is most common on the south-facing slopes in the central and eastern portions of the Central Valley (Junak et al 1995). Although much of the coastal sage scrub community has been heavily disturbed, some intact areas do occur on the slopes east of Valley Anchorage. In these "intact" areas, nearly impenetrable thickets of shrubs approximately 3-4 ft. tall are found. Dominant species within this community include: *Artemisia californica*, *Castilleja lanata* ssp. *hololeuca*, *Encelia californica*, *Eriogonum arborescens, Rhus integrifolia, Hazardia squarrosa, Opuntia littoralis*, and *Salvia mellifera*. Non-native annual grasses dominate the heavily disturbed areas of coastal sage scrub with occasional coastal sage scrub species scattered throughout. Coastal sage scrub intergrades with grasslands on gentle slopes with deeper soils and with island chaparral on north-facing slopes.

Southern Beach and Dune

Although steep coastal bluffs surround much of the perimeter of the island, a number of sandy beaches do occur especially on its south side. These sandy beaches for the most part are not large enough to form the typical southern dune scrub communities found on the mainland. Plant species found in these "limited" dune communities include sticky-sand verbena (*Abronia maritima*), silver beach-bur (*Ambrosia chamissonis*, sea rocket (*Cakile maritima*), beach evening-primrose (*Camissonia cheiranthifolia* ssp. *cheiranthifolia*), salt grass (*Distichlis spicata*), California saltbush (*Atriplex californica*), and Australian saltbush (*Atriplex semibaccata*). In the more stable dune areas, native plants such as, prostate coastal goldenbush (*Isocoma menziesii* var. *sedoides),* and silver lupine (*Lupinus albifrons* ssp. *douglasii*), also occur.

Riparian

The riparian vegetation on SCI is different than those found on the mainland. Riparian areas in general are the hardest hit vegetation community under intensive grazing regimes and the island riparian zones have been no exception. In many areas the native riparian plant species have been locally extirpated and non-native plants and grasses occupy the riparian zone. Historically, these areas were probably less diverse than comparable communities on the mainland. Mainland riparian dominants such as, white alder (*Alnus rhombifolia*), sycamore (*Plantanus racemosa*), and California bay (*Umbellularia californica*) do not occur on the islands (Junak et al, 1995).

Where the island riparian vegetation still exists it can be divided into two components: herbaceous riparian vegetation and woodland riparian vegetation. Herbaceous riparian vegetation occurs in canyon bottoms where soil moisture is available for most of the year. The more common plant species in this community include: California maidenhair (*Adiantum jordanii*), *Agrostis viridis*, sticky baccharis (*Baccharis douglasii*), mule fat (*Baccharis salicifolia*), toad rush (*Juncus bufonius*), common monkey flower (*Mimulus guttatus*), and cattail (*Typha domingensis)*.

Island riparian woodland can be found along permanent streams, especially on the north side between Cueva Valdez and Canada del Agua at the western end of the isthmus. Although heavily disturbed, Canada del Agua contains native riparian species such as big-leaf maple (*Acer macrophyllum*), stream orchid (*Epipactus*

gigantea), and California bulrush (*Scirpus californicus*). On the south side of the island, riparian woodlands are found in Alamos Canyon and in the Coches Prietos drainage. Santa Cruz Island riparian zones are dominated by black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), coast live oak (*Quercus agrifolia*), and willow (*Salix* spp.). The understory of this community is comprised of species found in the herbaceous riparian community as well as honeysuckle (*Lonicera hispidula* var. *vacillans*), blackberry (*Rubus ursinus*), and giant chain fern (*Woodwardia fimbriata*) in the wetter drainages.

Bishop pine woodland

Bishop pine, which occurs on Santa Cruz and Santa Rosa islands, is patchily distributed along the coast as far north as Humboldt County and down into Baja California. The phenology of this species can be highly variable and there is some controversy as to whether there is only one species, two species, or one species with two varieties or two forms. Some have proposed two varieties of Bishop pine, a northern variety, *Pinus muricata var. borealis*, and a southern variety, *P. muricata var. muricata*. Others have proposed that there be but two forms, *P. muricata forma muricata* and *P. muricata forma remorata*. Junak (1995) recognizes the two forms of *P. muricata*, *forma muricata* and *forma remorata*. Both these forms are present in the Bishop pine woodland on Santa Cruz Island. Large occurrences of Bishop pine are found on north-facing slopes in the upper reaches of Canada Christy, near Pelican Bay, and south of China Harbor. Smaller occurrences of Bishop pine are found in the upper portion of Canada de los Sauces, on Sierra Blanca ridge, and on the south side near China Harbor. Occasional overstory species mixed within the Bishop pine community includes: island ironwood (*Lyonothamnus floribundus ssp. aspleniifolius)*, coast live oak (*Quercus agrifolia*), and island oak (*Q. tomentella*). Understory species include: chamise (*Adenostoma spp.)*, coyote brush (Baccharis spp.) globe lantern (*Calochortus albus*), toyon, mouse ears (*Hypochaeris glabra*), island deerweed (*Lotus dendroideus var. dendroideus*), island monkeyflower (*Mimulus flemingii*), chaparral current (*Ribes malvaceum var. malvaceum*), poison oak (*Toxicodendron diversilobum*), canyon sunflower (*Venegasia carpesioides*), and the rare island barberry (*Berberis pinnata ssp. insularis*).

Island Woodland

This vegetation community can be found on SCI on deep, moist, rocky soils on the north-facing slopes, ravines, and canyons, particularly at the higher elevations (Cheatham and Haller, 1975, Philbrick and Haller 1977). Many of the dominant trees and shrubs in this community are endemic to one or more of the islands. Over-story species can vary from a mixture of island endemics to stands dominated by oak (*Quercus* spp.) or ironwood (*Lyonothamnus floribundus*). Other dominant species include toyon (*Heteromeles arbutifolia*), and island cherry (*Prunus ilicifolia* ssp. *lyonii*). The oak species found in this community are canyon live oak (*Quercus chrysolepis)*, Macdonald's oak (*Q. macdonaldii*) and island oak (*Q. tomentella*). This community intergrades with island chaparral on dry, rocky slopes, and form savannas on the deeper soils of the flats and more gentle slopes. The current extant of the savannas may be an artifact of the island's grazing history. Understory species include bent grass (*Agrostis pallens*), coyote-brush (*Baccharis pilularis*), Galium spp., manroot (*Marah macrocarpus*), island monkeyflower (*Mimulus flemingii*), lemonade berry (*Rhus integrifolia*), death camas (*Zigadenus fremontii*), and California polypody (*Polypodium californicum*).

Southern Coastal Oak Woodland

The dominant species within this community is coast live oak (*Quercus. agrifolia*)

and it occurs on north-facing slopes and shaded canyons in the Central Valley and on the north side of the island. On the slopes, the more common understory species include toyon, wood mint (*Stachys bullata*), creeping snowberry (*Symphoricarpos mollis*), and poison oak (*Toxicodendron diversilobum*). In the canyon bottoms, common understory species include honeysuckle (*Lonicera hispidula* var. *vacillans*), manroot, blackberry (*Rubus ursinus*), milkmaids (*Cardamine californica* var. *californica*), and climbing penstemon (*Keckiella cordifolia*).

Coastal Marsh and Estuary

Coastal salt marshes are restricted to the upper intertidal zone of protected shallow bays, estuaries, and coastal lagoons (Barbour and Major 1977). Santa Cruz Island has small marshes or wetlands at the estuaries of several canyons including Prisoner's Harbor, Canada de los Sauces, Canada de Malva Real, and Scorpion Canyon. The physical condition of these marshes is dominated by the tides and the duration of tidal flooding. At times, the more shallow estuaries may undergo periodic closure - sometimes seasonal or longer - from the ocean inlets (Barbour and Major 1977). The dominant plant species at each of the marshes on SCI can be quite different but one species that seems to be present at all the sites is *Distichlis spicata* or saltgrass (Junak 1995). Other native species that can be found at one or more of the marshes include *Scirpus californicus, Typha domingensis, Salix lasiolepis, Baccharis douglasii, Baccharis salicifolia, Suaeda taxifolia, and Atriplex californica*. Non-native species also occur at one or more of the marshes or wetlands. These include *Atriplex semibaccata, Cotula coronopifolia, Pennisetum clandestinum, Lythrum hysopifolium, Rumex crispus*, and *Hordeum murinum*. The feral sheep that once inhabited the island extensively used some of these marshes or wetlands. Since the removal of the sheep, vegetative cover, duration of flooding, and the depth of standing water has increased dramatically, especially in the estuaries on the south side of the island (Junak 1995).

Vernal Pools

Several vernal pools or ponds can be found scattered on Santa Cruz Island and more specifically at the western end of the isthmus near China Harbor. It is presumed that these vernal pools once supported an assemblage of native flora but because of the intensive grazing history of the island most of the plant species that occur within these pools are weedy non-natives. Species identified by Junak occurring in the vernal ponds near China Harbor include: Australian saltbush (*Atriplex semibaccata*), bindweed (*Convolvulus arvensis*), short-podded mustard (*Hirschfeldia incana*), common plantain (*Plantago major*), curly dock (*Rumex cripus*), common sow thistle (*Sonchus oleraceus*), and annual exotic grasses.

Mule-fat Scrub

According to Junak (1995), this community appears on level, broad floodplains throughout the island. The seasonally flooded alluvial deposits are dominated by *Baccharis salicifolia* with occasional stands of willow (*Salix lasiolepis, S. exigua*) where the water table is high. Associated species include *Astragalus trichopodus* var. *lonchus*, *Calystegia macrostegia* ssp. *macrostegia*, *Ceanothus arboreus, Ceanothus megacarpus* ssp. *insularis*, *Epilobium canum*, *Eriogonum grande* var. *grande*, *Gnaphalium bicolor, Gnaphalium californicum, Lotus dendroideus* var. *dendroideus*, *Lotus grandiflorus* var. *grandiflorus, Rhamnus pirifolia*, and *Rhus integrifolia*. There is concern that *Tamarix ramosissima* has become established in scattered localities within this community. Tamarisk has proven to be an invasive weed along riparian corridors on the mainland.

Coyote-brush Scrub

This vegetation community is widespread on SCI at elevations below 500 ft. It is found primarily on moderate slopes and flats with loam to sandy clay loam soils (Clark et al, 1990). It intergrades with coastal sage scrub on rocky slopes. As with most of the vegetation communities on SCI, this shrubland has been heavily disturbed by grazing. Many species found in the community are weedy non-native plants, particularly the annual grasses. Typical alien plant species include wild oats (*Avena* spp.), rip-gut brome (*Bromus diandrus*), soft-chess (*Bromus hordeaceus*), and black mustard (*Brassica nigra*). Yellow starthistle (*Centaurea solstitialis*) and fennel (*Foeniculum vulgare*), both destructively invasive non-native plants, are found in coyote-brush scrub.

Fennel Dominated Areas

Approximately 1,800 acres on the north side slopes of the isthmus are dominated by fennel. In some areas, fennel cover approaches 100% with little native vegetation present (personal observation). Other areas within the 1800 acres contain a mixture of fennel, annual grasses, and native vegetation. The most common native species in these areas are coyote brush (*B. pilularis*), California sagebrush (*Artemisia californica*), and island buckwheat (*E. grande var. grande*). Other, less common, native plant species in these areas include yarrow (*Achillea millefolium*), green everlasting (*Gnaphalium californicum*), and island paintbrush (*Castilleja lanata ssp. hololeuca*). Fennel cover in these areas ranges from 30 to 60 percent. Interspersed within these areas are moderate to steep sloping drainages where the native plant community is largely intact and fennel cover is low. There are also areas, covering approximately 1,600 acres, within the Central Valley of the island that are dominated by fennel to varying degrees.

Threatened and Endangered Plant Species

Introduction

There are nine plant species federally listed as Threatened or Endangered on Santa Cruz Island: *Dudleya nesiotica, Malacothrix indecora, Malacothamnus fasciculatus ssp. nesioticus, Helianthemum greenei, Galium buxifolium, Thysanocarpus conchuliferus, Arabis hoffmannii, Malacothrix squalida, and Berberis pinnata var. insularis*. The feral pigs on the island variously threaten each of these. The federal listing proposal for these species identified feral pigs as a major cause of decline for each of the plant species. The primary cause of impact to these rare species by feral pigs are rooting, direct feeding, and soil erosion.

Galium buxifolium

Galium buxifolium, or island bedstraw, is a small, woody shrub with separate male and female plants. Individuals can grow to a height of 4-ft. (1.2 m) with numerous branches. The leaves of this taxon are larger than those of most other species in the genus. This helps to distinguish it from the six other *Galium* species found on the Channel Islands.

Island bedstraw is known to occur on both Santa Cruz and San Miguel Islands. On Santa Cruz Island eight occurrences have been identified. In 1980, of these eight occurrences, two had populations of 50 plants or less and the remaining occurrences had less than six plants each (Hochberg et al 1980b). Two occurrences of *G. buxifolium* were discovered on San Miguel Island in 1993. One occurrence contained approximately 200 plants while the other occurrence contained fewer than 10 individuals. These two occurrences were re-located in 1998 and numbered 300 and 121 plants each. There are historical records of five additional occurrences on the island but no plants have

been located at these sites for approximately 30 years.

Island bedstraw grows on bluffs and rocky slopes in coastal sage scrub and island pine forest. Associated species include California sagebrush (*Artemisia californica*), San Miguel Island locoweed (*Astragalus miguelensis*), giant coreopsis (*Coreopsis gigantea*), Greene's dudleya (*Dudleya greenei*), seaside daisy (*Erigeron glaucus*), and red buckwheat (*Eriogonum grande* ssp. *rubescens*). On the steep, rocky, cliffs other associated species include: yarrow (*Achillea millefolium*), San Miguel Island deerweed (Lotus *dendroideus* var. *veatchii*), cliff aster (*Malacothrix saxatilis* var. *implicata*), wild cucumber (*Marah macrocarpa*), and lemonade berry (*Rhus integrifolia*).

Island bedstraw is threatened by soil loss and herbivory from feral pig rooting, and random (stochastic) extinction events due to its limited population size and range (USFWS 2000). The U.S. Fish and Wildlife Service (USFWS) listed this taxon as Endangered in 1997.

Helianthemum greenei

Helianthemum greenei, or island rush-rose, is a small shrub in the Cistaceae family. It can grow up to 18 inches tall and has alternate leaves covered with star-shaped hairs. It is distinguished from the common rush-rose (*H. scoparium*) by the dense reddish, glandular hairs that grow on the flower stalks. Island rush-rose was originally described by Robinson in 1895 and its type locality was a "dry summit near the central part of the island of Santa Cruz" (Abrams 1951).

Island rush-rose has been reported from four islands: San Miguel, Santa Rosa, Santa Cruz, and Santa Catalina. Both McMinn (1951) and Thorne (1967) reported seeing island rush-rose on San Miguel Island, but no collections from the island exist nor are there any known extant occurrences. On Santa Rosa Island, two collections were made from the 1930's but the plant had not been seen on the island since until April 1999 when two plants were found within a recently constructed elk and deer exclosure. In the spring of 2001, two additional occurrences of *H. greenei* were discovered on the northeast side of Santa Rosa Island. These two occurrences were comprised of one and two individuals (personal observation). Two extant occurrences of island rush-rose are also known from Santa Catalina Island (USFWS 2000).

There are 14 occurrences of island rush-rose on Santa Cruz Island. In 1994 and 1995, surveys sponsored by the Biological Resources Division of the USGS re-located all of those occurrences, ten of which had a mean number of nine plants. The remaining 4 occurrences ranged between 500 – 1,000 individuals with a mean number of 663 (McEachern and Wilken, 1996). It was subsequently determined the number of individuals in the latter occurrences was related to recent fires that had occurred on the island. This observation of increased numbers after fires suggests the species is a "fire follower" and that an integral part of its life history is spent as seed stored in the soil between fire episodes. This past spring, 6 additional occurrences of *H. greenei* were discovered on the NPS side of the island. The largest of these occurrences contained approximately 25 individuals. The second largest contained 9 plants and the rest were composed of 1or 2 plants. Island rush-rose grows in open, exposed areas in chaparral, coastal sage scrub, and island pine forest.

Island rush-rose is vulnerable to soil loss and rooting by feral pigs (USFWS 1999). This species was listed as Threatened by the USFWS in 1997.

Dudleya nesiotica

Dudleya nesiotica, or Santa Cruz Island live-forever, was first collected from the west end of Santa Cruz Island in 1950. It is a succulent perennial in the stonecrop family. This plant has a short, thick, underground stem

that is topped at the soil surface with 8-16 narrow leaves in a basal rosette. From this basal rosette, several flowering stems will arise.

Santa Cruz Island dudleya is only known to occur at Fraser Point on the west end of Santa Cruz Island. Within this general area, the plant occupies approximately 32 acres. From 1994-1996, estimates of the population ranged from 30,000 to 60,000 individuals.

Santa Cruz Island dudleya appears confined to the lower marine terraces in coastal scrub and grasslands. Associated species at the western end of the occurrence include California saltbush (*Atriplex californica*), crystalline iceplant (*Mesembryanthemum crystallinum)*, alkali heath (*Frankenia salina*, goldfields (*Lasthenia californica*), and pickleweed (*Salicornia subterminalis*). The eastern end of the occurrence is associated with Australian saltbush (*Atriplex semibaccata*), soft-chess (*Bromus hordeaceus*), goldfields, purple needlegrass (*Nassella pulchra*), and vulpia (*Vulpia myuros*).

Although Santa Cruz Island dudleya is a perennial, its leaves die back to the ground every year during the dry late summer and fall months. The underground corm takes several years to develop. This species is vulnerable to competition from non-native grasses, soil erosion, herbivory by feral pigs, and disturbance by pig rooting. Due to its limited range, this species is also threatened by random (stochastic) extinction events (USFWS 2000). In 1997, this species was listed as Threatened by the USFWS.

Arabis hoffmannii

Arabis hoffmannii, or Hoffman's rock-cress, was first collected from the coastal bluffs east of Platts Harbor on Santa Cruz Island. Hoffmann's rock-cress, a member of the mustard family, is a slender herb that lives for several years, flowers and then dies. This plant can grow to approximately 2 feet high and has one to several stems. This species was originally reported from three of the northern Channel Islands, Anacapa Island, Santa Cruz Island, and Santa Rosa Island.

Surveys conducted in the early 1990's though failed to re-locate the one reported occurrence on Anacapa Island. The original occurrence on Santa Rosa Island has also apparently disappeared but in 1996 a new location was discovered in middle Lobo Canyon. This new occurrence consisted of eight plants, three of which were flowering. Park personnel observed two plants flowering last year. There are three known extant occurrences for Hoffmann's rock-cress on Santa Cruz Island. The occurrence near Platts Harbor is located on rocky volcanic cliffs. Only a few dozen plants have been directly observed at this location. Another occurrence is found near Centinela Grade. When this occurrence was re-located in 1990, approximately 30 individuals were noted to exist at the site. Since that time, annual monitoring has found fewer than 30 plants and the very steep rocky site has been repeatedly rooted by pigs (Junak pers. comm.).

Ex situ studies (Wilken 1996) have shown that individual plants can reproduce within two years following establishment. Individual rosettes of the species are monocarpic, flowering once before dying; however, some plants have more than one rosette of leaves. Pollinators do not appear to be necessary for seed set and individual plants can produce between 3,000 – 4,000 seeds. However, monitoring at two of the SCI sites indicates that successful establishment of new plants is low. This is thought to be due to a lack of favorable seed germination sites, a high rate of seedling mortality, or a combination of both factors (Wilken 1996).

Arabis hoffmannii was listed as Endangered by the USFWS in 1997. Identified threats to this species include soil erosion, loss of shrub canopy cover, trampling and predation caused by feral pig rooting, and competition with non-native annual plants. This taxon is also threatened by stochastic extinction events because of its extremely limited distribution and population size (USFWS 2000).

Berberis pinnata ssp. insularis

Island barberry was first collected from Santa Cruz Island, west of Centinela Grade, in 1932. It is a perennial shrub with spreading stems that can reach 25 feet high. The leaves are large and are divided into five to nine shiny leaflets. The flowers are yellow and develop in clusters at the branch tips.

Island barberry was originally reported from three of the northern Channel Islands, Anacapa Island, Santa Rosa Island, and Santa Cruz Island. On Santa Cruz Island, there are three known occurrences. One occurrence is found on the north slope of Diablo Peak. In 1994 it consisted of 24 large stems and 75 small stems. These numbers may represent one to several clonal individuals. The second occurrence is near Campo Raton. In 1979, there were estimated to be fewer than 10 individuals but a recent survey was only able to find two plants. Both of these were reported by Wilken to be in danger of being uprooted from erosion (USFWS 2000). The third occurrence, at Hazard's Canyon, was reported by Junak to consist of approximately 20 stems, which may all be clonal (USFWS 2000). Both Santa Rosa Island and Anacapa Island were reported to each have one known occurrence of island barberry. Both of these occurrences are now thought to be extirpated.

Island barberry reproduces both sexually and asexually. Although it appears that pollen from the same plant is able to produce fertile seed, pollination by insects may be necessary to ensure seed set. Research by Wilken showed that each flower can produce two to three seeds but only eight out of 40 seedlings survived long enough to produce secondary leaves (USFWS 1999). Island barberry reproduces asexually by sprouting from underground stems. It is for this reason that the appearance of many stems may represent only one genetic individual.

Identified threats to island barberry include soil erosion and habitat alteration caused by feral pig rooting, lack of successful sexual reproduction, and extinction from random disturbance events (USFWS 2000). This species was listed as Endangered by the USFWS in 1997.

Malacothamnus fasciculatus var. nesioticus

M. fasciculatus var. nesioticus, or Santa Cruz Island bushmallow, was first collected from Santa Cruz Island in 1886 and is endemic to the island. It is a small to medium sized semi-woody shrub in the mallow family. This species can grow up to 6 feet tall, and has slender branches covered with star-shaped hairs. The leaves are bi-colored, dark green on the upper surface and gray on the lower surface. The flowers are pale rose colored and are scattered along the ends of the branches.

Currently there are three known occurrences of Santa Cruz Island bushmallow and all are found within chaparral and the remnant coastal sage communities. The number of individuals found within the three occurrences ranges from 19 to 60 plants. However, like island barberry, this species can reproduce asexually and the number of plants counted represent clones from only 3 – 10 genetic individuals. Cuttings grown at the Santa Barbara Botanic Garden have produced hundreds of flowers but have yielded only two to three seeds per plant. On Santa Cruz Island, associated plant species include Island scrub oak (*Quercus pacifica*), California sagebrush (*Artemisia californica*), Santa Cruz Island buckwheat (*Eriogonum arborescens*), toyon (*Heteromeles arbutifolia*), and lemonade berry (*Rhus integrifolia*).

Threats to Santa Cruz Island bushmallow include soil erosion and habitat alteration from feral pig rooting, and extinction from random disturbance events (USFWS 2000). This species was listed as Endangered by the USFWS in 1997.

Malacothrix indecora

Malacothrix indecora, or Santa Cruz Island malacothrix, is a mat-like herb in the sunflower family. The stems grow up to 4 inches tall and are surrounded by numerous fleshy leaves. The flowers are small and are yellowish-green in color.

Santa Cruz Island malacothrix is known to occur on three islands: San Miguel, Santa Rosa, and Santa Cruz. This species was originally collected from Santa Cruz Island in 1886 by Greene. It occurs on the edge of vegetated habitat along coastal bluffs and is often associated with midden soils. Because it is an annual species, the number of individuals can vary widely within an occurrence from year to year. On Santa Cruz Island, near Black Point, an occurrence discovered in 1980 by Steve Junak was observed to have several hundred plants in 1985. In 1989, however, this same occurrence was found to contain only 50 plants. Historically, there have been two to three occurrences recorded from Santa Cruz Island but these are thought to have been extirpated. Presently only one occurrence is known to exist on Santa Cruz Island, near Black Point.

Identified threats to Santa Cruz Island malacothrix include soil erosion and habitat alteration from feral pig rooting, herbivory by feral pigs, trampling by hikers, seabird nesting activity, and extinction from random disturbance events (USFWS 2000). This species was listed as Endangered by the USFWS in 1997.

Malacothrix squalida

Malacothrix squalida, or island malacothrix, was first collected from Santa Cruz Island by Greene in 1886, near Prisoners Harbor. A second collection was made on Santa Cruz Island in 1968, near Potato Harbor. To date the latter occurrence is the only one known to be extant on Santa Cruz Island. However, the plant was also later discovered growing on Middle Anacapa Island in 1963. Additional surveys observed the plant to be confined to several small colonies on top of coastal bluffs at the east-end of Middle Anacapa Island.

Island malacothrix is a small annual plant in the sunflower family. It grows to a height of approximately 12 inches and has basal leaves that can reach 6 inches in length. The flowers are light yellow and are cluster in small hemispheric heads. Through cultivation studies, it is known that this plant is self-pollinating and self-compatible.

Identified threats to *M. squalida* include soil erosion and habitat alteration from feral pig rooting, seabird nesting, and extinction from random disturbance events (USFWS 2000). This plant was listed as Endangered by the USFWS in 1997.

Thysanocarpus conchuliferus

Thysanocarpus conchuliferus, or Santa Cruz Island fringepod, was first collected from Santa Cruz Island in 1886 by Greene and Brandegee. A search of herbarium records identified 14 occurrences on the island. Surveys in 1980 were able to only re-locate 8 of those historical locations. Today the only current extant population is at Portozuela, consisting of only a few individuals. This species is endemic to Santa Cruz Island.

Santa Cruz Island fringepod is a small annual in the mustard family, growing to a height of only 5 inches. There are one to several stems per plant which terminate in a cluster of small pink to lavender flowers. Little is known about this species other than it blooms from March through April and that only one seed is produced per flower.

Identified threats to Santa Cruz Island fringepod are predation, soil erosion, and habitat alteration from feral pig rooting. This species is also threatened with extinction from random disturbance events. In 1997, this plant was listed as Endangered by the USFWS.

Non-Native Vegetation

Introduction

The oldest evidence of human occupation on Santa Cruz Island is 8,900 BP, though evidence from Santa Rosa and San Miguel Islands indicate human presence there are early as 10,000 years BP. The interactions of indigenous peoples with island vegetation included harvesting, habitat disturbance and directed, as well as accidental plant dispersal. They likely made large modifications to the landscape that influenced today's vegetation patterns, by burning, clearing, and cultivation.

The last 150 years have seen an enormous change in the vegetation of the island, in a very short period of time. The most significant factors have been the introduction and proliferation of feral sheep and pigs, cattle grazing, removal of native vegetation cover by these animals, and by the associated ranching and farming activities, and the arrival and spread of aggressive non-native plants.

Extremely high erosion rates have been documented, especially between 1874 and 1920, associated with the introduction of large, non-native grazing animals, particularly sheep. As evidenced by pollen records constructed for nearby Santa Rosa Islands (Cole, 1994), alien plants were arriving and spreading rapidly; presumably they were spreading similarly on Santa Cruz Island, which underwent the same agriculture-related impacts.

Feral pigs have also adversely affected plant communities, especially by trampling and rooting under oak woodland and chaparral canopies. Pig activities have inhibited regeneration of native trees and shrubs, caused destruction of litter and promoted accelerated erosion. The soil disturbance they cause, and the seeds they transport, have facilitated establishment of non-native plants within these communities.

Vulnerability of Islands

Islands and remote peninsulas seem consistently vulnerable to invasion by non-native plants. This may be because they have relatively low numbers of native species, or are missing certain distinctive plant groups, leaving "empty niches" that new arrivals can exploit. It may also be due to having no large native herbivores, so that native plants did not evolve the classic defense mechanisms such as spines, small hard leaves, or foul-tasting chemicals that would have made them unpalatable to the pigs, cattle, sheep and other grazers brought by humans. (Randall 1996)

Current situation on Santa Cruz Island

Santa Cruz Island today has a total of 650 plant taxa; at least 170 of these are introduced. This constitutes about 26% of island's total flora. This figure is at about the median point of the ranges of the proportion of non-native/total flora--20% to 47%--of all the eight California Channel Islands, is slightly lower than the average rate for the northern islands, and is notably lower than the average for the southern islands. Eleven of Santa Cruz Island's 88 plant families and 82 of its 348 plant genera are represented exclusively by non-native taxa.

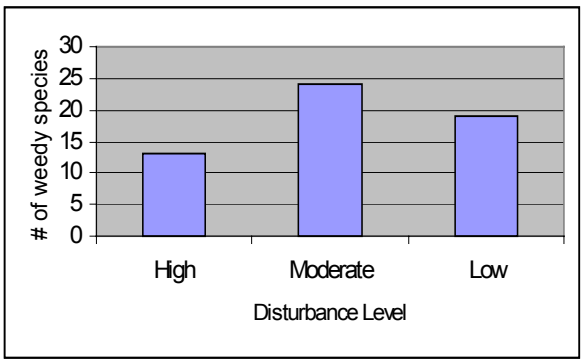
Santa Cruz Island is subject to the continual risk of colonization and re-colonization by non-native plants, because of transport of materials and vehicles to the island, travel to the island by residents and visitors, and natural processes of transport of seeds of non-native plants from the mainland to the islands. Non-native plants tend to be able to capitalize on disturbance to native vegetation, such as fire or grazing animals, to gain a foothold in a new area. Santa Cruz Island is particularly vulnerable to this because of the lack of adaptation by native plants to herbivory.

In general, worldwide, it has been observed that many decades often pass between the first introduction of a plant and its apparently sudden rapid spread. It is presumed that during this

period, seedbanks are developing, seeds are being dispersed, and the species is adapting to local conditions. Many of the species of non-native plants that occur on Santa Cruz Island, as well as on the California mainland, appear to be approaching the end of this 'lag phase', as evidenced by increasing abundance, ranges, and types of habitats invaded, and in the rate of increase of these attributes. Notable among these plants are smilo grass (*Piptatherum milliaceum)*, fennel (*Foeniculum vulgare)*, and tree tobacco (*Nicotiana glauca)*. We expect that many of the island's alien species are poised for this rapid expansion phase, making it even more critical to limit the disturbances that facilitate weed spread.

Alien plants of Santa Cruz Island, like any land management area, can be organized into functional groups, related by elements of their life histories such as physical stature, structure, seed longevity, dispersal mechanisms, type and amount of storage tissues, their relationships to current and previous land uses and past and ongoing disturbances. Distributions and abundance of at least 56 of the approximately 170 alien plants occurring on SCI are particularly dependent on the disturbance caused by the island's feral pigs (Figure 4). Some of the factors affecting this relationship are life history of the species, plants individual size and structure, the species' population patterns and persistence, seed longevity and dormancy mechanisms, and seedbank capability.

Figure 4. Weed species correlated to disturbance level



Fennel

History

Sweet fennel (*Foeniculum vulgare* Mill.) was present in California for over 100 years before it became an aggressive invader (Greene 1887, Jepson 1925, Hickman 1993). Within the last ten years fennel has successfully invaded grassland and coastal sage communities throughout California, displacing the native flora and reducing biodiversity by producing thick monospecific stands (Beatty 1991, Beatty and Licari 1992). In 1996 *Foeniculum vulgare* was placed on the CALEPPC (California Exotic Plant Pest Council) list of California's exotic plant species of greatest ecological concern (Anderson et al. 1996).

Fennel was introduced on Santa Cruz Island in the late 1800's (Greene 1887). Vectors for fennel dispersal during 19th and most of the 20th centuries were likely in the hoofs, fur and feces of cattle (*Bos taurus*) and feral sheep (*Ovis aries*), and along roadside passages (Beatty and Licari 1992, Brenton and Klinger *in press*). Although the grazers dispersed fennel, they also controlled fennel by consuming the plants that germinated and grew in the grasslands and disturbed communities (Brenton and Klinger 1994).

The removal of cattle and feral sheep from The Nature Conservancy portion of the island in the 1980's left Santa Cruz Island with a highly disturbed and vegetation free landscape- the perfect landscape for fennel invasion. Fennel was able to take advantage of this open disturbed space. With the end of a 4-year drought following the removal of grazers, prolific fennel growth occurred across Santa Cruz Island. Fennel spread throughout the Central Valley and into the upper grasslands and coastal sage communities displacing native species (Crooks and Soulé 1999). Fennel's ability to grow and reproduce during the hot and dry Mediterranean summers also increased the spread of fennel (Brenton and Klinger 1994). Fennel spread in many of the previous pasture

areas, and has spread via roadways and feral pigs throughout Santa Cruz Island, producing monoculture thickets with over 90% fennel cover (Klinger 1998, Erskine unpublished data). Currently, a large scale, model fennel management program is underway in Santa Cruz Island's Central Valley. The fennel management proposal for the isthmus of Santa Cruz Island follows the Central Valley management protocol.

Biology

Fennel is a perennial herb that can grow 1-3m tall. It is a dicot species in the Apiaceae family (carrot or parsley family). Economic Apiaceae plants include, among others, dill (*Anethum spp.*), celery (*Apium spp.*), and English-ivy (*Hedera spp.*). Other weedy species in the Apiaceae family, originally introduced as cultivated species include wild caraway (*Carum carvi*), and wild carrot (*Daucus carota*). Two well-known toxic weeds in Family Apiaceae are western water hemlock (*Cicuta douglasii*) and poison hemlock (*Conium maculatum*) (Whitson et. al. 1996, Zomlefer 1994).

Fennel produces a taproot that can range from 0.9-3m in length. It is native to southern Europe, escaped from cultivation in California, and is now a widespread weed. The photosynthetic stems are erect and branched with multiple stems produced from a single crown. The stems are pithy and become hollow as the season progresses.

Fennel reproduces sexually and is a primarily outcrossing species. Pollination occurs predominately via insects. Flower production begins as early as late May and continues through October (Erskine personal observation). Wind is not considered an important pollination device. Flowers are strongly protandrous, and bloom initially in the primary umbels, followed by secondary, then tertiary umbels (Koul *et. al.* 1993). Umbels are large and conspicuous to facilitate insect attraction. Sepals are absent and petals are yellow. Common pollinators of fennel include flies, bees, wasps and beetles. Tens of thousands of seeds can be produced on an individual fennel plant. The two seeds produced per ovary often fall together as one schizocarp (Munz 1986, Zomlefer 1994). Seed dispersal occurs when schizocarps fall off maternal plants to the ground, via water in riparian communities, via animals, anthropogenically (vehicles, shoes, and machinery), and animal dispersal. Some seeds can remain within the umbel over winter, and these seeds are viable the next spring.

Anecdotal evidence suggests a long-lasting seedbank (at least 5-7 years of viability) for fennel, yet there is no quantitative evidence of such a seedbank. Seeds do not require a chilling period or any type of scarification to germinate, although they do appear to need light for germination and growth. Optimal germination temperature ranges between 20ºC and 23ºC and germination primarily occurs within 5-7 days at these temperatures (Erskine unpublished data). With this fast germination time, fennel is able to germinate in early spring and throughout the spring (if rains continue) on Santa Cruz Island. Germination rate after one year of cold storage ranged from 60-85%, at temperatures between 16ºC and 25ºC. (A large portion of the seeds that did not germinate in this study were killed by fungi (Erskine unpublished data)). If the cold storage results are applicable to the field, these results indicate that those seeds that do not germinate the first year from the seedbank have a high probability of germinating the second year, even if the mother plants are removed. For this reason, a single year of treatment would never eradicate fennel.

Fennel possesses many phenotypic traits characteristic of weedy species: rapid growth rate, large seed rain, no specialized germination requirements and short juvenile period (Baker 1965, Erskine personal observation). Fennel also has the ability to reproduce asexually from the crown of the root system.

Fennel possesses biological characteristics that make it a good invader in California, and particularly on Santa Cruz Island. Fennel produces a large taproot to obtain water during

the dry Mediterranean summers, when most other herbaceous species have already set seed and died, and many perennials are dormant. By late June, flower production is in progress, and leaves begin to fall off the stems. Photosynthesis continues through the green, stomatic stems. Erect stems receive less direct light and transpire less than leaves, and therefore decrease summer stress such as high temperatures and water loss, to the plants.

Fennel is known to invade grasslands, coastal sage scrub, savannas, riparian communities, roadsides and most other disturbed communities, all of which are found on Santa Cruz Island. Fennel has the ability to tolerate soil pH values ranging from 4.8-8.3, precipitation between 30cm and 260cm annually, and temperatures between 0ºC and 27ºC (Simon 1984, Erskine personal observation). Fennel proliferates on well-drained loamy soils (Colvin and Gliessman 2000), but can also invade extremely eroded soils, cliff edges and south-facing slopes (Erskine personal observation). The ability to invade a wide variety of communities, and to tolerate extreme heat, dry, and freezing conditions, has allowed fennel to invade many plant communities on Santa Cruz Island. The only communities fennel has not invaded on Santa Cruz Island are those communities with heavy cover.

Fennel appears to need full sunlight to grow, and the seeds cannot germinate in communities with thick canopies. Although fennel seedlings can be found below fennel plants and within Mediterranean annual grass communities, these communities are usually patchy and allow enough sunlight for germination. Fennel seedlings are not generally found in such closed canopy communities as chaparral, oak woodlands and pine stands in the absence of large-scale disturbance (i.e. pig rooting or burning).

Disturbance and Fennel

Fire removes above-ground plant biomass producing open space and canopy gaps that allow for fennel seeds to germinate. Fire alone appears to promote fennel proliferation, but there are no quantifying data to suggest a mechanism for this improved invasion ability other than the increase in sunlight and soil temperatures, conditions that promote fennel seeds germination. In areas of high pig density, and large areas where pigs root, fennel seedlings can be found, as well as newly established adult fennel plants. As with fire, the anthropogenic and pig caused disturbances allow fennel seeds to receive more light, and therefore to germinate and thrive. Feral pigs, vehicles, humans, and machinery are vectors for fennel invasion through the disturbances they cause, and the transport of seeds.

Fennel covers approximately 10% of Santa Cruz Island (Klinger unpublished data), and is currently spreading along roadsides into many coastal sage, grassland and bare/disturbed sites. Although there appears to be distinctly separate large stands of fennel across the island, roads and pig trails are obvious corridors of invasion connecting these fennel populations.

Eradicating feral pigs from Santa Cruz Island would remove this major vector for dispersal and establishment of fennel, this, in turn, would facilitate fennel control throughout the island.

Cultural Resources

Historical Overview

Largest of the Channel Islands and containing a varied and complex series of plant communities, Santa Cruz Island seems to have supported a large human population during most of prehistory. Eleven historic villages are

known for Santa Cruz Island, equal to the total number recognized for both Santa Rosa and San Miguel Islands. Earlier sites, ranging in size from only a few meters square to extensive shell mounds covering hundreds of square meters are found along the coastline and within the interior at advantageous locations. Some of these mounds contain distinctive layers of red abalone shell, indicative of occupation about 5000 to 8000 years ago. In addition to shell mounds, prehistoric sites include chert quarries and workshop sites, rock shelters, and rock pavements ethnographically identified as shrines. Some of the rock shelters contain rock art of a simple style quite distinct from that known on the mainland. Formal cemeteries are found close to many villages, especially later sites, and isolated, seemingly random, human burials are recorded for the island as well. The potential number of burials ranges into the tens of thousands.

This rich complex of sites constitutes the remains of more than 8,000 years of occupation, development, and flowering of the group known as the Chumash, the inhabitants of the northern Channel Islands and the Southern California area from San Luis Obispo to Malibu. Recent research shows occupation 8,900 years ago, and the potential for even older material exists on the island. Like Santa Rosa and San Miguel Islands, deposits on the west end containing pygmy mammoth remains could also contain evidence of older human occupation.

Although Chumash occupation of Santa Cruz Island ended in the early nineteenth century, many individuals who trace their ancestry to specific villages retain a lively interest in the preservation and management of their heritage. Between three and ten thousand Chumash live in California today.

The European presence in the Channel Islands began with Juan Rodriguez Cabrillo's explorations in 1542, followed by the subsequent expeditions of Sebastian Vizcaino in 1602 and George Vancouver in 1769. While sea otter hunters, smugglers, and others visited the islands and left their traces during the historic period, permanent European settlement did not occur on the islands until the mid-1800s.

The Chumash population left Santa Cruz Island by the 1830s, settling primarily in and around the Spanish Missions in Santa Barbara and San Buenaventura. In 1839, the Mexican government granted title to the island to Andres Castillero, who became the first private owner of Santa Cruz Island. In 1853, Dr. James Barron Shaw, acting as agent for Castillero and the island's subsequent owners, the Barron and Forbes Company, began stocking the island with sheep, horses, cattle and hogs. Shaw managed the island rancho until 1869, developing several ranch outposts and the infrastructure that linked them. In 1869, ten San Francisco investors purchased the island and formed the Santa Cruz Island Company. Justinian Caire, a Frenchman and one of the ten investors, acquired the majority of the shares in the Santa Cruz Island Company during an economic downturn in the 1870s and became sole owner of the island by the end of the 1880s or early 1890s. Caire and his descendants continued and expanded the sheep ranching and agricultural enterprises on the island.

The heart of Shaw's and, later, Caire's operation was located in the island's central valley. The main ranch included a residence, bunkhouses for winemakers, shepherds and vaqueros, barns, winery buildings, a dining hall, bakery, laundry, kitchen, shops for wagon makers, blacksmiths and tool and saddle makers, and a chapel. Substantial acreage was planted in grapevines, hay and fruit trees.

Caire's island workforce consisted primarily of French, Italian, Hispanic and Native American workers, reflecting Caire's French origins, his wife's Italian heritage, and the local population. The island operation was a largely self-sustaining community that supported a diversity of permanent and seasonal employees, which included a blacksmith, carpenters, painters, team drivers, dairymen, cooks, stone cutters and masons, gardeners, dairymen, vintners, grape pickers, sheep shearers, wagon

and saddle makers, a cobbler, a butcher, a baker, and a sea captain and sailors.

The island ranching system developed by Shaw included the main ranch and satellite ranches at the east and west ends of the island and at La Playa (Prisoners Harbor). Caire continued to use these ranches, and established additional ranches and camps at other locations on the island. The main ranch and the outranches at Scorpion, Prisoners and Christy remained the primary ranches through the Justinian Caire period. The island's sheep population reached 40,000-50,000 head under Caire, their wool and meat being shipped to market from Scorpion Ranch and Prisoners Harbor. When Caire died in 1897, an unequal distribution of his estate among his heirs led to a prolonged period of litigation. Ultimately, the dispute was settled by a court-ordered partition of the island in 1925, which divided the island into parcels, with the western 90 percent (54,500 acres) of the island going to Caire's widow and four of their children, and the eastern 10 percent (6,000 acres) going to the two married Caire daughters. The Caire family maintained the western portion of the island until 1937, when they sold their land to Los Angeles businessman Edwin L. Stanton. Stanton attempted unsuccessfully to revive the island's sheep business, which had declined dramatically after Justinian Caire's death, and then switched to cattle ranching. Edwin Stanton's son and heir, Carey Stanton, continued the cattle ranching operations after his father's death in 1963. In 1978, the Nature Conservancy secured permanent protection of the property from Stanton, and full control of the property upon Stanton's death, which was in 1987.

The east end of the island remained in the hands of the Caire descendants, consolidated under the ownership of Ambrose and Maria Gherini. They continued the sheep ranching operation, with headquarters at Scorpion Ranch and Smuggler's Cove, the two east end satellite ranches. The ranch operations were overseen by a series of superintendents and caretakers until the island was converted to a private hunting, camping and recreational venture in the early 1980s. The National Park Service acquired full ownership of the east-end of the island in 1997.

Cultural Resources

Santa Cruz Island contains thousands of relatively intact archeological sites filled with rich research opportunities, especially for investigations into human adaptation and development in a context of changing environments and cultural conditions.

More than 630 archeological sites have been recorded on Santa Cruz Island, with intensive survey having covered only perhaps 20% of the island. The entire island probably contains about 3000 archeological sites.

Sites on Santa Cruz Island are receiving increasing attention from archeologists because of the relatively long and undisturbed record remaining on the island. Santa Cruz Island archeological sites remain relatively undisturbed because of the lack of intensive development and the absence of burrowing animals, such as gophers and squirrels, on the island. In contrast to the mainland, where development and burrowing have seriously impacted archeologists' ability to understand the Chumash past, the sites on the island and their relatively natural context constitute the best materials for understanding the past of the Chumash. Feral pigs and their destructive rooting threaten to destroy the record of this rich past.

The island's archeological resources were listed on the National Register in 1978 as the Santa Cruz Island Archeological District. The district encompasses only the western 90 percent of the island because of the division of ownership at the time of nomination and listing. The previous owners of East Santa Cruz Island did not choose to include their holdings within the District. There is no question that the archeology of the eastern portion of the island is at least as significant as the present archeological district, particularly since it contains most of the chert quarries exploited in

the past. The National Park Service is managing the archeological resources on the east end of the island as a property eligible for the National Register until such time as the existing nomination can be amended to add the east end acreage and resources.

In addition to the Chumash record, there is extensive historic archeology centered on the island locations where ranches developed, as well as on the numerous coastal fishing and recreational camps, which flourished around the turn of the 20th century. There are remnants of oil exploration on the island, at least one abandoned World War II military encampment, and the remains of shipwrecks can be found on the beaches and intertidal zone and in the waters surrounding the island.

The ranching and agricultural resources form a historic period cultural landscape over much of the island. The main ranch in the Central Valley is the largest and most significant of the ranch complexes. Most of the earliest buildings constructed under Shaw's superintendence were of adobe or wood, and most have disappeared. During the Caire era, much of the permanent construction was of stone masonry or brick. The design of the buildings with their whitewashed stucco surfaces, large corner quoins and cobble walkways exhibit the Mediterranean heritage of their owners. All of the construction materials except lumber were gleaned from the island; brick was produced in on-island kilns. Corrals and fencelines define the ranching-era work areas, fields and pastures. Furrow lines from the grapevine plantings can still be seen on many of the slopes that were cultivated for wine production.

In addition to the main ranch, significant building complexes remain at Prisoners' Harbor, Scorpion Ranch, Smuggler's Cove and Christy Ranch. Although all of these ranches except Smuggler's Cove were established during Shaw's management of the island, most of the remaining buildings date to the Caire period. The design and construction of the primary buildings on the outranches are similar to that of the main ranch, though they contain fewer buildings and landscape features.

Ranches and outposts once stood at Rancho Punta West, Rancho Nuevo, Buena Vista, Portezuela and Rancho Sur. Their locations are marked now by foundations, plantings and remnants of structures. Stone foundations of barns are found in a number of locations on the east end. A Stanton-period ranch was built at Del Norte in 1952-53. Its frame house and corrals have been maintained by the Santa Cruz Island Foundation.

Most of the island's road system dates to the Caire development period, although the Ridge Road or "Camino Viejo" predated Caire. The central valley roads lined with eucalyptus trees form grand avenues near the main ranch. The Scorpion Valley road supported by an immense dry stone retaining wall illustrates the challenges that the nineteenth-century ranchers faced in developing this difficult terrain. The Stanton family developed many dirt ranch roads in the 1940s through 1960s, especially on the isthmus, and the Navy improved the road from Prisoners' Harbor to the Navy base in 1950.

Dry stone structures, built in the late 1800s by Italian masons and laborers, are found throughout the island. Structures include stone-lined wells, rock retaining walls along stream channels and roads, and more than 200 check dams on the east end alone, built to control water flow and slow erosion. Large rock piles dot the east end of the island, these were created when the fields were cleared for cultivation.

Plantings of eucalyptus, Monterey cypress, pepper tree and other ornamental species are found at the ranch sites and elsewhere on the island, dating primarily to the Caire era. A large olive grove survives at Smuggler's Cove. Orchards and plantings of fruit and nut species are located at the main ranch and many of the outranches. A few rare examples of grape plantings remain in the Central Valley.

Fencelines throughout the island delineate pastures. Remnants of the sheep ranching operations include corrals, watering troughs and

other features. While the nineteenth-century fencelines and features on the eastern end of the island remain relatively unchanged since their construction, the ones on the western part of the island were altered about 50 years ago to accommodate Stanton's cattle operations.

The ranch complexes and cultural landscape features are considered significant under several National Register criteria although they have not yet been evaluated or nominated to the National Register of Historic Places. The long period of ranching and agricultural development has resulted in a pastoral landscape that reflects the island's management by Shaw, Caire and Stanton and which retains a great deal of historic integrity. The island itself may be considered a significant rural historic landscape, or palimpsest of historic landscapes.

Ethnographic Resources

Ethnography is concerned with the peoples associated with parks, with their cultural systems or ways of life, and with the related technology, sites, structures, other material features, and natural resources. Certain contemporary Native American and other communities are permitted by law, regulation, or policy to pursue customary religious, subsistence, and other cultural uses of park resources with which they are traditionally associated. Such continuing use is often essential to the survival of family, community, or regional cultural systems, including patterns of belief and economic and religious life.

Ethnographic resources are locales and sites, structures, objects and rural and urban landscapes assigned cultural significance by traditional users. Traditional users may assign significance to places closely linked with their own sense of purpose, existence as a community and development as ethnically distinctive peoples. To be considered traditional, associations with park resources will usually have endured at least two generations.

Channel Islands National Park has completed a study tracing the lineal descendants Chumash peoples who inhabited the northern Channel Islands, and has identified living descendents of the Santa Cruz Island Chumash. The park has not undertaken a formal ethnographic study to identify other groups with traditional ties to the island. However, the former island owners, including the Caire and Gherini families, whose forebears developed the island beginning in the 1870s, regularly visit the island and work closely with the park and The Nature Conservancy. Members of the Gherini family retain the right of use and occupancy of parcels on East Santa Cruz Island until 2012.

Anthropological sources and members of the local Chumash community clearly identify the Channel Islands as significant to the Chumash culture as their ancestral homeland. The park has facilitated the reburial of exposed human remains on the islands by members of the Chumash community, in accordance with the Native American Graves Protection and Repatriation Act (NAGPRA). The island itself, as well as the archeological sites and burials associated with Chumash occupation of the island, can thus be considered ethnographic resources. Other sites, locales and/or landscapes significant to island descendants and the local Chumash community have not been identified, but may exist.

In the 1970s the Chumash Maritime Association sponsored an inter-island *tomol* (traditional plank canoe) crossing and in 2001 a channel crossing from the mainland to Santa Cruz Island. Attendant celebrations marked these events, with the 2001 event attracting about 200 Chumash to the island. The park has not received any other requests for permits to hold ceremonies on the island or to collect traditional natural resources during the park's management of the island, nor is the park aware of any informal use of Santa Cruz Island for ceremonial or spiritual purposes.

Descendants of the Caire and Gherini families visit the island on a somewhat frequent basis. Gherini family members visit the east end

of the island, where they have use and occupancy rights, approximately 10 times per year, staying at the Scorpion ranch and visiting Smugglers ranch. Caire descendants visit the Main Ranch on The Nature Conservancy property perhaps 2-3 times per year for brief stays. The historic ranch complexes, ranch equipment and ranch landscapes are valued by these families and by many who worked for them on the island as part of their family heritage.

Human Uses and Values

Socioeconomic

Although all of Santa Cruz Island is within the boundaries of Channel Islands National Park, The Nature Conservancy owns the bulk of Santa Cruz Island. The National Park Service currently owns the eastern 24% of the island, while TNC owns the remaining 76%. In August of 2000 TNC completed a gift of 8,500 acres of property to NPS, increasing NPS holdings from 10% to 24%. The conveyance includes lands on the isthmus of Santa Cruz Island. The gift will allow NPS and visitors better access to SCI via Prisoners Harbor, and is intended to facilitate cooperation between NPS and TNC.

Use of the island is very different on lands owned by NPS and lands owned by TNC. In general, Santa Cruz Island lands owned by NPS are fully open to visitor access and use, whereas on TNC public access is limited. TNC does allow private boaters to secure landing permits. Permit holders can land in any anchorage and day hike to anywhere but the Main Ranch. However, they are not permitted to camp on TNC land. TNC licenses Island Packers to conduct public education trips to a variety of locations on the island.

Eastern Santa Cruz Island has been fully open to visitor use since 1997, and has become the most popular visitor destination in the park. The number of visitors to East Santa Cruz Island has increased since the Park completed acquisition of the east end in 1997. The Island Packers Company, as concessionaire, provides boat transportation to Santa Cruz Island, landing visitors at Scorpion Bay on a nearly daily basis. It also provides scheduled trips to several parts of TNC's lands. A campground has been established in Scorpion Valley and is very popular, with use heaviest on weekends and filled to capacity on holiday weekends. Visitor activities on east Santa Cruz include hiking, beach-going, kayaking, and snorkeling. Private boaters also visit east Santa Cruz Island. A popular hike is across east Santa Cruz from Scorpion Valley to Smuggler's Harbor and return.

The conveyance of lands on the isthmus to NPS would bring about changes in land use on that portion (8,500 acres) of the island. Prisoners' Harbor would become the main access point for visitors to the isthmus. The dock at Prisoners Harbor is currently being reconstructed. The NPS will reopen the dock in summer of 2002. Visitor services on the isthmus would be limited at first. Full development of visitor services would not be implemented until a planning effort is completed. Until that time, visitor services would likely be limited to restroom facilities at Prisoners Harbor, and two small backcountry campgrounds near Del Norte, and near Chinese Harbor. The latter facility would allow backpackers to hike from Prisoners Harbor across High Mount to Scorpion Valley.

The other visitor activity currently available for visitors to the isthmus is a reservations-only hike to Pelican Bay. TNC currently allows Island Packers Company to lead visitors on organized hikes to Pelican Bay and return. The Bay is accessible only via TNC-owned lands, and would remain so now that the land conveyance is complete. Additionally, TNC operates a landing permit program that allows private boaters to land at any of the anchorages and day hike in the vicinity.

Scientific research and teaching are the primary uses of TNC lands on Santa Cruz Island. The University of California has operated a field station on Santa Cruz Island since 1966. Santa Cruz Island Reserve is part of the University of California Natural Reserve System. Many researchers carry out projects on Santa Cruz Island through the UC Reserve annually.

Table 7. Number of Visitors on East Santa Cruz Island, 1996-1999.

	1996	1997	1998	1999
Recreational Day visitors on boats	19,870	63,851	50,020	55,818
Recreational Visitors ashore	8,423	13,581	16,395	18,236
Recreational Overnight visitors on boats	8,006	13,471	14,543	12,971
Campers	1,990	5,675	7,413	15,442
TOTAL	**40,285**	**98,575**	**90,369**	**102,467**

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 analaysis. 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 shub 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 an Coblentz 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 dapauperate 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 Nińa 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 Nińo was a somewhat of a mixed blessing. While the regeneration of tree and shrub species in the lowland area increased following an El Nińo 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 phenomenom 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
Arabis hoffmanii	Hoffman's rock cress
Berberis pinnata ssp. Insularis	Island barberry
Dudleya nesiotica	Santa Cruz Island dudleya
Galium buxifolium	Island bedstraw
Helianthemum greenei	Island rush-rose
Malacothamnus fasciculatus ssp. nesioticus	Santa Cruz Island bushmallow
Malocothrix indecora	Island malacothrix
Malacothrix squalida	Santa Cruz Island malacothrix
Thysanocarpus conchuliferus	Santa Cruz Island fringepod

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 anchoraged 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 Gliesman (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 intensitvy 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 chapparral 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 (*Artemesia 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 *Arctostaphlos sp.* (manzanita) and *Adenostoma fascilulatum* (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 gullying 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 to 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 *Artemesia 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 pinnnata* ssp. *insularis* and *Malacothamnus fasciculatu*s 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 endangerd 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 (*Dudlyea 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.

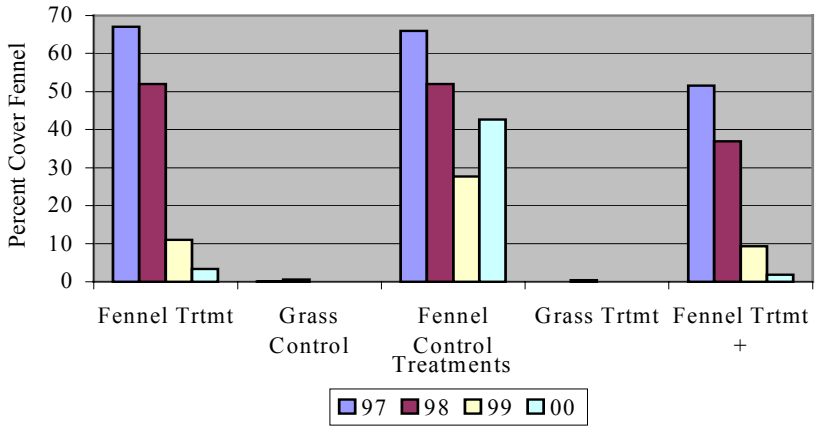
Effects of Implementing Fennel Control

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

Figure 5. The effect of an autumn burn ('98) and two subsequent spring sprays (1999and 2000) with Garlon 3A; Central Valley – Santa Cruz Island



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 harrassment, 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 CO_2 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 N_2 and SO_2 gas. Fire increases extractable P and the rate of

nitrification. Fire decreases organic P, phosphotase 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 N_2O, and the increased availability of NH_4^+ and NO_3^- (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 25ºC (Ahrens1994). 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 (Ahrens1994). Studies have found that, in general, triclopyr does not tend to move below the top 15 cm of soil in signficant 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 (aggredation 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 anchoraged 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 drank 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) conclued 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:

Triethyamine (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, vomitting 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 (*Pimephales promelas)*	LC50 11130 mg/l/96h
Freshwater Crustacean *(Daphnia magna)*	LC50 9500 mb/1/24h

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 fringepod (*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 breeching 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 anchoraged 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 uninfected 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 to 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 descendents 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

VisitorExperience

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	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. 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.	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.	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.	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 if fully within the control of NPS or TNC.

	Alternative One	Alternative Two	Alternative Three	Alternative Four
NATIVE PLANT COMMUNITIES	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.	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.	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.	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.
T & E PLANT SPECIES	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.	One listed plant species, *Galium buxifolium*, occurs on the isthmus where the dense fennel occurs. However, the *Galium* does not co-occur with the fennel. No burning or herbicide is planned for the coastal bluff habitat inhabited by the *Galium* and no effect is anticipated. The nine listed plant species and numerous rare plants should all benefit from the eradication of feral pigs.	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.	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.

	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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SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

CHAPTER FIVE

CONSULTATION AND COORDINATION

Coordination

Public Law 96-199, the act that created Channel Islands National Park, allows for federal funds to be used for cooperative resource management on lands owned by The Nature Conservancy within the boundaries of Channel Islands National Park. Cooperative management between the Park and TNC is essential for many resource issues that cannot be contained within ownership boundaries. Such issues include management of weeds, terrestrial resources (especially Santa Cruz Island Fox management), and feral animals.

As discussed in Chapter One, eradicating the feral pig population on Santa Cruz Island is the top priority for the NPS/TNC cooperative resource management effort. The Park has included TNC as a full partner in the development of strategies to eliminate pigs from Santa Cruz Island. Under TNC management, attempts at pig control, and research into feral pig impacts have been ongoing for 20 years. This experience has made them uniquely qualified to provide expertise into the development of this project.

As a federal project, the National Park Service retains final decision making authority for this project. As private landowners, TNC is not bound to implement the Park's decision. However, successful implementation of this project is contingent on TNC support of the Park's decision. To ensure success of the project, the Park will enter into a cooperative agreement with TNC to implement the Park's decision. The agreement will outline the necessary actions each entity must undertake to implement the project.

Public Involvement

Internal Scoping and Public Involvement Process

The NEPA "scoping" process [40CFR 1501.7] was used to determine the scope of the analysis and to identify potential issues and opportunities related to the Proposed Action. A complete summary of the scoping and public involvement process for the proposed project is as follows:

Internal Scoping

The Park has successfully eradicated pigs on Santa Rosa Island. Through this effort the Park has collective knowledge about the issues surrounding pig impacts and pig eradication.

External Scoping

External scoping refers to the effort the Park made to solicit input from the local public, organizations, and other government regulatory agencies. External scoping includes the input of The Nature Conservancy. Over 20 years TNC has been involved in attempting to control pigs on their land on Santa Cruz Island. The Park has worked in close cooperation with TNC in developing both pig eradication alternatives as well as fennel control measures. The outreach methods the Park used to solicit input included: scoping letter, public meetings, presentations, website, and direct communications.

Scoping Letter

A letter describing the proposed action was sent on October 8, 1999 to individuals and organizations who expressed interest in the Park's management, and government agencies who might have oversight/regulatory concerns about the project. Seventeen comments were collected during the scoping period. The most common comment was asking the park to consider the using sport hunters as part of the project.

Federal Register

A Notice of Intent to prepare an Environmental Impact Statement was published in the Federal Register on September 13, 1999. http://www.epa.gov/EPA-IMPACT/1999/September/Day-13/i23765.htm

Local Media Coverage

The Los Angeles Times (10/25/99) printed an article regarding pig removal. The article was entitled, "*With Sheep Removed, Swine Pose Threat to Santa Cruz Habitat*".

Public Meetings

The Park hosted two public meetings: . October 20th, 1999 in Ventura; On October 27th, 1999 in Santa Barbara. As part of this meeting the Park presented the need for the proposed action as well as the proposed action. The Park placed an announcement in the local newspaper to gain wider distribution (Ventura County Star 10/12/99).

Presentations

The Park and TNC met with several local organizations and interested agencies to personally inform them of the purpose and need for this action.

Website

The Park posted information regarding the project on its website the first of October, 1999. http://www.nps.gov/chis/restoringsci/island.html

Direct Communication

The Park made direct communication to regulatory government agencies that may have oversight concerns regarding the project. A list of these agencies can be found below.

Notification and Distribution of Draft EIS

Notification

The Park widely distributed the Draft EIS for comment. Methods the Park used to notify the general public that the Draft EIS was available for review and comment include:

Federal Register

The federal register posted a Notice of Availability for the Draft EIS on March 9, 2001. http://www.epa.gov/EPA-IMPACT/2001/March/Day-09/i5948.htm

Press Release

The Park issued a press release on February 23, 2001 to the 50+ local media outlets that are part of the Park's Public Relations mailing list. This resulted in an article in the Los Angeles Times (Biologists Propose Killing Wild Pigs on Santa Cruz Island) on February 28, 2001.

Public Meetings

Two public meetings were held: March 22, 2001 at the Santa Barbara Museum of Natural History; and March 29, 2001 at Channel Islands National Park Auditorium. A total of twenty-eight people attended the public meetings. Issues brought up at the public meetings included: fennel treatment, sport hunting, funding, California Department of Fish and Game role, and timing of eradication activities.

Legal Notice

Placement of a legal notice announcing the availability of the Draft EIS and announcement of the public meetings was placed in both the Santa Barbara News Press (3/5/01) and the Ventura County Star (3/6/01).

Website

The park posted the Draft EIS on its website in PDF format. The website became available the first of March, 2001prior to the Draft EIS becoming available to the public. The website is available as a link from the park's main website: www.nps.gov/chis . The projects website as its own URL is as follows: http://www.nps.gov/chis/restoringsci/island.html

Draft EIS List of Recipients

Below is the list of government, organizations and businesses, and individuals who were the original recipients of the Draft Environmental Impact Statement. Upon public release of the Draft EIS, many additional organizations and individuals requested copies. These additional groups and individuals that expressed interest in the project will be notified of the release of the Final EIS.

Government

- California Department of Fish & Game
- U.S. Fish and Wildlife Service (Ventura Office)
- Environmental Protection Agency (Washington Office)
- California Environmental Protection Agency
- Central Coast Regional Water Quality Control Board
- California Coastal Commission
- National Marine Fisheries Service
- Channel Islands National Marine Sanctuary
- U.S. Army Corps of Engineers
- U.S. Geological Survey
- U.S. Coast Guard
- Honorable Lois Capps
- Honorable Elton Gallegly

Organizations and Businesses

- Santa Barbara Museum of Natural History
- National Wildlife Research Center
- Institute for Wildlife Studies
- The Nature Conservancy
- Santa Barbara Botanic Garden
- Catalina Island Conservancy
- Environmental Defense Center
- National Parks and Conservation Association
- California Native Plant Society
- National Fish and Wildlife Federation
- Pacific Seabird Group
- Santa Cruz Island Foundation
- Island Packers

- Vail and Vickers Company

Individuals

- Dr. Larry D. Agenbroad
- Dr. Scott Anderson
- Jeanne Arnold
- Dr. Reg Barrett
- Dr. Michael Benedict
- Timothy K. Boyle
- Cherie Bratt
- Dr. Patricia Brown
- Harry R.Carter
- Dr. Charles Collins
- Paul W. Collins
- Dr. Scott D. Cooper
- Marla Daily
- Robert L. DeLong
- Diane Devine
- Thomas W. Dibblee, Jr.
- Clive E. Dorman
- Dr. Jenifer Dugan
- Mary Elaine Dunaway
- Jack Engle
- Dr. Wayne R. Ferren
- Amy Fesnock
- Laura J. Furlong
- Dr. Steve Gaines
- Dr. Michael A. Glassow
- Stephen R. Gliessman
- Jay Goldsmith
- Dr. Daniel A. Guthrie
- Peter L. Haaker
- Dr. Sally Holbrook
- Dr. John R. Johnson
- Donald Lee Johnson
- Kathy Jope
- Steven A. Junak
- Jon Keeley
- Doug Kennett
- Dr. Kevin Lafferty
- Dr. Lyndal Laughrin
- James Lima
- Dewey Livingston
- Dr. Larry Loeher
- Lynn Lozier
- Dr. Kathryn McEachern
- Dr. Leal A.L. Mertes
- Diane Noda
- Dr. Elizabeth L. Painter
- Ralph Philbrick
- Fred Piltz
- Dr. Elizabeth L. Painter
- Ralph Philbrick
- Fred Piltz
- Dr. Jerry Powell
- Dr. John Randall
- Dr. Marcel Rejmanek
- Elizabeth Riddle
- Dr. Gary Roemer
- Gary Rosenlieb
- Dr. M.A. Sanjayan
- Peter Schuyler
- Dr. James R. Shevock
- Dr. Robin Throp
- Dr. Dirk Van Vuren
- Dr. Nancy Vivrette
- Dr. Hartmut Walter
- Libe Washburn
- Dr. Adrian M. Wenner
- Dr. Dieter Wilken
- Dave Chipping
- Emilie Roberson
- Jake Sigg
- Dave Tibor
- Connie Rutherford
- Brian Huse

The Park maintains a mailing list of individuals and organizations interested in the activities of Channel Islands National Park. The executive summary and a notice was sent to this mailing list that notified them that the Draft EIS was available for review. The notice gave instructions on how to obtain a copy of the Draft EIS, including instructions on how to view it at the Park's website, at the Park or the local library. To reduce costs associated with distribution of paper copies, the Park distributed the Draft EIS on CD-roms. Upon special request paper copies were distributed. The Final EIS will be distributed in the same manner.

List of Preparers

EIS Preparation

Individuals who helped prepare the Final Environmental Impact Statement are as follows:

EIS Preparation	**Steve Ortega** Restoration Biologist and EIS Team Leader..... Channel Islands NP **Kate Faulkner** Natural Resources Division Chief ..... Channel Islands NP **Eric Aschehoug** Restoration Program Coordinator……The Nature Conservancy **Tim Coonan** Branch Chief Terrestrial Monitoring And Restoration..... Channel Islands NP **Dirk Rodriguez** Monitoring Botanist..... Channel Islands NP **Ann Huston** Cultural Resources Division Chief ..... Channel Island NP **Sarah Chaney** Restoration Ecologist..... Channel Islands NP
Review	**Allen Schmierer** Environmental Compliance Specialist……..Pacific West Region - NPS **Lynn Lozier** Director Santa Cruz Island Project.….The Nature Conservancy
Technical Assistance	**Cathy Schwemm** GIS Specialist…….…….Channel Islands NP

Response to Comments on Draft EIS

Chapter Six contains the response to comments that were made on the Draft EIS.

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SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

CHAPTER SIX
RESPONSE TO COMMENTS

Introduction

The purpose of this chapter is to analyze the comments given to the Park by the public. The Final EIS is to be an accurate analysis of impacts of the proposed action and its alternatives. Public and agency review of the draft helps to ensure quality. Analysis of comments allows the Park to identify the public's opinion on the project, garner new information on resources, alternatives, and environmental issues. The Park will use public comments to modify alternatives, supplement/improve/modify our analysis, make factual corrections, and clarify information in the draft version. The four sections in this chapter are:

- Introduction
- Commentator Summary
- Copy of Commentator Letters and e-mail
- NPS Response to Comments

In total, 36 letters or e-mail correspondence were provided to the Park during the 60-day comment period for the Draft EIS. From this correspondence, the Park identified 66 substantive comments. Substantive comments are those that are not simple statements for or against the proposal, but rather those comments that require additional explanation or analysis of data, or those that debated facts or conclusions rendered in the Draft EIS. These comments were divided into 14 categories. In the "Response to Comments" section the Park provides responses to all 66 substantive comments received on the project.

Commentator Summary

	Commentator Name	Comment Category	Comment Number
Government Agencies	**U.S. Environmental Protection Agency**	Herbicide	1
		Herbicide	2
		T&E Plants	3
		Water Quality/Erosion	4
		Alternatives	5
		Alternatives	6
		Exotic Species	7
		Cultural Resources	8
		Air Quality	9
		Air Quality	10
		Air Quality	11
		Water Quality/Erosion	12
		T&E Plants	13
		Economic	14
		Economic	15
		Purpose and Need	16
		FEIS Organization	17
		Effects Analysis	18
	U.S. Fish and Wildlife Service	Alternatives	19
		T&E Plants	20
		Island Fox	21
		Island Fox	22
	U.S. Army Corps of Engineers	Comments Noted	NA

Groups and Organizations

Commentator Name	Comment Category	Comment Number
In Defense of Animals (IDA)	Sterilization	23
National Anti-Vivisection Society (NAVS)	Sterilization	24
Santa Cruz Island Foundation	Alternatives	25
	Effects Analysis	26
	FEIS Organization	27
Santa Barbara Audubon Society	Exotic Species	28
	Herbicide	29
Catalina Island Conservancy	Alternatives	30
	FEIS Organization	31
	Alternatives	32
	Access	33
People for the Ethical Treatment of Animals (PETA)	Alternatives	34
	Alternatives	35
	Sterilization	36
California Native Plant Society	Herbicide	37
	T&E Species	38
	Exotic Species	39
	Water Quality/Erosion	40
Santa Barbara Museum of Natural History	Comments Noted	NA
University of California, Davis	Comments Noted	NA
California State University, Long Beach	Comments Noted	NA

	Commentator Name	Comment Category	Comment Number
Individuals	**Betine Corimby**	Alternatives	41
		Alternatives	42
	Mrs. Phyllis E. Grame	Sterilization	43
	Jeanne E. Arnold	Access	44
		Cultural Resources	45
	Maureen Edwards	Sterilization	46
	Linda Saffell	Alternatives	47
	Jeannette Ferro	Purpose & Need	48
		Island Fox	49
	Helene Schwartz	Sterilization	50
	Dieter Wilken, Ph.D.	Effects Analysis	51
	Siobhán Gephart	Sterilization	52
	Dolores and David Ferraro	Sterilization	53
	Betty L. Jeppesen	Sterilization	54
		Purpose & Need	55
	Diana Cora	Sterilization	56
	Joy M. Zakarian, M.P.H	Sterilization	57
	Andrea Heaton	Sterilization	58
	Ms. Gayle Harris Birk	Sterilization	59
	Pinky Jain Pan	Sterilization	60
	Larry L. Loeher, Ph.D.	Effects Analysis	61
		Effects Analysis	62
		Effects Analysis	63
		Effects Analysis	64
		Access	65
	Allison Marie Memmo Geiger	Sterilization	66
	Brian Ehler	Comments Noted	NA
	Jennifer Graham	Comments Noted	NA
	Ms. Robin Betian	Comments Noted	NA

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
VENTURA FIELD OFFICE
2151 ALESSANDRO DRIVE, SUITE 255
VENTURA, CALIFORNIA 93001

REPLY TO
ATTENTION OF:

March 7, 2001

Office of the Chief
Regulatory Branch

Attention: Tim Setnicka
United States Department of the Interior National Park Service
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001-4354

Dear Mr. Setnicka:

We are in receipt of your Draft Environmental Impact Statement (Draft EIS) for the Santa Cruz Island Primary Restoration Plan dated February 22, 2001. Your proposal involves a variety of work intended to enhance the natural and cultural resources on the island. The work potentially affects various waters on and around Santa Cruz Island, part of the Channel Islands, Ventura County, California. These activities may require a U.S. Army Corps of Engineers permit.

A Corps of Engineers permit is required for:

a) structures or work in or affecting "navigable waters of the United States" pursuant to Section 10 of the River and Harbor Act of 1899. Examples include, but are not limited to,

1. constructing a pier, revetment, bulkhead, jetty, aid to navigation, artificial reef or island, and any structures to be placed under or over a navigable water;

2. dredging, dredge disposal, filling and excavation;

b) the discharge of dredged or fill material into, including any redeposit of dredged material within, "waters of the United States" and adjacent wetlands pursuant to Section 404 of the Clean Water Act of 1972. Examples include, but are not limited to,

1. creating fills for residential or commercial development, placing bank protection, temporary or permanent stockpiling of excavated material, building road crossings, backfilling for utility line crossings and constructing outfall structures, dams, levees, groins, weirs, or other structures;

2. mechanized landclearing, grading which involves filling low areas or land leveling, ditching, channelizing and other excavation activities that would have the effect of destroying or degrading waters of the United States;

3. allowing runoff or overflow from a contained land or water disposal area to re-enter a water of the United States;

4. placing pilings when such placement has or would have the effect of a discharge of fill material; or

c) any combination of the above.

Unfortunately, we are currently unable to provide detailed comments on the Draft EIR due to our heavy permit workload. Enclosed you will find a permit application form and a pamphlet that describes our regulatory program. If you have any questions, please contact me at (805) 585-2143. Please refer to this letter and 200100690-LM in your reply.

Sincerely,

Lisa Mangione

Lisa Mangione
Project Manager

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

Mr. Tim Setnicka
Superintendent
Attn: SCPRP
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA. 93001

Dear Mr. Setnicka:

The Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (DEIS) for the **Santa Cruz Island Primary Restoration Plan, Santa Barbara County, California** (CEQ #010050). Our review is pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Section 309 of the Clean Air Act.

Channel Islands National Park, in coordination with The Nature Conservancy (TNC), proposes to eliminate the ecological degradation that is occurring on Santa Cruz Island from non-native feral pigs. The proposed action will reduce ecosystem and archeological site disturbance and promote species recovery through sequential hunting of feral pigs in six fenced units island-wide, as well as reduction of large monoculture stands of fennel through controlled, prescribed fire and two successive sprays of the herbicide Garlon 3A. The herbicide, in low mix rates of 0.5% - 4.0%, would be applied by hand, from a vehicle, or aerially using a helicopter. Feral sheep were successfully eliminated on Santa Cruz Island by 1999. As a result, native vegetation has begun to recover from the extensive overgrazing caused by these sheep. However, as native shrubs recover, it becomes more difficult to locate and hunt feral pigs in the increased vegetative cover. Therefore, hunting priority will be given to units where native vegetation is recovering quickly.

The DEIS evaluates four alternatives: No Action, simultaneous island-wide eradication of pigs, eradication of pigs from east Santa Cruz Island (National Park land)/exclusion of pigs from selected sensitive resources on central and west Santa Cruz Island (TNC land), and sequential island-wide eradication by fenced zone (unit) hunting. The preferred alternative is sequential island-wide eradication (Alternative 4). Removal of monoculture stands of fennel is common to all action alternatives and would only occur if feral pig eradication is approved.

EPA supports the proposed action to eradicate non-native feral pigs and dense monoculture stands of fennel. The extensive damage to archeological and historic sites and the significant risk to threatened and endangered native plant and wildlife species from pig rooting,

predation, habitat modification and transport of invasive weeds, clearly demonstrates the urgent need for action. Furthermore, the drastic decline of the endemic island fox (*Urocyon littoralis)* due to predation by non-native golden eagles supported by the piglet prey base underscores the need for action.

Because of this pressing need for action, we urge you to seriously consider selection of Alternative 2, simultaneous island-wide eradication of pigs. This alternative would eliminate feral pigs in two years instead of 6+years under the preferred alternative. We note that success under the preferred alternative is not guaranteed due to the higher risk of re-establishment of feral pigs and fennel (pg. 92 and Table 7. Summary Table of Environmental Consequences). The DEIS also states that the extended period of time for pig eradication under the preferred alternative may be too long for the endangered plant species, *Galium buxifolium* (island bedstraw), to survive since its population was extremely small when last surveyed (pg. 91).

We recognize the valid concern regarding the ability to fund and support a large hunting operation over a short period of time (i.e., Alternative 2). On-the-other-hand, sequential hunting of fenced units over six years (preferred Alternative 4) would require 40+ miles of fence, active monitoring and maintenance of the fence, active control of fennel re-establishment, and possible aggressive restoration techniques to facilitate native shrub re-establishment. Thus, we believe the significant benefits of quickly eradicating pigs without the cost of extensive fencing and monitoring or risk of re-establishment of pigs and fennel may actually prove to be more cost effective than sequential eradication of pigs over a longer period of time.

While we support the eradication of feral pigs and treatment of the fennel stands, we have concerns regarding potential aerial application of Garlon 3A, proposed mitigation, air quality, and water quality (see Detailed Comments). Because of the above concerns, we have rated the proposed project and DEIS as EC-2, Environmental Concerns - Insufficient Information (see attached "Summary of the EPA Rating System").

We appreciate the opportunity to review this DEIS. Please send two (2) copies of the final environmental impact statement to this office at the same time it is officially filed with our HQ Office of Federal Activities. If you have any questions, please call Ms. Laura Fujii, of my staff, at 415-744-1601, email: fujii.laura@epa.gov.

Sincerely,

Lisa B. Hanf, Manager
Federal Activities Office

File: santacruzislanddeis.wpd
Main ID# 003613
Enclosure: Detailed Comments (5 pages)
Summary of the EPA Rating System

DETAILED COMMENTS

Garlon 3A

1. To eradicate monoculture stands of fennel, two successive sprays of the herbicide Garlon 3A would be applied either by hand, from a vehicle, or aerially using a helicopter. Garlon 3A is a broad-leaf herbicide which results in reduction of forb species biomass. Thus, non-target forb species (e.g., threatened and endangered plant species) could be adversely affected by the direct spraying or spray drift from adjacent areas.

Recommendations:

We urge use of spray application via hand or from a vehicle where the fennel is close to listed plant species or species of concern. Precise helicopter applications are feasible and should include preapplication scouting using the Global Positioning System (GPS), identification of avoidance areas (e.g., location of non-target sensitive species), computerized nozzle action, and slow speed. Spray droplet size should be as large as feasible since this is the most important variable for drift, other than wind. Aircraft height should be low.

The FEIS should state the EPA Registration Number of any products anticipated to be used for the project. Whatever pesticide is used must be registered with EPA and the California Department of Pesticide Regulation. The pesticide must be used according to the label directions and Federal and State pesticide laws (Executive Order 12088). We note that Garlon 3A is registered and Federally allowed uses include "noncrop areas" and control of unspecified broadleaved weeds. The California Department of Pesticide Regulation website: http://www.cdpr.ca.gov/docs/es/db_desc.htm, should be reviewed for any potential pesticide use limitations related to listed species.

We recommend the FEIS include a description of the Section 7 Endangered Species Act consultation with the USFWS in regards to the use of Garlon 3A. The biological assessment/biological evaluation prepared for this consultation and the description of potential effects of Garlon 3A on sensitive plant species should be in the FEIS.

2. The DEIS does not appear to address the potential effect, if any, of Garlon 3A on water quality. While there are few perennial streams on Santa Cruz Island, there are many freshwater seeps and springs (pg. 26). While we acknowledge that Garlon 3A is in the category of "practically nontoxic" to all tested terrestrial and aquatic animals, it does have a half-life in soil of 10 - 46 days (pg. 79).

Recommendation:

The FEIS should include an evaluation of potential effects of Garlon 3A applications on water quality. Aerial spraying is of specific concern because of the potential for drift and application in non-targeted areas. For example, describe whether any seeps and springs are present in the targeted spray area(s), whether there is a risk of erosion of contaminated soil into these areas, and the chemical changes of Garlon 3A in water.

Alternatives

1. Although the DEIS states that Alternative 4, sequential, island-wide eradication of pigs by fenced units, has a high likelihood of success (pg. 89 and Table 7), it also states that feral pigs are notorious for undermining fencing on Santa Cruz Island (pg. 84). Given the construction and maintenance of 40+ miles of fencing for Alternative 4, we question the feasibility of assuring feral pigs and fennel do not re-establish in "cleared" fenced units over a period of 6+ years.

Recommendation:

The FEIS should provide additional information and supporting data demonstrating that fence monitoring and maintenance and periodic follow-up unit monitoring and hunting is financially feasible and would be effective in keeping "cleared" units pig and fennel free.

2. The sequential order of hunting fenced units under Alternative 4 is not specified. However, the DEIS appears to imply that the isthmus (eastern National Park lands) would be one of the last units to be treated (e.g., pg. 94). Given the monoculture stands of fennel on the isthmus and risk to the endangered island bedstraw (*Galium buxifolium*) from continued feral pig activity, we are concerned with the potential delay of pig and fennel eradication in this unit.

Recommendation:

The FEIS should describe the actual or likely sequence of hunting of the fenced units and the underlying rational for this sequence.

Mitigation

1. The DEIS clearly describes the potential for increased risk of invasive weed introduction, fire, soil erosion, and re-establishment of invasive weeds (e.g., Mediterranean annual grasses, yellow star thistle) in "cleared" units from hunting, monitoring, and fence maintenance activities (e.g., pgs. 70-75). Although mitigation for these potential adverse effects is discussed in general terms, a specific mitigation plan is not provided.

Recommendation:

To avoid replacing one management problem with another, we strongly recommend that a detailed, specific mitigation plan be developed and included in

DEIS COMMENTS, NPS, SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN, MARCH 2001

the FEIS. This plan should include prevention measures to minimize re-introduction of invasive weeds, soil erosion, and fire risk, and a backup plan in case invasive weeds become re-established and soil erosion increases.

2. The DEIS also states that controlled burning of the fennel stands creates the most potential for harm to cultural resources (e.g., pg. 81).

Recommendation:

The project mitigation plan, should also include a section describing specific measures to be implemented to minimize and avoid possible impacts to cultural resources from controlled fires and associated activities (e.g., fire break construction). We also recommend the FEIS include additional information regarding the requirements of Section 106 of the National Historic Preservation Act and proposed measures to meet these requirements.

Air Quality

1. There appears to be only a general evaluation of potential air quality impacts from the proposed action (pg. 80). We believe the FEIS should include a more in-depth evaluation of local air quality impacts which may be caused by project activities and smoke from prescribed fires.

Recommendations:

The FEIS should provide a discussion of air quality standards, ambient conditions, and potential air quality impacts for Santa Cruz Island and Santa Barbara County. Cumulative and indirect impacts should be fully evaluated. For instance, development or modified use of surrounding lands (e.g., increased recreational activity, fence construction) could influence sources of PM10.

Federal agencies are required by the Clean Air Act to assure that actions conform to an approved air quality implementation plan. If the proposed project area is in a nonattainment area, the National Park Service may need to demonstrate compliance with conformity requirements of the Clean Air Act [Section 176(c)]. General Conformity Regulations can be found in 40 CFR Parts 51 and 93 (58 Federal Register, page 63214, November 30, 1993). These regulations should be examined for applicability to the proposed actions.

We urge development of a mitigation plan if potential impacts to local visibility, air quality, and island visitors are identified. We also recommend issuance of public notices announcing the date, time, and location of proposed prescribed burns.

Water Quality

1. While the DEIS briefly describes surface water quality (pg. 26), it does not appear to address potential impacts to water quality from soil erosion that may be caused by the proposed action (e.g., fence building, prescribed fires).

Recommendation:

The FEIS should describe and evaluate the potential for increased sedimentation of seeps, springs, and streams from fence construction, increased vehicle traffic on existing roads, newly created trails and camp sites, prescribed fires, and other associated project activities. If potential adverse impacts exist, we recommend including mitigation measures in the project mitigation plan.

General Comments

1. The DEIS states that the National Park Service will confer with the US Fish and Wildlife Service (USFWS) on likely effects to threatened and endangered species. It is not clear whether such consultation has been initiated or has occurred. Consultation with the USFWS is critical given the large number of endemic, threatened and endangered species on the Island.

Recommendation:

We recommend the FEIS include a description of the Section 7 Endangered Species Act consultation with the USFWS and, at a minimum, the biological assessment/biological evaluation prepared for this consultation. If the USFWS has issued a Biological Opinion for the project, it should be included as an appendix to the FEIS.

2. Eradication of feral pigs and control of invasive plants is clearly an urgent need. The current choice of Alternative 4 as the preferred alternative, indicates a concern regarding funding and resource support for required actions. While we recognize and understand this concern, the DEIS does not clearly demonstrate whether Alternative 2 or 4 is more cost effective or financially feasible.

Recommendations:

The FEIS should provide a detailed evaluation and comparison of costs for each alternative. For example, provide costs for fence construction, hunting teams, fence monitoring and maintenance, monitoring of "cleared" units, and mitigation requirements.

We recommend continued efforts to seek necessary funding and other creative opportunities to achieve the required funds and support for the proposed action(s). For instance, additional paid sport hunts of feral pigs prior to project

DEIS COMMENTS, NPS, SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN, MARCH 2001

implementation and/or the collection of donations from park visitors may be able to help support the eradication program.

3. The National Park Service Channel Island General Management Plan and Resource Management Plan are referenced briefly in the DEIS. Since these plans direct the management actions taken on Santa Cruz Island, they should be described in more detail. We note that the General Management Plan is being considered for revision in 2001.

Recommendation:

Include in the FEIS a detailed summary of the management policies and actions outlined in the General Management and Resource Management Plans. Attachment of the executive summaries of these two plans as appendices in the FEIS should be considered. If feasible, describe the revisions to the General Management Plan being considered.

4. Chapter 4, Environmental Effects, provides a chart to describe the organization of the chapter discussions. However, this chart (pg. 55) does not closely match the actual Chapter headings. This is confusing.

Recommendation:

We recommend the chart include more detail and be consistent with the Chapter headings and actual organization of the environmental effects evaluations.

5. It is our understanding that eradication of sheep was a major effort in the late 1980s (pg. 35). It is not clear why eradication of the feral pigs was not undertaken at the same time.

Recommendation:

Provide a short description of the sheep eradication program and the reasons pigs were not eliminated at the same time.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003

April 19, 2001

Memorandum

To: Superintendent, Channel Islands National Park, National Park Service, Ventura, California

From: Field Supervisor, Ventura Fish and Wildlife Office, Ventura, California

Subject: Draft Environmental Impact Statement for the Santa Cruz Island Primary Restoration Plan, Ventura County, California (L7617-CHIS)

We have reviewed your letter, dated February 23, 2001, and received in our office on February 26, 2001, requesting our comments on the draft environmental impact statement (EIS) for the subject project. The National Park Service (NPS) proposes to help restore Santa Cruz Island's native flora and fauna by eradicating non-native feral pigs (*Sus scrofa*) and substantially reducing the distribution of the invasive fennel (*Foeniculum vulgare*) on the island. The NPS presented four alternatives to accomplish this goal: no action (Alternative One), simultaneous island wide-eradication of pigs (Alternative Two), eradication of pigs on the NPS-owned portion of the island but not the portion of the island owned by The Nature Conservancy (Alternative Three), and sequential island-wide eradication of pigs by fenced zone hunting (Alternative Four).

We applaud the NPS's initiative and its cooperative efforts to restore Santa Cruz Island to a more natural state. Eradication of feral pigs from Santa Cruz Island is the singlemost important action in the recovery of threatened and endangered plant species on Santa Cruz Island, including island bedstraw (*Galium buxifolium*), island rush-rose (*Helianthemum greenei*), Santa Cruz Island live-forever (*Dudleya nesiotica*), Hoffman's rock-cress (*Arabis hoffmannii*), island barberry (*Berberis pinnata* ssp. *insularis*), Santa Cruz Island bushmallow (*Malacothamnus fasciculatus* var. *nesioticus*), Santa Cruz Island malacothrix (*Malacothrix indecora*), island malacothrix (*Malacothrix squalida*), and Santa Cruz Island fringepod (*Thysanocarpus conchuliferus*). In addition, the removal of feral pigs from the island would aid in the recovery of the imperiled Santa Cruz Island fox (*Urocyon littoralis santacruzae*), a subspecies of island fox that has been subject to substantial, documented declines, primarily as a result of predation from golden eagles (*Aquila chrysaetos*). We are currently reviewing the status of the Santa Cruz Island fox to determine if listing the species as endangered under the authority of the Endangered Species Act of 1973, as amended, is warranted.

We strongly support Alternative Two, the environmentally preferred alternative for the project. This alternative would result in the highest benefit for listed plant species and the island fox because feral pigs would be removed sooner and the construction of fences, which could affect native vegetation, would be unnecessary. We understand that this alternative may be infeasible due to funding and logistics; therefore, we also support Alternative Four, which would result in overall long-term benefits to listed plants and the island fox. We believe that both alternatives One and Three would result in the continued downward trend of listed plant species by allowing continued effects to occur to listed plants from pig rooting. Likewise, alternatives One and Three would continue to endanger the island fox by allowing a substantial number of feral pigs, the golden eagle's primary prey base, to remain on the island.

We offer the following recommendations prepared in accordance with the Endangered Species Act of 1973, as amended, and other authorities mandating Department of the Interior concern for environmental values:

1. The draft EIS was unclear concerning when the pig eradication would begin. Species with small populations sizes, including the nine listed plants and the island fox, face a high risk of extinction due to stochastic events. We recommend that these restoration events begin as soon as possible, so that the population sizes of these species can recover to levels that can withstand unforeseen stochastic events. In addition, The Nature Conservancy, the NPS, and the Service have contributed substantial funds to remove golden eagles, an action which will continue to be necessary as long as feral pigs exist on Santa Cruz Island. By implementing feral pig eradication as soon as possible, the NPS will reduce the long-term expense of this emergency conservation measure.

2. The draft EIS indicates that sparks from ricocheting bullets could start wildfires, which could adversely affect listed plant species, and even cause the extirpation of the Santa Cruz Island fringepod under extreme circumstances. We offer the following recommendations to minimize the effect of a wildfire as a result of the proposed action on listed plants:

   a. In the event of a wildfire, fire-fighting personnel should be briefed on the locations of listed plant species, so that no hand lines, staging areas or fire retardant drops occur in locations with listed plant species present or nearby.

   b. We are aware that the NPS has considered actions to promote the recovery of listed species, such as seed banking and the propagation of plants in controlled greenhouse environments and subsequent reintroduction to the islands. In the case of wildfire damage, having propagules and seeds in protected locations may prove to be essential in the recovery of listed plant populations. We recommend that you apply for a recovery permit, pursuant to section 10(a)(1)(A) of the Act, and move forward with these efforts before the hunting of pigs commences. You can find our recommendations for the types of seed banking and captive propagation necessary for each listed plant in our final recovery plan for the thirteen plant taxa from the northern Channel Islands published on February 22, 2001.

3. The large amount of carrion that will be available on the islands during the pig eradication efforts may attract golden eagles or other large predatory birds, which may in turn prey upon island foxes and their young. We recommend that The NPS have measures in place to protect the island foxes in this event, including a contingency plan and funding to capture and relocate golden eagles or other potential predators of the island fox.

4. Measures to prevent the transmission of disease from dogs brought to the island to assist in feral pig identification should be developed in coordination with veterinary and disease transmission experts. In addition, we recommend that any working dogs displaying overtly aggressive behavior toward island fox be removed from the hunt or controlled in such a manner that would guarantee no injury or mortality to island fox.

We look forward to reviewing the final EIS when it becomes available. The NPS, as the lead federal agency for the project, has the responsibility to review its proposed activities and determine whether any listed species may be affected. If the NPS determines that a listed species or critical habitat is likely to be adversely affected, it should request, in writing through our office, formal consultation pursuant to section 7 of the Act. Informal consultation may be used to exchange information and resolve conflicts with respect to threatened or endangered species or their critical habitat prior to a written request for formal consultation. During this review process, the NPS may engage in planning efforts but may not make any irreversible commitment of resources. Such a commitment could constitute a violation of section 7(d) of the Act.

Should you have any questions regarding these comments, please contact Bridget Fahey of my staff at (805) 644-1766.

CALIFORNIA STATE UNIVERSITY, LONG BEACH

DEPARTMENT OF BIOLOGICAL SCIENCES

6 March 2001

TO: Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

FROM: Charles T. Collins, Ph.D.
Professor, Dept. of Biological Sciences

RE: Santa Cruz Island Primary Restoration Plan

Thank you for sending me the 'Summary of the draft environmental impact statement' for the Santa Cruz Island Primary Restoration Plan. I have read it carefully and offer the following comments. I would preface this by saying that I am fully familiar with both Santa Cruz Island and the problems posed by the introduced fennel and pigs. I have been conducting a long-term study of the endemic Island Scrub-Jay on Santa Cruz Island since about 1975. I have seen at first hand the effects of both the fennel and pig damage.

The draft EIS identifies four alternatives. Alternative one (no action) is clearly unacceptable! Fennel is taking over large stretches of the island and crowding out native plants and plant communities. Fennel also provides cover for the increasing feral pig population that is causing substantial damage to the island, its ecosystems and its cultural resources. A no-action alternative will result in further degrading of the island that we are entrusted to preserve and maintain.

Alternative two (simultaneous hunt) and alternative three (pig removal from only NPS land) are not really viable alternatives for the reasons identified. The eradication program envisioned by alternative two is not really practical. The funding would have to be exceptional and the chances of exterminating all individual pigs is not really likely. Although attractive from the point of view of a (possibly) shorter time line it has a very poor chance of success. Similarly, pigs do not respect fences and trying to exclude them from parts of the island rather than a full eradication is similarly unlikely to succeed.

Thus, alternative four is both the most cost effective and has the greatest chance for success. It will be a long and difficult process but it entirely necessary to check the current damage to the island ecosystem resulting from an unchecked population of feral pigs. I have seen this at first hand and the destruction is appreciable. I am also fully familiar with the decrease in the Island Fox populations due to Golden Eagle predation which is in turn related to the pigs providing a food supply to attract and hold the eagle population. This second-level effect is only one of many related to the pig populations on the island. Accordingly, I fully support the proposed program to curtail the spread of fennel and the eradication of the feral pig population on Santa Cruz Island. My evaluation is from the perspective of a trained ecologist and also as one who has had first hand experience with the ecological dynamics of Santa Cruz Island. The sooner this program can be initiated the better.

IDA
IN DEFENSE OF ANIMALS

19 April 2001

Santa Cruz Island Primary Restoration Plan
Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

Dear Mr. Setnicka,

On behalf of our 80,000 members nationwide I must convey to you in the strongest terms our objection to the killing of 4,000 (est.) feral pigs on Santa Cruz Island. The fact that this proposed action was developed in coordination with the infamous Nature Conservancy, who has been responsible for the death of thousands upon thousands of animals worldwide despite viable proven alternatives, gives the plan little creditability. This wholesale slaughter also brings dishonor to the National Park Service. The citizens of California have voted over and over again for non-lethal methods in situations involving animals. The expediency of a bullet is no longer acceptable. Man, who first brought the pigs to Santa Cruz Island, is to blame for this condition. Man, therefore, has a responsibility to seek a humane solution.

There is a new sterilization product called Gonex that is seeking a trial opportunity. I understand that it works on both male and female pigs, with a one-time only application, that can be delivered by a dart gun. The pig overpopulation problem could be eradicated over time through sterilization. It would behoove the Park Service to sponsor this trial which would add immeasurably to the world-wide feral pig dilemma and bring credit to the Department of Interior. Perhaps the wealthy Nature Conservancy (1999 income: $704, 004,760. according to *The Chronicle of Philanthropy*, November 2, 2000) could contribute to this worthy trial. (Gonex consulate, Ms. Carol Moulton, telephone 303-337-2728.)

I respectfully urge you to avoid the all-kill policies of the Nature Conservancy and to seek a non-lethal, alternative solution.

Yours truly,

Bill Dyer
Field Representative

IN DEFENSE OF ANIMALS • 131 CAMINO ALTO • MILL VALLEY, CA 94941 • (415) 388-9641 • FAX (415) 388-0388
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Web site: www.navs.org

April 19, 2001

Mr. Tim Setnicka, Superintendent
Channel Islands National Park
1901 Sinnaker
Ventura, California 93001

Dear Mr. Setnicka:

I am writing on behalf of our 75,000 members and donors to respectfully request that you humanely manage the pigs on Santa Cruz Island.

While we are sensitive to the destruction of archeological sites and endangered species of plants, surely there must be more creative ways to preserve these rather than a massive killing of animals. Could some of the endangered plants be relocated?

We understand that this is a complex issue with no easy answers. It's reported that 37,000 sheep were shot in the 1980's, and now it's proposed to eradicate as many as 5,000 pigs. What steps can we take to prevent this situation in the future?

In 1999 the National Anti-Vivisection Society (NAVS) awarded a Sanctuary Fund Grant to In Defense of Animals to assist in the relocation effort of goats from Santa Catalina Island. Even if disease and other factors prevent relocation of the pigs, it is our hope that the parties involved will seek and consider humane methods of control, such as sterilization. Additionally, should the Park Service permit relocation of any of the pigs to a sanctuary, NAVS will be happy to assist with relocation costs.

We have arrived at a critical juncture in human progress. If our planet is to survive, mankind must relinquish its role as "conqueror" or nature and instead become a "steward" of nature...accepting a new sense of responsibility toward all the earth's inhabitants and resources.

Thank you very much for your consideration, and please don't hesitate to contact me if we can be of service.

Sincerely,

Dawn C. Haney

Dawn C. Haney
Program Associate

UNIVERSITY OF CALIFORNIA, DAVIS

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COLLEGE OF AGRICULTURAL AND
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18 April 2001

Santa Cruz Island Primary Restoration Plan
Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Dear Superintendent Setnicka,

I have read the "Santa Cruz Island Primary Restoration Plan, Draft EIS", and I find the plan to be very well written, thorough, and well supported by available data.

I wish to express my support, in the strongest terms, for the proposed action (Alternative Four). Feral pigs are a well-known threat, based on voluminous and rigorous scientific research, to ecosystems around the world, including that on Santa Cruz Island. Feral pigs are especially onerous because of their multiple impacts: herbivory, predation, disturbance through rooting, and as prey for unwanted predators. And, invasion by fennel is a steadily increasing threat to native plant communities and the species they harbor. Thus, anything less than an aggressive, successful program to remove these threats would directly contradict the management responsibilities of Channel Islands National Park and The Nature Conservancy.

Alternative One would result in massive damage to island resources and is unacceptable.

Alternative Two deals with both threats effectively, but simultaneous island-wide eradication of pigs is risky. Numerous factors can slow or postpone an eradication program, leading to rapid restoration of pig numbers—and pig damage. Island resources are too vulnerable and too valuable for this risk to be inconsequential. Thus, this alternative is acceptable, but less desirable than Alternative Four.

Alternative Three removes pigs from only parts of Santa Cruz Island, and this alternative has two shortcomings. First, most island resources will continue to sustain damage from pigs; these resources are within the boundaries of Channel Islands National Park and should be valued accordingly, even they are not on NPS property. Second, thousands of pigs will remain on Santa Cruz Island, constantly threatening NPS resources and kept from doing so only by a fence. This fence must be patrolled and maintained constantly

and forever, and even then pigs will frequently breach the fence, requiring constant and perpetual control efforts. Such an approach is not cost-effective and it leaves NPS resources constantly and perpetually at risk. Because of these two shortcomings, Alternative Three is unacceptable.

Alternative Four is dedicated to the complete eradication of feral pigs, and by a sequential, segment-by-segment approach that has been proven elsewhere to be the most successful and safest approach. Management resources are concentrated on one segment at a time, each bounded by a pig-proof fence; if eradication is slowed or postponed for any reason, segments already cleared of pigs can be kept clear, thereby preserving island resources. I wholeheartedly endorse Alternative Four.

Congratulations on a comprehensive and carefully reasoned plan.

Sincerely,

Dirk Van Vuren
Professor

SANTA CRUZ ISLAND FOUNDATION
CALIFORNIA
SANTA CRUZ ISLAND

1 ANACAPA STREET SANTA BARBARA, CALIFORNIA 93101

April 23, 2001

Tim Setnicka
Supterintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

Dear Tim,

Thank you very much for the opportunity to comment from the draft of the environmental impact statement for the Santa Cruz Island Primary Restoration Plan. The Santa Cruz Island Foundation is in full support of your efforts along with those of The Nature Conservancy to control fennel and to eliminate feral pigs. The following are comments specific to items in the Plan:

- The Plan does not adequately address or reference swine diseases, surveys conducted for swine diseases, the results of the those surveys, and sampling results. Please be sure the final EIS is specific on these issues (allegations of the presence of hog diseases are often misquoted and passed along without factual basis. See Chapter 2, p. 21; Chapter 3, p. 32).
- The Plan does not appear to address carcass handling and disposal, nor does it address the impact of these carcasses on other species (ravens, foxes, predatory birds, etc.) or watersheds.
- The Plan does not include an accurate and complete list of references cited:
  E.g., p. 31: (Barrett, 1999), (Schuyler, 1988), (Baber and Coblentz, 1987), (Babbler, 1982); p. 32 (Sterner and Barrett 1991); (APHIS, 1988), (Vandevelde, 1990), (Glosser, 1988); and p. 33 (Davis, 1999), (Timm et al., 1994), (Jessup and Swift, 1993), (Updike and Waithman, 1996), etc., etc.
- Several references are duplicated.

Thank you for the opportunity to comment. We look forward to the above modifications and receipt of the final Plan.

Sincerely,

Marla Daily

SANTA BARBARA MUSEUM OF NATURAL HISTORY
Increasing understanding of our natural and cultural heritage

16 April, 2001

Tim Setnicka
Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Dear Tim:

I am writing in support of Alternative No. 4 for the Draft Environmental Impact Statement for the Santa Cruz Island Primary Restoration Plan. As you know, I have a longstanding research interest in the cultural resources of the Channel Islands. I have been studying these resources for about twenty years and have been all over Santa Cruz Island on many fieldtrips during the course of that time. I have had an opportunity to observe firsthand the tremendous damage that is continually underway to archaeological sites on the islands by the rooting activities of feral pigs.

Island archaeological sites were once fairly pristine in terms of their finely laminated stratigraphic record, because no burrowing rodents are present on Santa Cruz Island. Many of the sites, especially those with wild fennel as a vegetative cover, have had the upper meter of deposit badly churned by pigs who dig deeply to obtain the tap roots of plants that provide them with food. This activity seriously diminishes the stratigraphic integrity of the upper levels of archaeological deposits, to the detriment of our ability to learn more about Chumash lifeways, especially during the later periods of prehistory.

Removing the pigs from Santa Cruz Island is essential for the long-term conservation of the archaeological resources on the island. Because of the high density of significant archaeological sites on the island, it would not be practical to fence each area of high sensitivity, as is stipulated in Alternative 3. With regard to Alternative 2, the simultaneous removal option, it seems unlikely that full funding would be obtainable for such a massive hunt, and I have considerable doubt that it could be managed effectively with the assurance that impacts to cultural resources would be minimized. I am in favor of Alternative 4 because phased eradication of pigs will allow for careful, systematic planning, including prior archaeological reconnaissance, which is designed specifically for each section of the island.

I appreciate all the thoughtful work undertaken by the National Park Service staff to develop the Santa Cruz Island Primary Restoration Plan. The invaluable cultural resources of the island will benefit from this effort. It is a credit to your concern for the island and its resources that you are undertaking this important work.

Sincerely yours,

John Johnson

John R. Johnson, Ph.D.
Curator of Anthropology

Santa Barbara Audubon Society, Inc.
A Chapter of the National Audubon Society

5679 Hollister Avenue, Suite 5B, Goleta, CA 93117 (805) 964-1468

April 21, 2001

Attention: SCPRP
Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Dear Superintendent Setnicka:

RE: Santa Cruz Island Primary Restoration Plan
Comments on Draft EIR

Santa Barbara Audubon is a non-profit organization dedicated to preservation and conservation of wildlife and natural habitats. Santa Cruz Island is "in our backyard", and we support the removal of feral pigs from and control of non-native fennel on the island to allow for recovery of the native vegetation, and to preserve endangered and threatened plants and Island foxes.

From the perspective of impacts, Alternative 2 is preferable, reducing the length of time that the pigs continue degradation of the island vegetation, and increase the likelihood of survival of the SCI Island fox. We strongly urge that Alternative 2 be adopted, and sufficient "up-front" funds be found to initiate this alternative.

However, if *waiting* to secure additional funds for Alternative 2 were required, it would be preferable to institute Alternative 4, with available funding. Clearly, the fennel must be controlled and pigs must be eliminated from the island for meaningful recovery of the island's flora and fauna. Perhaps a mix of the two alternatives is feasible.

The partnership of The Nature Conservancy and the National Park Service is the best way to address this problem–in fact, the only workable means to eradicate the feral pigs on the island. Other potential funding sources should be investigated: State Coastal Conservancy and California Department of Food and Agriculture, which oversees Weed Management Areas, and funds control of invasive exotic plant species. The additional years of disturbance to the Archeological sites should interest the Santa Ynez Band of Chumash Indians; the casino has provided them with funds to help with local projects. Have private foundations such as the Packard Foundation been approached?

An intensive hunting program in two years would not require the estimated $2 million to build and remove the fencing to establish control areas. It would also eliminate the impacts from fence construction, maintenance, and removal. These funds could be used for a more intensive hunting program.

http://www.audubon.org/chapter/ca/santabarbara

We are very concerned about the survival of the SCI Island fox. The decline has been strongly correlated with the presence of Golden Eagles, which are attracted by the prey base of piglets, but which find the Island fox easy prey. The longer the pigs remain on the island, even with relocation of Golden Eagles, the lower chance of recovery of the Island fox. Thus we strongly encourage the adoption of Alternative 2. We also support the re-introduction of Bald Eagles, which is expected to discourage Golden Eagles.

In regards to the adequacy of the draft EIR, the document clearly identifies Alternative 2 as the Environmentally Superior Alternative. We urge you to seek funding to implement this alternative.

Two suggestions to reduce impacts of the program: 1) There has been conversation with a volunteer in the Weed Management Area of Santa Barbara County, of which NPS is a participant, for Yellow Star Thistle (YST) control on Santa Cruz Island. It would be advantageous to implement this control effort during the planning stages of the Primary Restoration Plan, to reduce the risk of spread of YST subsequent to the fennel control.

2) When spraying herbicide in the vicinity of the threatened and endangered plant populations, in addition to use of backpack sprayers for better specificity, I recommend screening to direct the spray. This can be screening around the sensitive plant species, or between the target plants and the sensitive plants. One method I have used, for protecting individual plants, is a 5 gallon bucket with the bottom cut out–easily placed over the plant to be protected when spraying in the vicinity.

In summary, Santa Barbara Audubon strongly supports the feral pig eradication and fennel control on Santa Cruz Island. The dEIR documents the potential impacts–in the long term highly beneficial. We urge The National Park Service and The Nature Conservancy to seek funding to implement Alternative 2, but not to delay implementation even if Alternative 4 must be followed.

Sincerely,

Darlene Chirman

Darlene Chirman
President

Copy:
The Nature Conservancy
Attention: Erik Aschehoug
Attention: Lynn Lozier
213 Stearns Wharf
Santa Barbara, CA 93101

CATALINA ISLAND CONSERVANCY

April 23, 2001

Mr. Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

Dear Mr. Setnicka:

Thank you for the opportunity to review Santa Cruz Island Primary Restoration Plan DEIS. I have a made a number of comments in the margins of the document which I am sending back to you rather than rewriting them all in a separate document. I am also including a number of general comments in this letter.

First, I am very happy to see the National Park and The Nature Conservancy working together on this important conservation project. In my opinion, the removal of feral pigs from Santa Cruz Island is the highest priority facing your agency and the one action that will achieve the greatest conservation impact in the near future. I concur with the DEIS assessment of Alternative 4 being the preferred alternative.

One theme that runs through out Alternative 4 as outlined in the DEIS is the fact that one zone will be completely cleared of pigs before moving on to the next (see exec. summary, page 16, etc.). I think this is a mistake and would not only extend your timeframe greatly but will also decrease your effectiveness in the working zone. It will probably take several years to reach a "presumed zero" in each zone; if you wait until this stage before moving on you are looking at a 12+ year program. Also, we have found here on Catalina that by controlling pigs on both sides of a fence we can achieve greater success. Take the case of working in zone A, which is divided by a fence from zone B. Obviously control efforts will be taking place through all of Zone A. However, by controlling pigs in a buffer zone (of a some specified distance) on the Zone B side of the of the fence right from the start, at least two important things are achieved:

1) Pressure on the fence by pigs is reduced thereby reducing risk of fence failure and subsequent immigration of pigs from zone B to A,
2) Fewer numbers of pigs are on the Zone B side of the fence so if there is a fence failure by some other cause, chance of immigration into Zone A from B is reduced and there is a slightly longer period of time in which the fence break can be discovered and fixed.

Also we have found that the level of activity required in each zone drops off after some initial high peak. In order to keep your hunting team fully working, they can start on the next zone as soon as time permits – i.e. as long as Zone A control needs are being fully met, there is absolutely no reason not to hunt in Zone B just because there might be a few pigs left in Zone A.

Another consideration is that it is important to keep the dogs fully trained. As pig numbers drop off in a zone, it is nice to have an alternate zone with higher numbers of

SANTA CATALINA ISLAND CONSERVANCY

Post Office Box 2739 Avalon, California 90704 310/510-2595

animals to train the dogs. Not only are the dogs being trained, pig numbers are being reduced in a new zone. Obviously, the last zone will have to be done without this benefit.

It is obvious that a lot of time, effort and research has gone into the writing of this DEIS. However, it it unfortunate that a final proofreading was not conducted before the document was sent out for public comment. There are numerous references (25+ - I stopped counting) that are cited in the text but are not in the bibliography, there are double citations of references in the bibliography, references in the text to figures and tables do not always match up and there are occasional misspellings. I mention these points only because they detract from the overall credibility of the work, which overall is high.

A program of this magnitude needs to be considered in two ways: the broad strategy and a detailed operational plan. Without both perspectives, the program is subject to failure. This DEIS does a fine job outlining the broad strategy: I hope equal attention will be given to the operational aspects of the chosen alternative. I know from experience that the small things can have great ramifications if overlooked. Along these lines, I noticed there was no mention of any public relations / education component to any of the alternatives. Again from experience, the development of PR / educational materials should be done before they are needed rather than waiting to be put in a responsive/defensive position.

One point that has come out of the last 11 years of pig control on Catalina Island is the need for total commitment and dedication to complete removal. From 1990 to 1996 we had a program of taking as many pigs as possible but without a firm commitment to complete removal. In hindsight and looking back over the numbers of animals removed each year, we really had no effect on the total pig population. Year in and year out we ended up taking nearly the same number of pigs.

In terms of allowing public access during the control operations, it was not clear to me if private boat owners would also be included. Based on our work controlling sheep on Santa Cruz (we advised people not to go further than the beaches but allowed access on the beach) and our pig control program here on Catalina (where we get almost 1,000,000 visitors/year) I think you should consider some way to at least continue limited access during the program rather than complete exclusion.

Thank you again for the opportunity to review this document. If I can be of any further help, please feel free to call me. Good luck with the program. It is the right thing to do.

Sincerely,

Peter Schuyler

Peter Schuyler
Director of Ecological Restoration

April 24, 2001

PETA
PEOPLE FOR THE ETHICAL TREATMENT OF ANIMALS
501 FRONT STREET
NORFOLK, VA 23510
TEL 757-622-PETA
FAX 757-622-0457
www.peta-online.org
info@peta-online.org

Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

Dear Mr. Setnicka:

The following comments are submitted on behalf of People for the Ethical Treatment of Animals (PETA) and its 700,000 members. The comments are in reference to the Draft Environmental Impact Statement (~~DRAFT EIS~~) for the Santa Cruz Island Primary Restoration Plan. The program would involve killing approximately 4,000 feral pigs living on Santa Cruz Island in an attempt to eliminate the last remaining non-native wildlife population at the park. **PETA strongly opposes the adoption of any lethal program and urges the National Park Service (NPS) and The Nature Conservancy (TNC) to rely on sensible humane methods to gradually reduce the feral pig population on Santa Cruz Island.**

We regret that the NPS and TNC wish to remove feral pigs from the island, but to do so using lethal methods is unconscionable when other methods exist. We have seen the horrifying results of lethal methods used by TNC in Hawaii and other "conservation" groups elsewhere—pigs and "nontarget" animals ensnared in wire that slices into their flesh, some living for many days until starvation and dehydration finally bring relief from the swarming flies and maggots; goats, pigs, and other unwanted animals dying slowly of gunshot wounds in the brush where no one can find them or will even take the time to look for them; and animals ripped to shreds but still alive after dogs are set upon them.

Although my education is in wildlife biology, I am appalled at the lack of concern for individual animal suffering that fellow biologists frequently display when supporting management plans like the one proposed for Santa Cruz Island, which often do not even produce the desired result for the ecosystem.

Regarding the proposed action, hunters often assume that the animals they gun down have been killed instantly, when in reality, they have been severely wounded and are left to drag their crippled bodies into cover only to suffer slow, painful deaths. These violent, cruel deaths are unacceptable by any standard. Furthermore, they are illegal under the anti-cruelty laws of California, Penal Code 597 (b), which states:

> **... every person who ... cruelly kills any animal ... or causes or procures any animal to be ... cruelly killed; and whoever, having charge or custody of any animal, either as owner or**

otherwise, subjects any animal to needless suffering, or inflicts unnecessary cruelty upon the animal ..., is, for every such offense, guilty of a crime punishable as a misdemeanor or a felony or alternatively punishable as a misdemeanor or a felony and by a fine of not more than twenty thousand dollars ...

A "kill" permit does not exempt the NPS or TNC from complying with California's anti-cruelty laws. Instead of using cruel, lethal methods of control, TNC and the NPS must consider using immunocontraceptive methods to slowly reduce the feral pig population on Santa Cruz Island in a humane way.

Fortuitously, consultants with the company that manufactures Gonex, a new mammalian sterilization product, are looking for study sites to perform field trials. This product requires only a single application via darts and is effective on both male and female pigs. The NPS should take this opportunity to use the feral pig control program to help develop a more effective, humane wildlife population control tool that can be used in the future to resolve conflicts with feral pigs around the world. Given TNC's reputation for killing animals using cruel methods, the NPS must not permit TNC to continue its egregious war against non-native wildlife on Santa Cruz Island. The NPS should require that TNC contribute to the development of effective, humane control alternatives by directing TNC to fund an immunocontraception trial on Santa Cruz Island. With a reported annual income of more than **$700,000,000**, it can afford to do the right thing (*The Chronicle of Philanthropy*, November 2, 2000).

Our members are anxiously waiting to hear that the feral pigs on Santa Cruz Island will be spared. We hope that the NPS and TNC will reconsider the proposed pig slaughter and, instead, fund a nonlethal immunocontraceptive study that will serve as a model for future feral pig control programs. I can be reached at 757-622-7382, extension 1614, or by fax at 757-628-0781 if you have questions or need additional information. Thank you for your consideration.

Very truly yours,

Stephanie Boyles

Stephanie Boyles, Wildlife Biologist
Research, Investigations & Rescue Department

cc: Matt Surman, *Los Angeles Times*

California Native Plant Society

Kate Faulkner
Chief of Natural Resources
Channel Islands National Park
1901 Spinnaker
Ventura, CA 93001

Subject: Comments on Summary of the DEIS for the Santa Cruz Island Primary Restoration Plan

Dear Ms. Faulkner,

The California Native Plant Society (CNPS) would like to comment on the Draft Environmental Impact Study for the eradication of feral pigs and fennel on Santa Cruz Island. CNPS both applauds and concurs with the National Park Service's goals for restoring the island's native flora and fauna. The actions of the feral pig populations uproot established native plants, disrupt mycorrhizal connections, expose seed banks to predation, and foster invasive plant species establishment.

As the summary states, nine of the island's plants have listing under the Endangered Species Act. The preservation of these plants is of genuine concern to the CNPS, as are the native plant populations of the island as a whole.

The following comments will refer to the pages of the summary.

Page 3.

The CNPS agrees that priority should be given to eradicating pigs in areas that are undergoing native vegetation recovery. We are concerned with proposed measures for elimination of *Foeniculum vulgare*. It is preferable that physical means are used to remove this invasive species rather than using chemical ones. If this is impractical, sensible spot application of herbicides may be a "necessary evil". However, aerial spraying of Garlon 3, a chemical that kills broadleaf herbaceous and woody plants, is an irresponsible use of this poison. The drift from spraying would ensure that non-targeted natives would be affected as well as the fennel.

Page 4.

CNPS would like to see the removal of feral pigs achieved in as short a time frame as possible, but if due to work power and funding shortages, this cannot be accomplished in a 2 year period, a 6 year time frame is preferable to no action at all. It is reassuring that *Galium buxifolium* will not be exposed to the planned fennel control, but what of the other listed species?

Page 5.

Dedicated to the preservation of California native flora

California Native Plant Society

On the issue of the burning of fennel stands, CNPS would like measures that foster establishment of weeds such as Mediterranean grasses be avoided. Although there are native species that are fire adaptive or dependent, we are concerned those species on which fire would have a deleterious effect on those plants that are not.

Page 6.

Alternative 2 states that herbicide use and burning could lead to soil erosion and consequent sedimentation of streams. Erosion displaces existing plants and hampers the recruitment of seedlings. Sedimentation can adversely affect aquatic plants as well. These effects should be avoided if possible.

In conclusion, while CNPS agrees with the goals and objectives of the DEIS for Santa Cruz Island, we oppose the indiscriminate use aerially applied herbicides. Physical methods of removing fennel such as pulling or cutting would be preferable. If this proves impractical, spot application of poison maybe a compromise that is acceptable. Burning of weed stands would be best conducted in areas with large numbers of fire dependant or adaptive plant species that are growing on topographically flat regions. Conducting this program in the shortest time possible is ideal, but due to various constraints a 6-year period is better than no action.

Thank you for allowing consideration of our comments,

Sincerely,

Alexander Fuentes
Volunteer with CNPS

Channel Islands National Park
19015 Spinnaker Drive
Ventura CA 93001-4354

Dear Gary Davis,

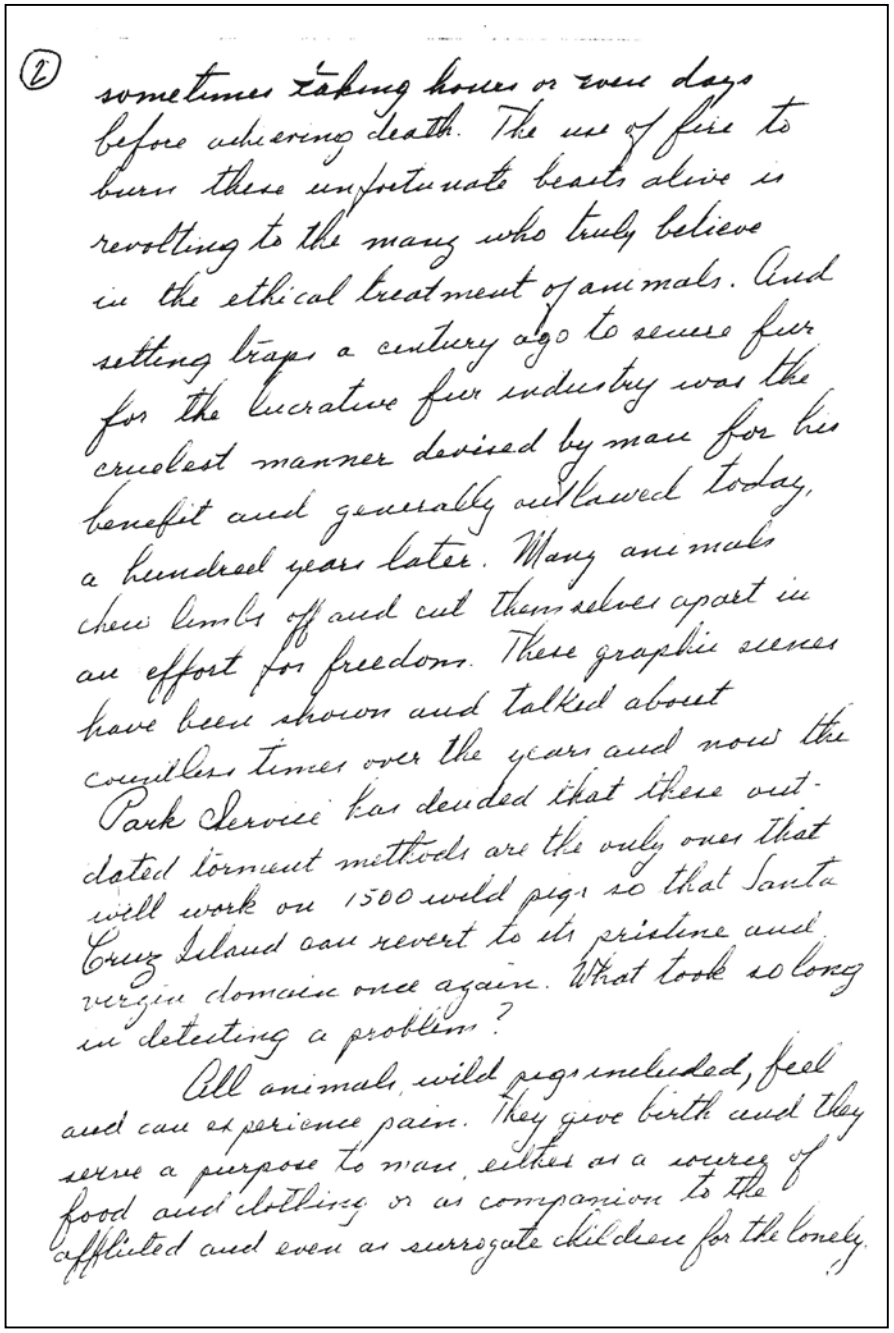
I am writing to you to express my approval for the eradication of the wild pigs on Santa Cruz Island. I am currently a student at Ventura Junior College, and I am taking an Environmental Issues class. This class has made me aware of issues that normally I would never have taken an interest in. When I first read the head line regarding the pigs on Santa Cruz Island, I have to admit I was a little skeptical. The thought of killing thousands of pigs had to be justified for a good cause. After looking into this issue I learned that this process had also been used to eliminate the Feral Pigs on Catalina Island, which had a successful outcome. These pigs definitely seem to be bringing more harm to the Island than good, and it would be in the best interest of Santa Cruz Island to proceed with this process.

I have never been a fan of hunting animals for game or even killing innocent animals other than for food purposes. However after reading of the chaos the pigs are causing it will benefit the island and its natural resources. I feel preserving the rare plants and animals that are being destroyed by the pigs is a great goal for Santa Cruz Island. Bringing the natural Bald Eagle back, and trying to revive the threatened island Fox is just the way to bring back the islands surroundings and inhabitants. Most people would argue that this process in extremely inhumane and down right cruel but it seems to be the only practical solution to the problem. I feel that killing the pigs and restoring the island is for the good of Santa Cruz Island and I thought I would express my support in hopes that all goes as planned. I will be keeping an eye on the progress of this plan and hopefully will see it successfully put into effect.

Sincerely,
Jennifer Graham
Jennifer Graham

It is certainly appalling that the Nat'l Park Service, as advocates to preserve, care for and maintain our nation's glorious parks, should designate themselves as candidates in favor of atrocious animal abuse. The horrifying methods, suggested by the Park Service to eradicate 1500 wild pigs from Santa Cruz Island forever, leaves many of us wondering about the significance between restoring indigenous plants in favor of brutality against fauna which were not there initially but thrived and populated to excess.

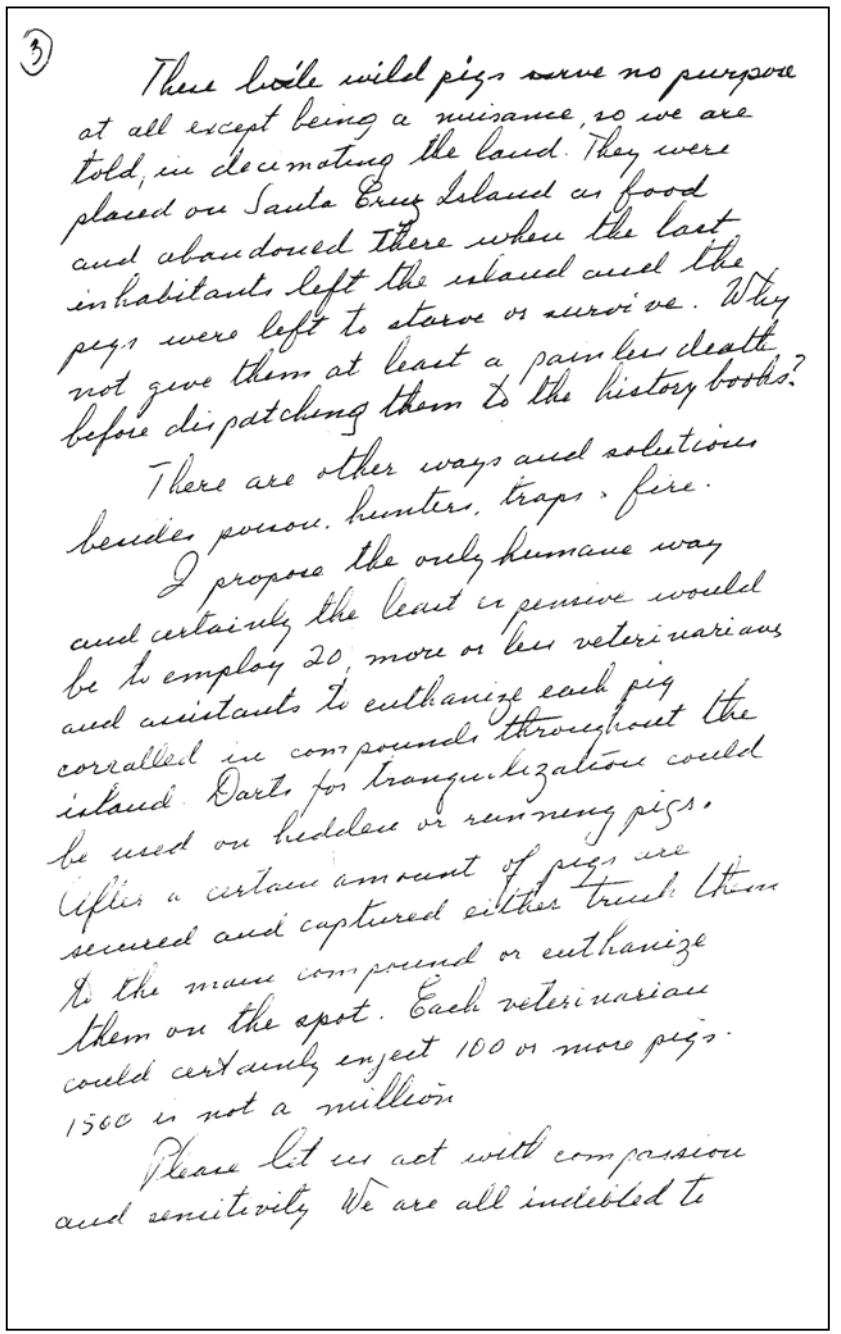
We all understand the problems of endangered wild life, soil conservation and erosion. but to suggest poison, traps hunters, and fire in order to kill these poor animals is nothing short of shocking. It is a known fact that amateur and week-end hunters are by no means crack shooters and often leave animals badly maimed, bleeding profusely with half the body still alive though riddled with holes. Poison is an agonizing process



(2)

sometimes taking hours or even days before achieving death. The use of fire to burn these unfortunate beasts alive is revolting to the many who truly believe in the ethical treatment of animals. And setting traps a century ago to secure fur for the lucrative fur industry was the cruelest manner devised by man for his benefit and generally outlawed today, a hundred years later. Many animals chew limbs off and cut themselves apart in an effort for freedom. These graphic scenes have been shown and talked about countless times over the years and now the Park Service has decided that these out-dated torment methods are the only ones that will work on 1500 wild pigs so that Santa Cruz Island can revert to its pristine and virgin domain once again. What took so long in detecting a problem?

All animals, wild pigs included, feel and can experience pain. They give birth and they serve a purpose to man, either as a source of food and clothing or as companion to the afflicted and even as surrogate children for the lonely.



(3)

These hoofed wild pigs serve no purpose at all except being a nuisance, so we are told, in decimating the land. They were placed on Santa Cruz Island as food and abandoned there when the last inhabitants left the island and the pigs were left to starve or survive. Why not give them at least a painless death before dispatching them to the history books?

There are other ways and solutions besides poison, hunters, traps, fire.

I propose the only humane way and certainly the least invasive would be to employ 20, more or less veterinarians and assistants to euthanize each pig corralled in compounds throughout the island. Darts for tranquilization could be used on hidden or running pigs. After a certain amount of pigs are secured and captured either trank them to the main compound or euthanize them on the spot. Each veterinarian could certainly expect 100 or more pigs. 1500 is not a million

Please let us act with compassion and sensitivity. We are all indebted to

(4)

what is we before us accountable to whatever follows us. These pigs fed many humans once living on Santa Cruz Island and we owe them a small debt in keeping our ancestors alive — I'm certain that many of us had a distant relative residing on this land, so close to Santa Barbara a long time ago. It is our responsibility now as thinking feeling humans to devise a swift and painless death to 1500 pigs and piglets The irony of it all is the fact that these pigs will never actually leave the island at all. Their presence will be gone but the pig lore and stories and the tales of how and why they made Santa Cruz their home and why they were removed forever will be a source of identification and synonymous with Santa Cruz Island for generations yet to come.

Denise Connolly

93 Manzanita Lane - Santa Barbara
Paradise Ca 93105

Date: 04/13/2001 11:42 AM
Sender: BEhler4193@aol.com
To: CHIS Restoration
Priority: Normal
Subject: "Restoring" Channel Islands

I support the "no action" alternative regarding the project. First you get rid of the wild horses, goats and now the pigs, fennel and eagles so the wimpy designer "native" species can thrive. You guys sound like textbook "rescuers".
The plan to develop the island to accomodate dogs, "hunters" and "biologists"
to get rid of some pigs and fennel sounds like an expensive (5 million dollars!!) waste of time. Such arrogance!

Save the fennel and stop the biologists from micro-managing nature!

Sincerely,
Brian Ehler
Carpinteriacoyotereview.com

April 21, 2001

Supt. Setnicka,

Re: 4000 feral pigs

I just learned of the above problem on Santa Cruz Island. Do hope that you'll consider a humane solution like sterilization. Sincerely,

Mrs. Phyllis E. Grame
99 San Juan Ct
Los Altos, CA 94022

Date: 04/23/2001 1:41 PM
Sender: Jeanne Arnold <jearnold@ucla.edu>
To: CHIS Restoration
cc: Ann Huston
Priority: Normal
Subject: draft EIS

Here are my comments on the Draft EIS:
Please forward as needed to appropriate parties (Kate Faulkner, Steve Ortega):

Alternative Two is preferable to speed the removal of the pigs, because more cultural resources can be protected sooner. Alternative Four is adequate if there is no other reasonable choice financially.

My concern, either way, is with the fennel removal and burn. Burning over archaeological sites will cause two kinds of damage, one minor, one major.

(1) Many archaeological site datums (stakes marking site centers) are staked with numbered redwood stakes (e.g., SCRI-XXX) that will be destroyed in burns. These should be relocated and replaced with stamped aluminum stakes (with their site numbers) before the burns. Otherwise, important site location markers will be lost.

(2) Second, burns scorch all artifacts on site surfaces, destroy shellfish remains, damage stone tools (especially groundstone tools), etc., and accelerate erosion. These impacts should be acknowledged and efforts made to minimize them. Also, any DIGGING of firelines should be kept well away from all archaeological sites, and no fennel should be DUG out of the ground. If it is, cultural resources will be badly damaged.

Let me know if you have any questions about my comments.

Jeanne E. Arnold
Professor of Anthropology
310-206-5801 (phone)

Maureen Edwards
[redacted]
25055 Mulholland Highway
Calabasas, California 91302

April 23, 2001

Mr. Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

Dear Mr. Setnicka:

I am greatly distressed to learn of your plan to kill 4000 feral pigs on Santa Cruz Island. Humans take outrageous liberties with other species – not only because of wanting to destroy the pigs but also because they were brought there in the first place by mankind. Why should they suffer the consequences for mankind's poor judgment?

I have heard that there is a new sterilization product called Gonex that is seeking a trial opportunity. It reportedly works on male and female pigs, works with only one application and can be delivered with a dart gun. The pig overpopulation problem could be eventually be eliminated this way – in a humane fashion. What could be more perfect?

I strongly urge you to consider this alternative solution, or any solution that would preempt pig killing.

Thank you.

Very truly yours,

Maureen Edwards

Maureen Edwards

ME:bc

April 18, 2001

4203 Enterprise Road
Bowie MD 20720-3515

Kate Faulkner
Chief of Resources
Channel Islands National Park
1901 Spinnaker
Ventura CA 93001

Dear Ms Faulkner

I am writing to you to express serious concern over the efforts to engineer nature in conserving Santa Cruz Island. I realize that there are archeological interests at stake. Yet I also feel that there are certainly humane approaches to dealing with so-called "exotic" species on the island - exotic species which may be more natural than we are currently aware of. I support a nonlethal approach: certainly there are means available of confining feral pigs, of controlling their population growth, and of using attrition to prevent them from destroying valued human property. Surely, the National Park Service cannot exterminate every "alien and introduced" species from our land? Otherwise, I wonder whether some day we will find that our land is Unnaturally quiet and barren. I wonder, too, how those of European descent would feel, since we are similarly "alien and exotic," in some views.

I would appreciate your response indicating that you are taking steps to avoid killing whenever possible in the restoration of Santa Cruz Island.

Sincerely

Linda Saffell

Linda Saffell

Date: 04/24/2001 2:53 AM
Sender: KsAPigButt@aol.com
To: CHIS Restoration
Priority: Normal
Subject: RE: Restoration Of Santa Cruz Island

I strongly disagree with your intent to eradicate 4,000 feral pigs from the Island for the purpose of restoring the ecosystem. I challenge anyone on your staff to prove that fennel or eagles or pigs have ever been responsible
for wiping out another species. This is simply not true. As for soil erosion or the pigs tilling the soil, there are many humane alternative solutions for this. In the length of time the pigs have inhabited the island, if they were the cause of the degree of destruction as you claim, there wouldn't be an island today.

Man is the only species who disturbs our ecosystems. Animals and plants don't relocate themselves to foreign parts. Humans transplant them. Unlike
humans, other life forms on earth know instinctively how to balance themselves or evolve to work with their environment.

The feral pigs on that Island were put there over 100 years ago. Nature balances itself, provided man does not interfere. If food and water sources
are not sufficient to keep the species thriving, they will naturally adjust their population without our interference. You have heard about the "Circle
of Life"?

This is a national wildlife park. It was established to allow the wildlife to live without our interference. We don't have the right to declare war on
them.

Will man be satisfied when all our natural resources are gone? Why can't man
create solutions to work with nature instead of against it or trying to change it to their needs or liking? Actually, we already have many solutions. For some, however, it isn't as appealing as killing and destruction, and it may be a little more time consuming, and perhaps not as much fun.

If the population of the fox and "other one of a kind species" (whatever those are) are declining, it is because their are problems for that particular species. It is not because of the pigs or eagles or fennel killing them off as you say.

Most of these sudden emergency crisis occur because their is a money issue or
other underlying issue somewhere that is the sole contributing factor. Could
this be another attempt to allow hunters and trappers access to more protected game on protected soil?

Hire personnel who know and better understand nature and who will preserve the wildlife and ecosystem instead of further destroying it. Protect those animals and their home. Stop the killing and stop interfering with nature.

Jeannette Ferro
321 Lynnette Drive
Metairie, LA 70003-6557

Helene Schwartz

2217 Tyson Avenue
Philadelphia, Pa 19149
(215) 624 7864
bozzybear@msn.com

Mr. Tim Setnicka
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Dear Mr. Setnicka,

The Nature Conservancy's recommendation to kill the feral pigs on Santa Cruz Island is receiving negative national attention. I am compelled to write to you to voice my objection to killing the pigs as a form of population control.

It is my understanding that the pigs are not indigenous to the island and were introduced. It is unfair to kill them, especially under those circumstances. I also understand that a simple method of population control called Gonex is safe, humane and the funds are available for it's use by a private foundation.

I urge you to take advantage of Gonex. Such animal population methods have proven successful in other situations similar to the one on Santa Cruz Island.

Thank you.

Sincerely,

Helene Schwartz

2627 State Street No 2
Santa Barbara, CA 93105

Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

RE: Santa Cruz Island Primary Restoration Plan

I strongly favor Alternative 4 of the Santa Cruz Island primary restoration plan. Feral pigs clearly present a significant threat to natural restoration of many native plants on Santa Cruz Island and clearly contribute to expansion of invasive exotic plant species.

I have spent over 7 years conducting field studies on Santa Cruz Island with respect to state and federally listed threatened and endangered plant species. Populations of most of them, especially Santa Cruz liveforever (*Dudleya nesiotica*), Hoffmann's rock cress (*Arabis hoffmannii*), Santa Cruz Island buxh mallow (*Malacothamnus fasciculatus* var. *nesioticus*), and Island lacepod (*Thysanocarpus conchuliferus*), have experienced significant losses as a result of intense rooting by feral pigs. Survival of the few remaining populations and restoration under natural conditions depends on complete removal of feral pigs from the island.

Little (if any) recruitment of oak species on Santa Cruz Island is taking place. Feral pigs clearly favor oak woodlands, and actively disturb soil through rooting for oak acorns (see plan references, Peart et al. p. 111). Soil disturbance by feral pigs has led to an almost total absence of young oak plants throughout much of the island and also has contributed to a significant loss of ecologically important crypto-biotic crust. It is well known that the latter is critical to nutrient recycling and to establishment of native plant species.

Finally, it is also very clear from general observations, that most native bulb species, including onions, mariposa lilies, brodiaeas, Humboldt lilies, and triteleias, are rare on Santa Cruz Island because of feral pig activity. In at least two 6-year old "pig exclosures" constructed on Santa Cruz Island, reproductively mature plants of onions and blue dicks have increased exponentially since pigs were excluded. These observations strongly suggest that feral pigs are a significant threat.

None of the other alternatives are acceptable, including alternative 3, which does not provide for natural restoration and long-term survival based on current scientific standards of conservation biology. In the long-term, alternative 4 is also the least expensive approach to ensure long-term survival and restoration.

Yours most sincerely

Dieter Wilken, Ph.D.

7019 Tulip Street
Philadelphia, PA 19135
siobhangephart@aol.com

Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

Dear Superintendent Seticka:

I must convey to you in the strongest terms my objection to the killing of about 4,000 feral pigs on Santa Cruz Island. The fact that this proposed action was developed in coordination with the infamous Nature Conservancy, which has been responsible for the death of thousands of animals worldwide despite viable proven alternatives, gives the plan little credibility.

Voters have expressed their overwhelming approval for non-lethal methods in situations such as this. The expediency of a bullet is no longer acceptable. It was humans that first brought the pigs to Santa Cruz Island, thus, it is our responsibility to correct our mistake humanely. The most humane way to rid the island of these feral pigs is through sterilization. There is a new sterilization product called Gonex that is seeking a trial opportunity. Gonex reportedly works on both male and female pigs, with a one-time only application that can be delivered by a dart gun. Thus, this dilemma could be solved with out killing.

It would behoove the Park Service to sponsor this trial, which would add immeasurably to the worldwide feral pig dilemma and bring credit to the Department of Interior. Perhaps the wealthy Nature Conservancy (1999 income: $704, 004,760, according to The Chronicle of Philanthropy, 11/2/00) could contribute to this worthy trial. (Gonex consulate, Ms. Carol Moulton, telephone 303-337-2728.)

I respectfully urge you to avoid the all-kill policies of the Nature Conservancy and seek alternative, nonlethal solutions. Thank you for taking the time to read my letter. I look forward to hearing from you on this matter.

Sincerely yours,
Siobhán Gephart

April 22, 2001

65-60 Booth St.
Apt #1K
Rego Park, NY 11374

Mr. Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Dear Superintendent Setnicka:

We would like to express our strong opposition to the killing of the thousands of feral pigs on Santa Cruz Island. We believe that alternatives to using bullets to solve this problem do exist and should be used. The most humane alternative is a new sterilization product called Gonex, which reportedly works on both male and female pigs. It requires a one-time only application and can be administered via a dart gun. Therefore, the pig overpopulation problem could be eradicated over time through sterilization.

We are also very disturbed that the killing plan has been coordinated with the Nature Conservancy, which has a long history of killing thousands of animals worldwide despite the existence of alternatives. We cannot continue to slaughter animals once they have become "pests" or "inconvenient" to us. It is we humans who brought these pigs to Santa Cruz Island, and in the ultimately the blame for the current conditions rests with us. Therefore, we have a responsibility to find and utilize humane alternatives to solve such problems. We also think the very wealthy Nature Conservancy ($704,000,000 1999 income-The Chronicle of Philanthropy) should help out with the cost of using Gonex.

We join the majority of Californians, who have voted overwhelmingly for non-lethal methods in problems involving animals, in imploring you to use humane, non-violent alternatives to solving the feral pig problem.

Respectfully yours,
Dolores Ferraro
Dolores and David Ferraro

BETTY L. JEPPESEN
Attorney at Law
800 Garden St., Suite K
Santa Barbara, Ca. 93101
(805) 963-8621

April 23, 2001

Santa Cruz Island Primary Restoration Plan
Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

BY FACSIMILE AND
REGULAR MAIL

Re: Pigs on Santa Cruz Island

Dear Mr. Setnicka:

The Santa Barbara News-Press recently ran an article entitled "Waging war on wild pigs". They state "There will be no prisoners taken." It indicated that the Park Service is planning to inhumanely shoot to kill approximately 4000 pigs on Santa Cruz Islay by the use of traps, dogs, and fences with the excuse of saving 9 species of native plants. Can this be true'

I have learned that it is possible to use a tranquilizer type gun to administer a one-time sterilization called Gonex (Gonex consulate, Ms. Carol Moulton, telephone 303-337-2728). Surely, this has to be less expensive than the approximately $750,000 it cost to eliminate the pigs on Santa Rosa Island. Please consider this much more humane alternative to the current plan.

Also, these pigs are not wild. They were introduced by man in 1852 as domestic pigs. Second, there was no mention in the News-Press article whether killing all the pigs on Santa Rosa Island in 1991 and 1992 helped the plants at all. The only mention is that on Santa Cruz Island "since the wild sheep were killed off … the weeds have come back with a vengeance." Do we want weeds??? Are we hunting down and slaughtering intelligent pigs for a bunch of weeds??? Please, let's stop and **think** like the human beings we claim to be. Please let me know if I can help save these pigs. Thank you very much for your time in reading my letter and in anything you can do to save this carnage.

Yours very truly,

Betty L. Jeppesen

Betty L. Jeppesen
Attorney at Law

April 23, 2001

Diana Cora
25-42 43rd Street
Apt #6
LIC, NY 11103

Dear Mr. Setnicka:

I am writing to express my strong objection to the slaughter of the approximately 4,000 feral pigs on Santa Cruz Island, especially in light of the fact that a humane alternative exists. There is a new sterilization product called Gonex that requires a single application which can be delivered by dart gun. Gonex works on both male and female pigs. (Gonex consulate: Ms. Carol Moulton, telephone: 303-337-2728).

I am also highly skeptical about any plan that has been developed in coordination with the Nature Conservancy. This organization has a terrible reputation for killing countless animals all over the world, and rarely if ever uses humane alternatives in dealing with problems involving animals. In fact, the Nature Conservancy should help pay for the sterilization of these pigs; they certainly have the funds for it (over $700 million in income for 1999).

Mr. Setnicka, we are not ignorant, cruel, savages; we are compassionate, intelligent, human beings living in the 21st century. Solving our problems by violence and killing is totally unacceptable. We have the technology, the funding, and the knowledge to use humane and non-violent solutions to many problems involving animals, and I ask that you take this route in dealing with the feral pigs on Santa Cruz Island.

Thank you for your time.

Sincerely,

Diana Cora

Diana Cora

April 21, 2001

Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

Joy M. Zakarian, M.P.H.
2442 Oxford Ave.
Cardiff, CA 92007

Dear Mr. Setnicka:

I am writing to urge you to reconsider your plan to kill the feral pigs on Santa Cruz Island. The Nature Conservancy, which is apparently collaborating with you in this proposed effort, is infamous for their killing of animals in the name of conservation. Yet the majority of Californians do not support killing of wildlife.

Apparently there is a new contraceptive called Gonex that requires only a one-time application to sterilize both male and female pigs. I urge your agency to sponsor a trial of Gonex on the Channel Island pigs, as a much preferable alternative to lethal control.

Sincerely,

Joy M. Zakarian, M.P.H.

Andrea Heaton
4615 White Oak Rd.
Minnetonka, MN 55345-3844
aheaton@heatonbrandt.com

April 20, 2001

Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

Dear Mr. Setnicka,

I am writing to respectfully urge you to support a non-lethal management plan for the feral pig colony on Santa Cruz Island.

The mass slaughter of this population is cruel and unnecessary. Please use this opportunity to implement and validate a humane sterilization program and refuse all Nature Conservancy proposals that include extermination.

Sincerely,

Andrea Heaton

Gayle Harris Birk
14188 Shadow Bay Drive
Willis, TX 77318
936-890-2152; fax 936-890-2368

April 20, 2001

Tim Setnicka, Superintendent
Santa Cruz Island Primary
Restoration Plan
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Dear Mr. Setnicka:

As you are aware, California citizens have cast their votes for non-lethal methods where animals are concerned. I have been told that there is a product known as Gonex that can be used to carry out test trials on female and male pigs to assure their sterilization. I urge you to please give them this product a chance to work before agreeing to kill 400 pigs on your island.

My admiration for the Nature Conservancy has faded over the years when I continued to read of their killing of thousands of innocent animals. To sacrifice them for a restoration program is not a fair exchange. These pigs can be relocated and saved from slaughter. Perhaps Nature Conservancy could use some of their over seven million dollars to help the pursuit of a sterilization program.

Your agreeing to sponsor this trial using Gonex would put the Department of Interior in a good light in the eyes of the public. To continue the slaughter of millions of animals by the federal government is ludicrous and does not live up to our claim of being a ""Christian"" nation. The inhumane, brutish activity of destroying living creatures must stop.

To learn about the Gonex program, please call Ms. Carol Moulton at 303/337-2728.

Thank you for "listening."

Thank you!

Respectfully submitted,

Ms. Gayle Harris Birk

Santa Cruz Island Primary Restoration Plan
Tim Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

Dear Mr. Setnicka,

On behalf of our 80,000 members nationwide I must convey to you in the strongest terms our objection to the killing of 4,000 (est.) feral pigs on Santa Cruz Island. The fact that this proposed action was developed in coordination with the infamous Nature Conservancy, who has been responsible for the death of thousands upon thousands of animals worldwide despite viable proven alternatives, gives the plan little creditability.

This wholesale slaughter also brings dishonor to the National Park Service. The citizens of California have voted over and over again for non-lethal methods in situations involving animals. The expediency of a bullet is no onger
acceptable. Man, who first brought the pigs to Santa Cruz Island, is to blame for this condition. Man, therefore, has a responsibility to seek a humane solution.

There is a new sterilization product called Gonex that is seeking a trial opportunity. I understand that it works on both male and female pigs, with a one-time only application that can be delivered by a dart gun.

The pig overpopulation problem could be eradicated over time through sterilization. It would behoove the Park Service to sponsor this trial, which would add immeasurably to the worldwide feral pig dilemma and bring credit to the Department of Interior. Perhaps the wealthy Nature Conservancy (1999 income: $704, 004,760. according to The Chronicle of Philanthropy, November 2, 2000) could contribute to this worthy trial. (Gonex consulate, Ms. Carol Moulton, telephone 303-337-2728.)

We respectfully urge you to avoid the all-kill policies of the Nature Conservancy and to seek a non-lethal, alternative solution.

Sincerely
pinky jain pan
P.P.Box 14982
Santa Rosa,CA, 95402

Larry L. Loeher, Ph.D.
11876 Rochester Avenue
Los Angeles, CA 90025-1404
(310) 825-9149
lloeher@ucla.edu

April 24, 2001

Tim J. Setnicka, Superintendent
Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001

Re: Santa Cruz Island Primary Restoration Plan

Dear Superintendent Setnicka:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement for the Santa Cruz Island Primary Restoration Plan. I find it to be a realistic approach to a long-term and severe problem, and the recommendations of Alternative Four seem within the bounds of responsible management.

There are several issues, however, which the Plan either needs to address, or which it needs to amplify in order to clarify its intent. I have these comments:

1. Chapter Four, page 69. The DEIS states, "Single fire events do not negatively affect chaparral and other California/Santa Cruz Island communities." While this statement is true, it is not sufficient to address the specific concerns of Santa Cruz Island. Within the shrub communities there are exemplar species individuals of particular age, size, formation, or location as to make them significant. In the isthmus area, for example, I have found Toyon stems growing from a previous (and larger) original root structure which were (in 1990) 106 years old, plus or minus 3 years. This stem had fallen due to structural failure of the original root platform and was not due to senescence, thus could have achieved an even more significant age. Since communities on the mainland rarely exceed 60-80 years of age before succumbing to fire or environmental factors, these individual specimens have noticeable interest. These long-lived and physiologically healthy individuals have scientific value that supercedes the comment about the collective community.

Likewise, Santa Cruz Island Manzanita (A. insularis) stems in excess of 90 years in age have been collected. The actual age is greater, possibly by as much as 30 years, but undeterminable due to center rot or termite invasion along the pith of

the stems. These stems were from individuals blown over by microburst winds in November of 1987, but were otherwise vigorous and productive, as is the remaining population. Again, there is no correspondence to mainland situations (not to mention the species difference itself).

The point is that not all aspects of a community are comparable, and plans to control burn – already demonstrably problematic on Santa Cruz Island due to wind behavior – must address the unique value of some parts of the larger shrub population and take particular measures to protect them. The survival of the community is a different issue than the preservation of unique specimens within the community.

2. Chapter Four, page 69. The DEIS states: "Fire will burn the outer branches of the shrubs, but most native California shrubs are adapted to fires and will resprout from the crowns and buds on burnt branches." This statement applies to some selected portions of the community, but not to all. Only low-intensity burns fail to consume the majority of the plant – not so much "the outer branches" as stated, but rather those of the smallest diameter (often <2.0 cm or, depending on conditions, a "one-hour fuel") irrespective of their location within the canopy. The majority of standing material is usually – with the exception of oaks - killed under normal burning conditions. Also, the dominant member of the chaparral community on much of the island, namely A. insularis, does not establish a root crown and cannot resprout.

The comment here is to emphasize that generalizations about the relationship of shrub communities with fire, their seeding and resprouting capabilities, and their potential for reestablishment is based on a state of knowledge that is incomplete and still-evolving. Management protocols must remain sensitive to differences within the community.

3. Chapter Four, page 70. An additional benefit to native vegetation accruing from pig removal, which you could choose to include, is that pigs currently cause significant mechanical damage to seedlings and young shrubs that are extending the limits of existing shrub canopies. Pigs, for unknown reasons, often rip stems apart and destroy re-colonizing small shrubs. This happens on plants too young to produce significant amounts of seed, too small to provide shade and cover, and too small to recover from the mechanical damage. Up to 35% of such shrubs, according to my measurements, may be impacted. This does not occur within contiguous chaparral canopies, but impacts only those exact individuals that are most critical to chaparral community reestablishment in Mediterranean grasslands.

4. Chapter Four, page 90. The DEIS states that, "Mediterranean annual grasslands have already begun to invade pristine native communities such as chaparral, coastal sage, and oak communities." I hate to be quibbling, but in the instance of chaparral, most of the evidence points to the exact opposite being true. No matter, the real concern is with the statement, "Aggressive restoration techniques may be needed to facilitate the re-establishment of native shrub communities in areas of invasive species infestations." If the mechanisms of invasion themselves are not clearly understood, and they are not, then aggressive measures may be inappropriate and possibly even detrimental to some plants within the community. Aggressive control of invasives is not comparable to aggressive restoration techniques, especially where there is a demonstrated bias towards active management practices such as prescribed burning. The types of restoration techniques employed need analysis and evaluation separately from fennel control and feral pig removal.

5. Chapter Four, Page 96. The DEIS states that, "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." Research projects may, in some instances, represent significant personal, public, and other resource investments, and often no alternative sites are available - especially for on-going research. The Plan must assure that such access reduction is neither arbitrary nor for the mere casual convenience of pig-hunters who are not actively engaged in continuous 24-7 hunting. Compelling circumstances must be found to permit exclusion for more than moderate periods of time, and even then, opportunities for partial access must be made available. Such research is in the Park Services' own interest in that the data obtained may provide critical information on maintaining long-term positive effects for restoration.

I appreciate the effort which went into the development of this DEIS, and am in total agreement with its long-term objectives. The selection of Alternative Four as the preferred alternative causes me no general concern, but I do feel that addressing the points raised above will add to the quality of the plan and the achievement of its stated objectives.

Sincerely,

Larry L. Loeher
Ph.D.

218 W. 7th Avenue
Conshohocken, PA 19428-1640

April 22, 2001

Tim Setnicka, Superintendent
Santa Cruz Island Primary Restoration Plan
Channel Islands National Park
1901 Spinnaker Drive
Ventura, California 93001

Dear Mr. Setnicka:

I will be brief. Please oppose the killing of the estimated 4,000 feral pigs on Santa Cruz Island. The fact that this proposed action was developed in coordination with the infamous pro-kill Nature Conservancy gives the plan questionable credibility.

Please use a humane, non-lethal means of managing the pig population such as Gonex. Gonex works on both male and female pigs with a one-time only application that can be delivered by a dart gun. This means that the pig overpopulation problem could be eradicated over time through sterilization.

Sincerely,

Allison Marie Memmo Geiger

Mr. Setnica,

I hope that you will reconsider the barbaric slaughter of the feral pigs. Only man lets a problem get out of hand and then says he is forced to deal with it in a violent manner. There are humane solutions as there are to all problems. Cruelty is not ever the answer. Please listen to all the options.

Thank you
\
Robin Betian

Ms. Robin Betian
10501 Trunk Bridge Rd.
Pecatonica, IL 61063-9016

NPS Response to Comments

1 Mitigation will be incorporated that ensures that herbicide application would only occur within designated fennel areas. NPS botanists will be involved to identify designated spray areas to ensure rare or intact native communities are not sprayed. To ensure precise application in areas that cannot be aerially sprayed, hand spraying would be done. Garlon 3a aerial application would be done by a California certified agricultural herbicide applicator. The applicator would meet all pertinent state and federal standards for herbicide application. At a minimum the park will require that the applicator have: 1) OAS and California Department of Agriculture certification for aerial application of herbicides; 2) helicopter equipped with differential GPS units to ensure even and accurate coverage of the target area; and 3) experienced in aerial activities in remote offshore park islands.

2 EPA registration number for Garlon 3A is 62719-37. In addition Garlon 3A is a registered product with California Department of Pesticide Regulation. Certified aerial applicators will be applying the herbicide within a defined area that contains the target species fennel (*Foeniculum vulgare*). Application will adhere to label direction and Federal and State pesticide laws. There are no pesticide use restrictions that would disallow use of Garlon 3A for this project.

3 A full Biological Assessment (BA) describing the effects on threatened and endangered (T&E) plants will be submitted to the US Fish and Wildlife Service for their review and concurrence. A summary of this BA can be found in the Appendix. The BA includes an assessment of potential effects to ESA listed T&E species from the use of Garlon 3A. Analysis of effects to listed plant species can also be found in Chapter Four, Alternative Two - Threatened and Endangered Plants.

4 Garlon 3A effect on water quality is discussed in Chapter Four (pg. 100). In general, Garlon 3a in surface waters breaks down rapidly under sunlight conditions, with the half-life in water being less than 24 hours. Leaching of triclopyr into groundwater depends on the soil type. Triclopyr should not be a leaching problem under normal conditions since it binds to clay and organic matter in soil. There is no live water within the treatment area.

5 Fence must be of high quality construction and must be maintained to a high standard to keep pigs restricted to/from an area. Long-term fence maintenance is a concern, especially if there is constant pressure placed on the fence by a dense pig population. Because of these reasons the Park has a concern that implementation of Alternative Three will not be efficacious. Alternative Three implementation would likely result in pigs eventually breaching both the NPS/TNC boundary fence but also the fences that are necessary for protection of sensitive resources. Alternative Four, however, only needs to maintain the fence to a high standard for two to four years depending on whether the section is common to a zone that is populated with pigs. In addition, the pressure placed on the fence by pigs would be much less because of lower pig densities as hunting progresses within a hunting zone. A high level of commitment to pig fence construction, maintenance and monitoring is required because project success depends on adequate fencing. Pig fence would be of similar construction type and quality as other pig fencing found on Catalina Island and Hawaii Volcanoes NP; these fences have proved sufficient to restrict pig movement.

6 For Alternative Four, vegetation recovery is the driving factor for selecting hunting units. The removal of sheep has allowed vegetation on the island to recover substantially. The Nature Conservancy land, where the sheep have been removed for approximately 16 years, has recovered considerably more than on NPS lands where the sheep have been removed only for three years. With each passing year vegetation cover increases. As hiding cover increases for pigs, the difficulty in removing them also increases. Hunting units that have the greatest pig cover are the most likely units that will receive the

earliest treatments. These areas are mostly located in the southwest portion of the island. Once a unit is completed, removal activities would move to an adjacent unit with a common fence. When operations move to a new unit, the new unit would be directly adjacent to the completed unit. The difficulty of defending against pig invasion is more difficult in non-adjacent units because there is considerably more fence to monitor.

7 The potential for exotic weeds to invade areas treated or disturbed as a result of proposed activities are described in Chapter Four. In this discussion mitigation measures are prescribed that would prevent or minimize invasive species from being reintroduced. If the the mitigation measures are included in the final decision, the mitigation measures will be in a distinct section of the decision document. Having mitigation measures explicitly described in the ROD would preclude the need to have a separate mitigation plan.

The activities associated with this project are intended to improve the long-term condition of soils and reduce pig-related disturbance that leads to ruderal species invasion. Some short-term impacts are expected; however, these impacts are not on the same scale as the current disturbance that is occurring as a result of feral pig rooting. Should the short-term impacts described in this analysis linger or became exacerbated over time then they will be addressed as part of the Park's resource management program. On a priority basis, the resource management staff currently deals with exotic species control, erosion abatement, and native species restoration.

8 Mitigation measures will be presented in a distinct section within the Record of Decision. Within this section mitigation measures for cultural resources will be described and will be required for implementation to commence. Chapter Four "Cultural Resources" (pg. 131) includes a section that summarizes Section 106 compliance.

9 Chapter Three "Air Quality" (pg. 29) has been updated to include the park's air quality standards, ambient air conditions, and potential air quality impacts for Channel Islands National Park, including Santa Cruz Island. The data is derived from Santa Barbara Air Pollution Control District, and the ozone monitoring station on Santa Rosa Island. Chapter Four "Air Quality" (pg. 102) discusses the air quality cumulative effects of present and future actions with the impacts associated with implementing each alternative.

10 Santa Cruz Island is located in Santa Barbara County. The Environmental Protection Agency approved Santa Barbara County's Clean Air Plan on August 14, 2000. This plan becomes the federally enforceable ozone plan for Santa Barbara County. Prescribed burning on Santa Cruz Island would require a permit from Santa Barbara County Air Pollution Control District. The burn plan to be developed for the burn is required to meet standards in Santa Barbara's Clean Air Plan. The district can also impose mitigation measures on the burn that would minimize smoke impacts.

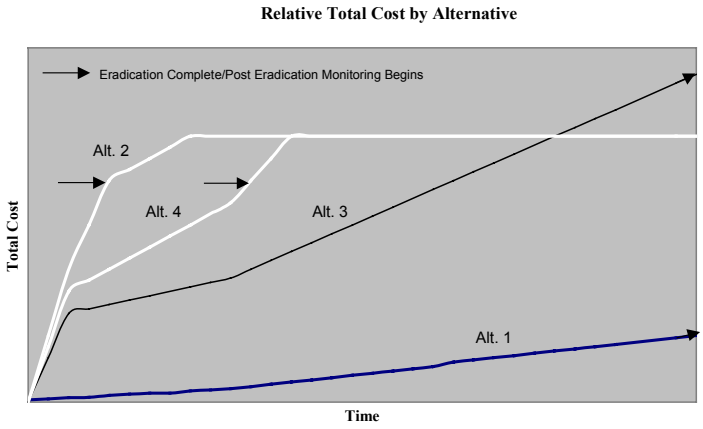
11 Mitigation measures have been incorporated into the air quality effects analysis. These mitigation measures will be the same for each alternative and will be carried forward into a distinct section within the Record of Decision. Within this section mitigation measures for conducting the fennel burn will be described and will be required for implementation to commence. These mitigation measures, although not inclusive because the prescribed burn plan has not been submitted to Santa Barbara County APCD, can be found in Chapter Four (pg 103).

12 The effects analysis has evaluated all potential land disturbing activities and their effect on soil and water quality. Generally, the analysis concludes that the effects are expected to be negligible, short-term, and would reverse upon completion of project activities. The long-term benefits of eradicating

pigs on soil and water quality far outweigh the short-term impacts. The analysis also recognizes that there may be areas that need restoration because of activities associated with the project. These disturbed areas would be evaluated by NPS and TNC restoration specialists to determine what actions would be necessary to mitigate these impacts. The recommendations would be implemented on a case by case basis.

13 The Park will be submitting a biological assessment (BA) to the U.S. Fish and Wildlife Service for concurrence. A summary of biological effects to listed species can be found for each alternative in Chapter Four of the EIS. A summary of the BA for the Park's preferred alternative for T&E plants is included in the Appendix.

14 In the EIS analysis, the NPS discussion of project funding is always made in association with other factors the Park must consider in its overall management of five off-shore islands. These factors include marine transportation, island housing, island transportation, personnel support, other island support, and other park priorities. It is estimated that the total cost of eradicating pigs under Alternative Two and Alternative Four is about the same. The biggest funding difference between these two alternatives is when the activities and their associated costs are incurred. The figure below gives a general idea of how the relative costs would be incurred over the course of the eradication program and post-eradication monitoring (and beyond for Alts 1 and 3). Alternative One is an estimate of the control costs under its existing management and would be incurred into perpetuity. Alternative Two has all of its costs within the first four years of the program, with the majority of costs incurred during the first two years of the project. Alternative Three would have high startup cost to begin eradication efforts on NPS lands, and would have annual monitoring and control costs that would be incurred into perpetuity on TNC owned lands. Alternative Four would have startup costs similar to Alternative Two, but would have relatively stable costs for the remainder of the project.



In considering when costs and activities are incurred with the factors listed above, the Park has identified adequate funding for Alternative Four, and has not identified a way to fund Alternative Two. In addition, the Park believes that supporting the implementation of Alternative Four would be easier than Alternative Two (see Preferred Alternative discussion pgs. 25-26). Alternative One and Three would have substantive intangible (loss of economic value of knowing that a resource exists in a given context) and ecological costs (loss of natural and cultural resource values) associated with allowing pigs to remain on the island. Given these costs, the Park strongly believes that the eradication of pigs is the most cost effective action that can be done to protect the island and avoid incurring costs for protection of sensitive resources into perpetuity.

15 The Nature Conservancy allowed California Department of Fish and Game to conduct a one-time limited sport hunt on their property in the spring of 2002. Sport hunting is not allowed on NPS-owned lands. There is substantial evidence that sport hunting is not a viable option to eradicate feral pigs (See

"Alternatives Considered but Dismissed – Public Hunting"). Because eradication of pigs will require extensive time, energy, persistence, and experience, hired expert hunters will be used for this project. Funds have been identified for this project, however, the NPS and TNC continue to monitor project needs and will cooperatively seek future funding as necessary.

16 This project is consistent with the management guidelines in the General Management Plan. Sections of the GMP and RMP (Resources Management Plan) that support this project has been included in this EIS (See "Guidance for Resource Management" Chapter One pgs 2-4). As recommended under NEPA guidelines (40CFR 1508.28), to eliminate repetitive discussion and reduce paper waste the Park has tiered this analysis to the GMP, rather than reprint extensive sections of this document in the EIS. The Park is currently in the early stages of revising its General Management Plan. This multi-year GMP revision process is expected to be completed in 2004/2005, and therefore would not be completed in sufficient time to have an influence on this project. This project is being implemented under the guidance of the existing GMP.

17 The chart has been revised to match the organizational structure of Chapter 4.

18 Eradication of feral pigs has always been seen as being more difficult than feral sheep eradication. Limited resources prompted The Nature Conservancy to focus on one major eradication project at the time. Eradication of sheep on TNC land was seen as a viable goal given their resources at the time. At the time NPS did not have full ownership of any portions of SCI.

Although TNC eradicated sheep from their lands, sheep remained on east Santa Cruz Island. Upon acquiring east SCI in 1997, the NPS was funded to remove the remaining sheep from the island. Pig eradication could not have been attempted at that time because it was not funded.

19 The Park and TNC have made this project their top restoration priority for Santa Cruz Island. The compliance process is on schedule to be completed within the 2002 calendar year. Depending on the outcome of the environmental analysis, implementation activities could occur as soon as the fall of 2002. The Park understands the urgency of the project and is actively moving forward to complete the compliance process. The Park's compliance process is important as it ensures compliance with all applicable federal, state, and local laws.

20 Your suggestions will be added to the mitigation measures needed to protect T&E listed plant species found on Santa Cruz Island. The NPS and USGS-BRD applied for and received a permit to collect and propagate individuals of the Channel Island's 13 listed plant species (Federal US Fish & Wildlife Permit # TE044846, 10/29/2001)

21 The Park has recently completed a draft recovery plan for the island fox. This recovery plan includes Santa Cruz Island. The draft recovery plan makes the following recommendation for the island fox on Santa Cruz Island: 1) Complete removal of golden eagles from Northern Channel Islands; 2) Recover wild fox population to viable levels by implementing captive breeding on Santa Cruz Island; 3) Protect island foxes from canine diseases by enforcing no dog policy and vaccination on working dogs; 4) Remove feral pigs; 5) Reintroduce bald eagles; 6) Restore native vegetation communities. The NPS and TNC are working aggressively to remove golden eagles, these efforts will continue as long as necessary to protect the island foxes, including throughout the pig eradication project.

22 Mitigation is included that requires dogs used in the pig hunting operation be vaccinated and free of potential diseases that could be transmitted to the island fox. The dogs used in the operation will be under the care of veterinarian, and veterinarians are also an integral part of the fox recovery efforts. Dogs will be trained to avoid non-target species, and any dog that exhibits aggressive behavior to the

fox or other non-target species will be removed from service. This method has been successfully used on Santa Catalina Island where pig-hunting dog teams are used in an environment with island foxes.

23 Gonex

Gonex is a chemical compound currently under development for use as an injectable sterilant for all mammals. It works by destroying the gonadotropin hormones secreted by the anterior pituitary gland. Those hormones are required for successful reproduction, and are the same in all mammals.

Gonex does not have Food and Drug Administration (FDA) approval and therefore cannot be used on this project. There is no indication that this drug would receive FDA approval in the near future. Even if Gonex were to gain FDA approval there is no indication that it would be a viable tool for feral pig eradication, since sterilants in general have proven ineffective for use in an eradication program.

Sterilization

Sterilants in general cannot be used for this project because: 1) use of a sterilant would require injecting and marking each pig on the island; and 2) they are unproven for an eradication program.

Requires Injecting and Marking Each Pig on the Island: The logistics of delivering the sterilant to all pigs on the island comprises an insurmountable obstacle. Because a certain percentage of pigs become trap shy (avoid traps), delivering injections to all pigs would be impossible. The annual effort required would exceed the capabilities of NPS and TNC. And unless treated animals were marked, it would be impossible to distinguish treated pigs from untreated pigs. There is no permanent marking for a feral animal that is not directly handled.

Unproven for an Eradication Program: Sterilants are unproven for any mammal eradication program. Use of any sterilant on Santa Cruz Island feral pigs would be a waste of money and would not achieve the purpose of this plan, which is to eradicate feral pigs island-wide. Use of any sterilant would, at best, control pig populations for the period of time that teams of hunters would be funded, and certainly could not eradicate them. Short-term control of the pig population is not acceptable, because pigs would quickly multiply and continue to impact natural and cultural resources.

Humane Treatment

The EIS did look into other methods of killing pigs, including snares, poison, and introduction of swine diseases. These methods were dismissed in part because they would not have the efficacy of a well-placed gunshot. These other methods could also inflict more pain and suffering to the pigs. In a report sponsored by the American Veterinarian Medical Association (2001) they indicate that an accurately delivered gunshot is an acceptable method of euthanasia. For wild or free-ranging species, a gunshot may be the most practical and logical method of euthanasia and has the advantage of minimizing stress induced by handling and human contact (AVMA 2001).

Annually, Park and TNC staff, as well as the visiting public, witness the starvation of pigs on the island. Park staff, especially those who work on the island, feel strongly that it is more humane to deal with pigs in the manner proposed in this EIS, versus having to witness the annual starvation that occurs to pigs on the island. The Park and TNC agree with the characterization of the humane treatment of pigs on Santa Cruz Island provided by Adrian M. Wenner, Professor emeritus, Department of Ecology, Evolution and Marine Biology UCSB:

> *"As a biologist, I have had extensive experience on the island and can report first-hand about the pig situation there. Feral pigs on the island number in the thousands. In good years, they reproduce to their full ability and soon exceed*

their food source. As they run out of easily obtainable food, such as acorns, they desperately plow up the ground in search of bulbs, roots and tubers, leaving the soil open to being washed away in future rains; and thereby exterminating native plants. They then eat non-nourishing grass as they starve. During the 1988 and 1989 droughts, for example, perhaps nine-tenths of the pigs died of starvation. But pigs don't starve immediately; as the weaker ones succumb, they get attacked and eaten by stronger pigs. At those times we could hear the squeals of pigs in such fights. By the end of 1989, nearly every pig I encountered was nothing more than a bag of bones that could hardly move. When they noticed us, they most often fell over as they tried to move. Even in good years feral pigs suffer. Last week we grabbed a piglet for examination. Dozens of black-legged ticks -- vectors of Lyme disease, fleas and lice lived on its soft underside. Island feral pigs, when they overpopulate, cannot migrate to greener pastures; they starve. Is it more humane to let these feral pigs continue their overpopulation, starvation and cannibalism or eliminate a few thousand from the island now, before untold thousands die in the future during such cycles?" - Adrian Wenner (May 8, 2001)

24 California Department of Fish and Game, which has jurisdiction over these game animals, will not permit transportation of live pigs to the mainland because of the possibility of disease transfer to domestic pigs or other livestock or to mainland wildlife. Additionally, feral hogs are difficult to capture. USDA-APHIS has gone on record as opposing any plans to bring pigs from Santa Cruz Island to the mainland, based upon potential transmission of pseudorabies or other diseases (See Chapter Two - Alternatives Considered but Dismissed pg. 21).

25 A complete discussion of feral pigs is given in Chapter Three - Non-native Pigs (pg. 38). Included in this discussion is information on the distribution and abundance of pigs on Santa Cruz Island, diseases of feral pigs with a summary of disease testing done on Santa Cruz Island pig, and a discussion of feral pigs in California and a summary of pig eradication programs.

26 Carcasses will be left where they lay unless they lie in a live stream, spring, or seep, from which they will be removed. Non-lead bullets will be required to reduce the risk that of secondary lead poisoning to scavenging animals. Impact of the availability of carcasses to other species has been updated in Chapter Four Island Fauna Effects. In summary, the temporary availability of those pig carcasses would provide scavengers such as common ravens, golden eagles, bald eagles, and other pigs with increased food. Pig die-off is significant on Santa Cruz Island with as many as half the pig population dying annually, especially following drought years. Carcass availability would be greatest during the early implementation of the project, and diminish as the program progresses.

27 All references have been updated in the Final EIS.

28 The park has been working closely with The Nature Conservancy to identify all known locations of yellow star thistle and other invasive species. Together with TNC an island-wide strategy has been devised to categorize these species into treatment strategies. The park will continue to work closely with TNC to treat exotic species that have been prioritized by the treatment plan.

29 Only one ESA listed species (*Galium buxifolium*) is known to occur close to the fennel treatment area. There are no other known occurrences for listed species within the fennel control project area. However, should surveys find additional listed species, mitigation measures would be implemented (See Chapter Four "Threatened and Endangered Species" pg. 92).

30 Alternative Four is modeled to a great extent after the pig eradication effort on Catalina Island. It is in the best interest of the Park to learn from the operational aspects that have proven effective for the Catalina pig eradication effort. Operational aspects of Alternative Four will be changed to reflect Catalina's experience with their zonal eradication strategy.

31 Thanks for the careful review of our draft document; the Final EIS will amend all of the draft documents inadequacies.

32 The Park appreciates Catalina sharing their operational experiences to us as the Park moves forward on this project. The Park and TNC are both committed to educating the public about the devastating impact pigs are having on Santa Cruz Island and the need for this eradication project. The Park will continue to be proactive in working with the public and media on park-related issues.

33 Public safety will be the highest goal for operational activities. Access to the island by visitors may change as operations move from one part of the island to another. Access to the island by private boaters is different for TNC and the Park. Access for private boaters are allowed by permit only on TNC lands, the Park allows boaters to come ashore on NPS land. Both TNC and NPS will implement short-term closures when operations are occurring that could jeopardize visitor safety. At this early stage it is impossible to put pre-determined dates or areas for these closures.

34 Snares will not be used on this project (See "Alternatives Considered and Dismissed" pg. 22).

35 All activities associated with the implementation of this project will meet federal, state, and local laws. (Also see Response # 23)

36 See Response # 23

37 The recommendation to aerial spray trichlopyr was made only after careful discussion and an analysis of the benefits versus the costs. Given the extensive research that has been sponsored by The Nature Conservancy, the Park is confident the method will be effective and best for long-term recovery of native plants. Two other options were considered: physically uprooting the fennel plants or the use of the cut and spray method. Unfortunately, both alternatives are labor intensive and prohibitively costly. Physically uprooting the plants also creates large amounts of soil disturbance, which would exacerbate the already high levels of soil erosion currently caused by pig rooting. It is true that native plants inside the target area and those directly adjacent to the target area could be affected by drift of the aerial spray. Some mortality of native plant species is likely to occur. However, mitigation measures will be implemented to minimize impacts to native plant species (See Response #1). These mitigation measure are described in Chapter Four "Native Plant Communities".

38 There are no other known occurrences for T&E listed species within the fennel control project area. Keep in mind that the fennel infestation that will be treated is confined to a portion of the island's isthmus, and is inhibiting T&E habitat from establishing. The great majority of the island will not be burned or sprayed with trichlopyr.

39 The vegetation response of the dense fennel thickets on the isthmus, upon fire treatment and two successive applications of Garlon 3a, would likely be dominated by annual grasses. This vegetation response is mostly due to the fact that this area was annual grasslands, perpetuated by the extensive historical grazing, prior to fennel dominance. Prior to the introduction of grazing, this area would likely be chaparral habitat. Upon removal of grazing disturbance, annual grasslands are much more likely to be conducive to colonization of native grasses and shrubs then fennel dominated areas. For annual grasslands, the Park has documented this change upon the removal of cattle on Santa Rosa Island and sheep on Santa Cruz Island. Because of the heavy dense thickets of fennel that exists on the isthmus,

colonization of native species has not occurred, and wouldn't become established unless it is treated. It would be desirable to have the initial colonization of species (post-treatment) be mostly native, it is not the successional pathway that has been observed.

40 There are no perennial streams and associated riparian vegetation communities within the proposed fennel treatment area, therefore it is not likely that aquatic plants would be impacted by increased sedimentation. Although it is estimated that erosion due to the project activities would be negligible, monitoring erosion is still being recommended. If monitoring determines that excessive erosion is occurring as a result of the project's activities, Park staff would implement erosion abatement practices in those areas.

41 Poison, leg traps, snares, and fire are methods the Park has dismissed from using on this project. The commentary incorrectly infers that amateur hunters would be used. The Park proposes using only professional hunters as part of this operation. The commentary incorrectly infers that fire will be used to kill feral pigs on the island. The Park proposes the use of fire to treat large thickets of fennel thereby reducing hiding cover for pigs - not as a method for eradicating pigs. The commentary incorrectly infers that leg traps would be used to catch pigs. The park will not use snares or leg traps to catch pigs.

42 It would be impossible to successfully trap all the pigs on the island in corrals or traps. Pigs can be very wary and may not enter traps. Without 100% removal of the pig population the eradication program will not attain its objective.

43 See Response #23 and Chapter Two "Alternatives Considered and Dismissed" pg. 21.

44 The Park will work with the UC Santa Cruz Island Reserve and The Nature Conservancy to identify all research work that is going on inside the prescribed burn project area. Notice will be given to researchers whose research could be affected. The Park will allow researchers the opportunity to modify stakes or grid markers to avoid losing these reference points.

45 As someone who is familiar with the cultural resources of the island your personal observations have assisted the Park in identifying sites and potential impacts to these sites. The Park has consulted with California's Office of Historic Preservation and the Chumash Tribe to determine acceptable mitigation measures for implementing this project (See Chapter Four "Section 106 Summary" pg. 131). A Memorandum of Agreement between these parties contains the agreed upon mitigation measures (stipulations). These mitigation measures are also summarized in Chapter Four "Cultural Resources" pg. 105.

46 See Response # 23

47 Your suggestions are very similar to the actions identified in Alternative Three. Alternative Three is described in Chapter Two "Alternative Three" pg. 17.

48 Channel Islands National Park was established by Congress on March 5, 1980 (Public Law 96-199). It was established to protect the nationally significant natural, scenic, wildlife, marine, ecological, archaeological, cultural, and scientific values of the Channel Islands. Furthermore, this law directed management of the park to adhere to the Organic Act (1916) for the conservation and management of wildlife, and natural and cultural resources. This project is being proposed under this basis.

49 The information the Park has collected conclusively determine that non-native feral pigs are responsible for the degradation of natural and cultural resources. Independent researchers have reached the same conclusion and emphatically support their removal. The non-native feral pigs have disrupted the ecological balance on Santa Cruz Island to the point that their presence is jeopardizing the endemic

island fox. The plight of the island fox has been described in Chapter Three "Island Fauna" (pgs. 35-37), and the beneficial effects to the island fox of removing feral pigs is described in Chapter Four "Island Fauna" (pg. 102).

50 See Response # 23

51 The Park and other researchers have described the on-going disturbance that pigs are having on the native plant community on Santa Cruz Island. This information lends substantial support to the Park's goal of curbing pig-related impacts to Santa Cruz Island.

52 See Response # 23

53 See Response # 23

54 See Response # 23

55 Significant improvement to natural resources occurred after feral pigs were removed from Santa Rosa Island. The most noteworthy improvement that occurred post-pig removal was the increase in the natural regeneration of oaks on the island. Acorns, when available, are a preferred food source by the feral pigs. Significant improvement also occurred in the reduction of soil disturbance. Feral pig rooting was responsible for upturning/tilling large areas on the island. These areas have mostly improved upon removal of the pigs resulting in less erosion. Unfortunately, some of the beneficial improvements of removing pigs on Santa Rosa Island were not fully realized because cattle grazing was still ongoing, and resulted in disturbance to riparian areas similar to pigs.

A dramatic example of the vegetation change on Santa Cruz Island that can be expected when pigs are excluded from an area was demonstrated by Peart et al. (1994). In this study exclosures were constructed around preferred pig habitat - coast live oak stands. After 5 years of exclusion, seedling abundance was greater in fenced plots (85%) than in the open, unfenced plots (15%). This study supports the Parks contention that feral pigs are significantly retarding woody-species regeneration.

56 See Response # 23

57 See Response # 23

58 See Response # 23

59 See Response # 23

60 See Response # 23

61 The point about unique individual plant specimens within a larger community is well taken. There indeed may be scientific value in preserving these specimens. It is interesting however that the ages of these unique specimens (as given by Dr. Loeher) do not predate the era of active European settlement of the islands. This raises the question as to whether these specimens are representative of the possible vegetative growth on the islands or are an artifact of the recent grazing history of the island. In any case, there is indeed some short-term risk to these unique specimens by treating the fennel. These must be weighed against the long-term benefits to the species as a whole from removal of feral pigs and reduction in fennel cover. Each specimen's probability of survival in the face of a fennel burn would depend on their location within the project area. If these specimens are located in the oak-dominated type 3 drainages within the project area, they will likely be unaffected by the proposed burn and herbicide treatment. These areas are largely free of fennel and will not be actively burned or sprayed with herbicide. The accidental spread of fire into these drainages is always a possibility but efforts will be made – such as helicopter water drops – to minimize any impacts from fire into those areas. These

'fennel-free' drainages would also be excluded from aerial spray zone and mitigation would be in place to avoid accidental drift (See Mitigation - Chapter Four - Native Communities pg. 89). It is likely these unique species are located in the woody draws and not intermixed within the dense stands of fennel. Their location in the draws would make it easier for them to survive because these areas are not targeted for treatment.

62 Dr. Loeher is correct on all points. Unfortunately, most major management activities are based on a state of knowledge that is incomplete and still evolving. Comments from the public and the scientific community are extremely important in this regard. One thing that needs to be made clear however, is that the majority of the standing vegetation within the project area is fennel and not native island plant species including *A. insularis*. Will impacts to native vegetation occur? Most definitely. That is essentially a given on a vegetation modification project of this magnitude. In the long-term though, the island's native vegetation should benefit from reduction of fennel on the island. It should also be pointed out that even after this project is complete, removal of remaining fennel on NPS lands would remain a priority for the Park.

63 This information is additional proof that feral pigs are impacting native vegetation communities. Their removal should help native shrub seedlings become established, and overall assist succession of annual grasslands towards their potential natural community.

64 Dr. Loeher is correct with regards to intact chaparral communities being largely impervious to invasion by non-native annual grasses. In California, invasion of chaparral communities, and most native plant communities for that matter, by introduced annual grasses is largely facilitated by large-scale and frequent disturbance regimes. This statement has been changed in the FEIS. Dr. Loeher is also right in that aggressive restoration techniques may be inappropriate or even detrimental for some plants within a native vegetation community. However, lack of any restoration efforts may also be inappropriate or detrimental to some plants within the project area. Again what must be pointed out is that the vegetation community to be treated is largely disturbed land that is dominated by invasive fennel. Some native plants are found within the dense fennel stands and these for the most part are native colonizers such as coyote brush (*Baccharis pilularis*), and buckwheat (*Eriogonum grande*). What is of greater concern is the possibility that residual native seed bank may be present in the area. If present, this seed bank would in all probability respond to the prescribed burn and germinate vigorously the following spring. Unfortunately, any germination would likely impacted by the aerial spraying of trichlopyr. Even with active restoration efforts annual grasses in the short-term would likely dominate much of the area.

65 Under existing TNC/Park policy, people who have on-going research on the island will continue to be allowed access during project implementation. However, the Park and TNC will restrict visitor and researcher access in certain areas when project activities may compromise personal safety. Personal safety will be an overriding mandate during implementation activities.

66 See Response # 23

SANTA CRUZ ISLAND PRIMARY RESTORATION PLAN

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Appendix

Summary of the

Biological Assessment

for

Threatened and Endangered Plant Species

Santa Cruz Island Restoration Project

Channel Islands National Park

Prepared By: Dirk Rodriguez
Botanist
Channel Islands National Park

I. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

[See Final EIS Chapter Two pgs 13-20]

II. EXISTING ENVIRONMENT

[See Final EIS Chapter Three]

III. THREATENED, ENDANGERED PLANT SPECIES

[See Final EIS Chapter Three "Threatened and Endangered Plants" pgs 48-53]

IV. T&E EFFECTS BY ALTERNATIVE.

Alternative One: No Action

In the Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan (USFWS 1999), feral pigs were identified as a potential threat to each of the nine listed plant species found on Santa Cruz Island - Hoffman's rock cress (*Arabis hoffmanii*), island barberry (*Berberis pinnata* ssp. *insularis*), Santa Cruz Island dudleya (*Dudleya nesiotica*), island bedstraw *(Galium buxifolium*), island rush-rose (*Helianthemum greenei*), Santa Cruz Island bushmallow (*Malacothamnus fasciculatus* ssp. *nesioticus*), island malacothrix (*Malacothrix indecora*), Santa Cruz Island malacothrix (*Malacothrix squalida*, and Santa Cruz Island fringepod (*Thysanocarpus conchuliferus*). 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, bed down, or root 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, 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 landsliding.

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 listed plant species. Disturbances caused by feral pigs in and around listed plant occurrences can lead to increased erosion within those occurrences. This increased erosion can expose the roots of listed plant species inhibiting water and nutrient uptake or in severe cases completely up-root 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 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 plants vigor and health (Williams and Haynes 1995). Adjacent plants may benefit from the extra nutrients available in urine and feces similar to the effects seen with the application of normal 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 plant species that benefit the most from increased nutrient availability.

Cumulative Effects:

Cumulative effects are those factors which in the past, present, or future have affected T & E plant species. All species - but 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 gene pool from inbreeding, loss of heterozygosity, and, for those species arising from colonization and subsequent adaptive radiation, possible Founder effects. There is no clear indication however whether a decrease in genetic diversity leads to a decrease in species fitness (Shafer 1990).

Cumulative effects that may impact listed plant occurrences are similar to those listed for plant communities but the consequences may be more severe. Because listed plant species are rare and limited, either in absolute numbers or number of occurrences, impacts to a portion of a population can have severe consequences. Common plant species are often extirpated in localized areas, either from natural disturbance events or human caused disturbances. These areas are usually eventually re-colonized however, from seed stored in the soil or propagules from adjacent areas. Rare plants species on the Santa Cruz Island don't have those options 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.

Alternative Two (Island-wide eradication)

The short-term impacts associated with this alternative although similar in nature to those described for the plant communities could be more severe for listed plant species. This is due to the inherent rarity of these species. Trampling of even only a few individuals could have a substantial impact on a single occurrence. Some of the listed species which are annuals like *Thysanocarpus conchuliferus* and *M. indecora*, would be protected for much of the year when they exist only as seeds in the soil. They would be prone to trampling effects though when they are actively growing. Some occurrences of rare species like those *Galium buxifolium, M. squalida,* and *Arabis hoffmannii* occurrences would be protected due to their growing on steep, coastal bluffs. Areas that are unlikely to be traversed by either feral pig or pig hunter. *Dudleya nesiotica* is also in a fairly remote area but it is more accessible. However this population would be able to recover from incidental trampling of individuals because of the large number of plants (30,000 – 60,000) within the population. Feral pigs are known to root up the plants however (USFWS 2000). *Berberis pinnnata* ssp. *insularis* and *Malacothamnus fasciculatu*s var. *nesioticus* would likely be protected from trampling because of their stature as large perennial shrubs. Young seedling and saplings of these species would continue to be at risk however. *Helianthemum greenei* while neither an annual nor located in inaccessible areas is also somewhat insulated from impacts associated with trampling. This is because of its known life history which 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. This large number is believed to be related to having been burned in 1994. It is likely then that the 10 smaller occurrences each has a substantial seed bank which would be expressed once they are burned. As seeds stored in the soil they would be unaffected by trampling. Trampling does pose more of a substantial threat to two occurrences *Arabis hoffmannii*. *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 a fire, the adverse impacts to listed species – except for *H. greenei* - are likely to be more severe. A large fire could cause the extirpation of one or more rare plant occurrences. Some of the listed plants occurrences would again be protected because the habitat where they occur is not likely to occur (e.g. steep, coastal bluffs). Because the likelihood of an accidental fire becoming large would only be in the fall, annual plants such as *T. conchuliferus* and *M. indecora* would be relatively insulated as seeds in the soil. Another concern with fire is the possibility that it will stimulate germination of seed stored in the soil. If the resulting seedlings are trampled, uprooted, or prevented from reaching maturation, then they will not replenish that species seed bank. The end result may be the expirpation of that occurrence.

In the long-term, T & E plant species should experience increased survivorship and seedling establishment and recruitment. T & E plant species are likely to benefit from decreased disturbance levels, increased litter retention, and re-development of the soil crusts. As T & E populations recover,

they should be able to better withstand any natural disturbance events that may occur. Larger population numbers provide insurance against the loss of a few individuals and the formation of genetic bottlenecks. Replenishment of the seed bank - for those species which rely on natural disturbance events - means adequate seedling establishment and recruitment will 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 (*Dudlyea 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. For other species such as Santa Catalina mimulus (*Mimulus traskiae)*, it may be too late. This species was only known from Santa Catalina Island and has not been seen for over 60 years.

Alternative Three (Eradicate on NPS property and control around sensitive resources on TNC land)

Under this alternative, T & E plant occurrences would be protected on both NPS and TNC property on Santa Cruz Island. However, there would be difference in how they are protected. Those occurrences on NPS property would 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 draft recovery plan for these species (USFWS 2000). 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 greater risk of extinction from random stochastic events.

Because the T & E plant occurrences on TNC property would 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 probable 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 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 – 1 occurrence of (*D. nesiotica*), 8 occurrences of island bedstraw (*G. buxifolium*), 3 occurrences of island barberry (*B. pinnata* ssp. *insularis*), 1 occurrence of Santa Cruz Island malacothrix (*M. indecora*), 3 occurrences of Santa Cruz Island bushmallow (*M. fasciculatus* var. *nesioticus*), 1 occurrence of Santa Cruz Island fringepod (*Thysanocarpus conchuliferus*), 3 occurrences of Hoffman's rockcress (*Arabis hoffmanii*), and 8 occurrences of island rush-rose (*Helianthemum greenei*) (USFWS 2000).

Alternative Four (sequential eradication through fencing)

Direct Impacts:

Direct impacts to listed plant species could occur if fencing were placed within listed plant occurrences. Individual plants could be crushed or uprooted when fence posts are placed in the ground. NPS employees 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. With proper planning, known rare plant occurrences could be avoided and botanical surveys conducted to locate unknown rare plant occurrences so that they could also be avoided. 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 zoning fences. Until a zone is hunted free of pigs, any T & E 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.

Indirect Impacts:

Indirect impacts to listed plants could occur if invasive non-native seeds are transported into listed plant occurrences either on the fencing material itself or on the boot and clothing of the NPS employees constructing the fence or on the vehicles used to move the fencing material. As discussed previously, invasive weed species are able to out-compete native plant species including T & E plants for available water, nutrients, and sunlight. Measures such as washing vehicles, removing seeds from boots and clothing, and educating those involved in constructing the fences about the dangers of invasive weed species, can be enacted to minimize the risk of spreading these weed species. Until a zone is hunted free of pigs, any T & E 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 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.

Cumulative Impacts:

The cumulative impacts associated with this alternative would be similar to those discussed under

Alternative Two.

V. DETERMINATION OF EFFECTS

Alternatives 1 or 3:

It is my determination that selection of alternative 1 or 3 may affect and is likely to adversely affect *Galium buxifolium, Malacothrix indecora*, *Dudleya nesiotica, Malocothrix squalida*, *Berberis pinnata* ssp. *insularis, Malacothamnus fasciculatus var. nestioticus, Thysanocarpus conchuliferus, Helianthemum greenei* and *Arabis hoffmanii* and their critical habitat. Endangered Species Act Section 7 Formal Consultation with U.S. Fish and Wildlife Service will be required for this project.

Alternatives 2 or 4:

It is my determination that selection of alternative 2 or 4 under the Santa Cruz Island Restoration project (a) will not affect (**with the recommended mitigation**): *Malacothrix indecora*, *Malocothrix squalida*, *Berberis pinnata* ssp. *insularis, Malacothamnus fasciculatus var. nestioticus, Thysanocarpus conchuliferus* and *Arabis hoffmannii;* and (b) may impact individuals of *Helianthemum greenei* and *Dudleya nesiotica* but is not likely to adversely affect them.

VI. MITIGATION RECOMMENDATIONS

- Re-visit sites of extant and historical occurrences for *Arabis hoffmannii, Berberis pinnata* ssp. *insularis, Galium buxifolium, Malacothamnus fasciculatus* var. *nesioticus*, *Malacothrix indecora*, *Malocothrix squalida*, *Thysanocarpus conchuliferus, Helianthemum greenei* and *Dudleya nesiotica*.
- Fencing of any of the re-visited sites where it is determined that pig rooting or trampling by hunters has or may impact a site. This recommendation is impractical for *H. greenei* or *Dudleya nesiotica* due to the relatively large sizes of their occurrences. The number of individuals within their occurrences though should be sufficient to withstand impacts associated with the eradication of feral pigs. *H. greenei* is also somewhat protected due to its use of a stored seed bank as an integral part of its life history. Impacts to *D. greenei* could be significantly reduced under alternatives 2 and 4 by initiating the hunt at the west end of the island.
- Placement of sensitive resource signs in areas where hunt activities could occur in *H. greenei* and *Dudleya nesiotica* occuppied habitat. Hunters should be instructed to avoid these areas unless active pig use is occurring in them.
- Annual inspection of any T and E fenced occurrences. If the occurrences are not effective in protecting the occurrences then consultation with USFWS will occur.
- No smoking allowed while hunting
- Maps of sensitive areas plant areas made available to fire suppression supervisors

VII. OTHER MANAGEMENT RECOMMENDATIONS

Fennel Treatment:

- 30' to 50' buffer zone between fennel dominated areas to be treated and outside, adjacent native plant communities. Fire may run through these areas and into adjacent native plant habitat but these areas should recover from a single fire event. The most important aspect of the buffers would be to minimize accidental overspray of Garlon into adjacent intact native plant communities. This buffer zone could then be herbicided by hand if necessary.

- Relatively large, intact native plant communities within the treatment area should be identified and protected from prescribed burning and aerial spraying of Garlon. It is important that these native plant refugia survive relatively intact as they can serve as native plant seed sources for the treated areas.

- All major drainages should be identified and to the extent practical protected from fire and herbiciding. These areas have largely intact native plant communities and serve to filter rainwater and decrease peak water flows.

- Measures should be taken to prevent the spread of yellow star thistle into the treated area. All vehicles traveling from yellow star thistle 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 star thistle should be rapidly treated.

LITERATURE CITED

References:

[See Final EIS "References" pg. 181

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Santa Cruz Island Primary Restoration Plan Draft Environmental Impact Statement, Channel Islands National Park, Santa Barbara County, California; Notice of Availability

[Federal Register: March 9, 2001 (Volume 66, Number 47)]
[Notices]
[Page 14196-14197]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr09mr01-85]

DEPARTMENT OF THE INTERIOR

National Park Service

Santa Cruz Island Primary Restoration Plan Draft Environmental Impact Statement, Channel Islands National Park, Santa Barbara County, California; Notice of Availability

SUMMARY: Pursuant to Sec. 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 81-190 as amended), the National Park Service, Department of the Interior, has undertaken a conservation planning and environmental impact analysis effort assessing the potential impacts of restoring Santa Cruz Island by eradicating feral pigs from the island. A draft Environmental Impact Statement (DEIS) has been prepared which analyzes the foreseeable effects of implementing proposed actions that accomplish the following objectives: (1) Restore native plant communities; (2) protect plant species that have been listed as endangered or threatened under the Endangered Species Act; (3) reduce the spread of noxious weeds; (4) protect the native Island fox; (5) protect archeological sites; and (6) conserve soil resources on the island. The proposed action was developed in coordination with

The Nature Conservancy, owners of 75% of Santa Cruz Island. The actions proposed in this DEIS are necessary because of the adverse ecological impacts the pigs are having on Santa Cruz Island.

Proposal: The proposal for eradicating pigs from Santa Cruz Island is to divide the island into six fenced zones and to sequentially eradicate pigs zone by zone. Approximately 45 miles of fence would be constructed along existing fence lines, thereby creating six distinct management units of about 12,000 acres each. Complete eradication would be achieved in each of the zones in a coordinated effort lasting approximately one year using trained, professional hunters. The techniques and tools for achieving the eradication goal would be similar to other pig eradication efforts such as neighboring Santa Rosa Island and Santa Catalina Island. A helicopter may occasionally be used to transport hunters or serve as a hunting platform.

The eradication campaign would occur in four distinct phases. Phase I (Administration, Infrastructure, and Acquisition) includes putting in place the necessary staff to oversee, manage, direct, and carry out the project including fencing and hunting contractors. It also includes bolstering current housing structures and establishing adequate communications on the island. Necessary equipment and supplies would also be secured at this time. Phase II (Fencing) involves constructing six distinct zones of pig-proof fence across the island. Hunting and trapping in a zone may begin as soon as the zone fence is completed, and prior to the next sequential zone fence being completed. Phase III (Hunting) involves eradicating pigs within a zone, then moving to the next zone in sequential order. Eradication techniques include trapping and baiting, as well as ground hunting with dogs. Once hunting commences, it is estimated that a near complete island-wide eradication could be achieved within six years. Phase IV (Final Hunting and Monitoring) is perhaps the most important, as the intention is to exhaustively search the island for remnant pigs and pig sign. A systematic protocol of monitoring for remnant feral pigs would be developed for the island. Monitoring of the island would continue for five years after elimination of the ``last pig'' in order to insure success. Long term ecological monitoring to assess ecosystem changes due to pig eradication would continue into the foreseeable future.

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It has been determined that in order to successfully eradicate pigs from Santa Cruz Island that fennel will have to be controlled in areas where it has formed large dense thickets. These dense thickets of fennel create a safe harbor for pigs to escape from being hunted, and thus potential failure of the project. Fennel would be burned in the fall with a follow-up treatment of herbicide (Garlon 3A) in the two springs following the burn. The Nature Conservancy developed this protocol in an extensive 600-acre test program in the Central Valley of Santa Cruz Island. The fire and herbicide treatment would involve application by hand, from a vehicle, and from a helicopter.

Alternatives: After identifying the significant environmental issues associated with the proposed action, the Park began developing alternatives to the proposed action. Modifying the eradication strategies to address the environmental issue concerns was the basis used to develop alternatives. In all, three alternatives were developed, including the ``No Action'' Alternative (which maintains the existing minimal management). The two ``action'' alternatives are as follows: Alternative Two, ``Simultaneous Island-wide Eradication of

Pigs'', involves eradicating pigs island-wide without the use of fenced zones. A simultaneous island-wide operation would require several teams of hunters and dogs repeatedly working sections of the island. This is considered to be a high intensity effort for a short period of time, approximately 2-3 years in duration to have near complete eradication island-wide. Alternative Three would eradicate pigs from eastern Santa Cruz Island but only exclude pigs from selected sensitive resources on central and western Santa Cruz Island. Selected sensitive resources including archeological sites, and threatened and endangered plant species, would be protected from pigs by constructing and maintaining pig-proof fence around these selected sensitive sites.

SUPPLEMENTARY INFORMATION: Public meetings will be held in the area, with confirmed dates and locations to be announced on the park's website. The DEIS is now available for public review (distribution began during mid-February); copies can be obtained at the park, on the Park's website (http:www.nps.gov/chis/homepage/restoringsci.html), Ventura's Foster Library, and Santa Barbara's Central Library. After a reasonable number of printed copies have been made available, CD copies will be the preferred method of distribution of the DEIS. Inquiries and comments regarding the DEIS should be directed to: Superintendent, Channel Islands National Park, 1901 Spinnaker Dr, Ventura, California 93001. The telephone number for the park is (805) 658-5700.

All written comments must be postmarked on or before May 8, 2001 (as soon as this date has been determined it will be confirmed on the park's website). Persons wishing to express any new concerns about management issues and future land management direction are encouraged to address these to the Superintendent, as noted above. If individuals submitting comments request that their name or/and address be withheld from public disclosure, it will be honored to the extent allowable by law. Such requests must be stated prominently in the beginning of the comments. There also may be circumstances wherein the NPS will withhold a respondent's identity as allowable by law. As always, NPS will make available to public inspection all submissions from organizations or businesses and from persons identifying themselves as representatives or officials of organizations and businesses; and, anonymous comments may not be considered.

Decision: After the formal draft EIS review period has concluded, all comments and suggestions received will be considered in preparing a final EIS. The park expects to complete the final EIS during July 2001. Its availability will be announced in the Federal Register and in local and regional news media. Subsequently a Record of Decision would be executed no sooner than 30 (thirty) days after release of the final EIS. The official responsible for the final decision is the Regional Director, Pacific West Region; the official responsible for implementation is the Superintendent, Channel Islands National Park.

Dated: February 14, 2001.
Patricia L. Neubacher,
Acting Regional Director, Pacific West Region.
[FR Doc. 01-5948 Filed 3-8-01; 8:45 am]
BILLING CODE 4310-70-P

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Primary Restoration Plan for Santa Cruz Island, Channel Islands National Park, Santa Barbara County, California; Notice of Intent To Prepare an Environmental Impact Statement

[Federal Register: September 13, 1999 (Volume 64, Number 176)]
[Notices]
[Page 49502-49503]
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[DOCID:fr13se99-104]

DEPARTMENT OF THE INTERIOR

National Park Service

Primary Restoration Plan for Santa Cruz Island, Channel Islands National Park, Santa Barbara County, California; Notice of Intent To Prepare an Environmental Impact Statement

SUMMARY: Pursuant to Sec. 102(2)(c) of the National Environmental Policy Act of 1969 (Pub. L. 91-190) and Council on Environmental Quality regulations (40 CFR 1508.22), the National Park Service intends to prepare an Environmental Impact Statement for a Primary Restoration Plan that focused on removing non-native species from Santa Cruz Island, Channel Islands National Park, California. During the ensuing conservation planning-environmental analysis process, comprehensive management alternatives will be developed which will address recovery of the island's natural communities. Throughout the restoration planning process will be conducted in consultation with affected federal agencies, State and local governments, tribal groups, and interested organizations and individuals.

BACKGROUND: The National Park Service completed a General Management Plan (GMP) and Environmental Impact Statement for Channel Islands

National Park in 1985. The park's Resources Management Plan was approved in 1994 (and last updated in 1998). Both documents set clear direction and priorities for responding to invasive species. This focused restoration planning effort is intended to expand and refine that management direction, with the focused objective of preparing a Primary Restoration Plan and Environmental Impact Statement (PRP/EIS) specific to Santa Cruz Island. The PRP/EIS will identify, analyze, and select the immediate, critical management actions necessary to initiate recovery of the island's natural communities. Of special concern is the pressing need to address alternative methods for removal of feral pigs (Sus scrofa) and control of fennel (Foeniculum vulgare), an invasive alien plant species. Based upon scientific review, at this time it is anticipated that bringing management and control efforts to bear primarily upon these two species would facilitate the restoration of many other native ecosystem components. The fennel and feral pig initiatives will be implemented in collaboration with The Nature Conservancy, Santa Cruz Island Preserve.

SCOPING: The NPS is hereby initiating the scoping phase with a request for comments and information from interested individuals, organizations, and agencies. Responses are encouraged, and may address current issues and concerns, relevant research, immediate management options, mitigation strategies, future direction for recovery efforts, and other factors relevant to a comprehensive restoration planning process. Written comments must be postmarked not later than November 30, 1999, and should be directed to the Superintendent, Channel Islands National Park, 1901 Spinnaker Dr., Ventura, CA 93001. In addition, public scoping sessions are scheduled for October 20 (Ventura) and October 27 (Santa Barbara). Details as to time and location will be announced via local and regional press releases, notices distributed to area libraries, and direct mailings.

SUPPLEMENTARY INFORMATION: Periodic information updates about various aspects of the restoration planning process will be distributed via direct mailings, the park's website (http://www.nps.gov/chis/naturalresources/restoration.html), and regional and local news media. To request placement on the PRP/EIS mailing list, interested parties may contact Mr. Steve Ortega, Restoration Biologist, at (805) 658-5784 or CHIS__Restoration@NPS.gov.

REVIEW AND DECISION PROCESS: The Draft PRP/EIS is anticipated to be available for public review and comment during winter-spring, 1999-2000. Availability of the Draft document for review and written comment will be announced by formal Notice in the Federal Register, through local and regional news media, the internet, and direct mailing. At this time it is anticipated that the Final PRP/EIS will be completed during October, 2000. Subsequently, notice of an approved Record of Decision would be published in the Federal Register not sooner than thirty (30) days after the Final document is distributed. This is

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expected to occur by December, 2000. The official responsible for the decision is the Regional Director, Pacific West Region, National Park Service; the official responsible for implementation is the Superintendent, Channel Islands National Park.

Dated: August 31, 1999.

John J. Reynolds,
Regional Director, Pacific West Region.
[FR Doc. 99-23765 Filed 9-10-99; 8:45 am]
BILLING CODE 4310-70-P

Restoring Santa Cruz Island

Restoring Santa Cruz Island
Island Information
Plan Timeline
Draft EIS
Public Input
Links to Related Information

Santa Cruz Island is the largest and most diverse of the eight Channel Islands. This treasure of the Channel Islands National Park has two owners: the National Park Service (NPS) owns the eastern 25% and The Nature Conservancy (TNC) owns the western 75% of the island.

NPS and TNC have embarked upon a multi-year program to restore Santa Cruz Island and to manage the entire island as an interconnected natural ecosystem.

It is important to restore Santa Cruz Island for many reasons. Some of the most significant are:

- There are ten plants and animals currently threatened with extinction on the island, most not found anywhere else on earth. Presence of wild pigs, fennel and the golden eagle are the main causes for the decline of the island fox and other "one of a kind" species.
- A partnership between the NPS and TNC provides a long-term opportunity to restore the island to a fully functioning ecosystem. If we don't restore its' natural vitality, we're condemned to artificial life support and frantic

fixes.

- The Channel Islands, resources of national significance, are within 1/2 day travel of the 18 million people of southern California. The islands provide a superb opportunity for a large urban population to experience the natural and cultural heritage of coastal California.

The NPS and TNC have embarked upon a multi-year program to remove golden eagles, reintroduce bald eagles, and eradicate the pigs and fennel from the island. The NPS has drafted a plan for restoration of the island and would like to hear public comments on the plan.

Restoring Santa Cruz Island | Island Information | Plan Timeline | Draft EIS | Public Input | Links to Related Information

Channel Islands National Park

TO CONTACT US:

Phone: 805/658-5700

Fax: 805/658-5799

E-mail: CHIS Restoration @nps.gov

1901 Spinnaker

Ventura, California 93001

Plan Timeline

Restoring Santa Cruz Island
Island Information
Plan Timeline
Draft EIS
Public Input
Links to Related Information

October 2000 — Scoping comment period begins

October 20 and 27, 2000 — Scoping meetings

Feb. 23, 2001 — Federal Register Notice and beginning of public comment on Draft plan

Completed

April 24, 2001 — Comment period for draft plan ends

Early summer, 2001 — NPS responds to comments and prepares Final plan and EIS

Mid-summer, 2001 — NPS distributes final EIS

Late summer, 2001 — NPS signs Record of Decision

2002 — Begin implementation of recovery actions

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