House Mouse Eradication from the South Farallon Islands
Draft Environmental Assessment

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Executive Summary

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1. Purpose and Need

1.1. Introduction

The United States Fish and Wildlife Service (USFWS, FWS or "the Service") proposes to undertake the following actions on the South Farallon Islands, part of the Farallon National Wildlife Refuge (FNWR or "the Refuge"):

1. Eradication of the non-native house mouse (*Mus musculus*); and
2. Prevention and emergency response plan for dealing with re-introduction of mice, other non-native rodents, and other animals to the islands.

In accordance with the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 *et seq.*, as amended), and Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 CFR 1500 *et seq.*), Federal agencies must consider the environmental effects of actions[1] they propose to undertake. Federal agencies must also consider the environmental effects of a range of reasonable alternatives to that action, and make the public aware of the environmental effects of the proposed action and other reasonable alternatives. If adverse environmental effects cannot be avoided, NEPA requires an agency to show evidence of its efforts to reduce these adverse effects through mitigation. An environmental analysis, such as this Environmental Assessment (EA) documents that an agency has considered and addressed all these issues.

This EA will be used by the Service to solicit public involvement and to determine whether the implementation of the proposed action or a reasonable alternative would have a significant impact on the quality of the human environment.

1.2. Purpose of the Proposed Action

The purpose of the proposed action is to protect and restore the ecosystem of the South Farallones, including seabirds and other native biological resources, by eradicating non-native house mice.

The South Farallones have sustained ecological damage over many years from the presence of non-native house mice. Prior to the introduction of non-native mammals, the South Farallones provided seabirds with breeding and roosting habitat nearly devoid of land-based predatory threats. Introduced rabbits and cats, which were later removed, and house mice, which remain on the South Farallones today, have had noticeable negative impacts on native species. Removing house mice would improve the breeding habitat for a rare and declining seabird species, the ashy storm-petrel, and may improve breeding habitat for other seabirds as well. This action would also improve the quality of habitat for other native species such as salamanders, invertebrates, and plants.

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[1] Under NEPA and implementing regulations, *action* refers to a policy, plan, program, or project that is implemented, funded, permitted, or controlled by a federal agency or agencies.

1.3. NEED FOR ACTION

1.3.1. Summary of House Mouse Impacts on the South Farallones

The Farallon National Wildlife Refuge, which originally encompassed the islets to the northwest of the South Farallon group but did not include the South Farallones themselves, was established by President Theodore Roosevelt under Executive Order 1043 of 1909, as a preserve and breeding ground for marine birds. Since then the Refuge has expanded to include all of the islands in the Farallon group, but it is still managed with the same basic purpose. Non-native house mice are negatively impacting the populations of burrow- and crevice-nesting seabirds, particularly the ashy storm-petrel (*Oceanodroma homochroa*), and the Service has identified mouse eradication as an important aspect of fulfilling its purpose.

Researchers have discovered that house mice are actually indirectly responsible for heavy storm-petrel predation by burrowing owls (*Athene cunicularia*) (Sydeman et al. 1998; Mills 2006; PRBO unpubl. data). Burrowing owls that choose to winter on the islands subsist largely on mice for the fall and early winter seasons, but by mid-winter the mouse population has plummeted (the cyclical counterpart to its fall peak). As a result, the wintering burrowing owls are forced to find an alternative food source, and they resort to preying on adult ashy storm-petrels that arrive on the islands in mid-winter to breed. This predation accounts for substantial annual mortality in breeding ashy storm-petrels, which have recently undergone a precipitous population decline at the South Farallones. Unfortunately, the same burrowing owls that prey on ashy storm-petrels on the Farallones ultimately fare no better than the storm-petrels. The majority of the owls that are monitored through the winter on the islands do not survive, partly as a result of food scarcity and partly due to fatal attacks by the highly territorial nesting Western gulls (*Larus occidentalis*) that dominate the islands by spring.

Mice also likely directly impact seabirds through egg predation and disturbance. The well-hidden and difficult to observe nest sites of many of the most vulnerable nesting seabirds has made evidence of predation and disturbance on the South Farallones scarce, but mice have been demonstrated to prey on seabird eggs and chicks on other islands similar to the Farallones throughout the world (Wanless et al. 2007; Cuthbert and Hilton 2004).

While there are currently few data on mouse impacts to other native island species on the South Farallones, evidence from other islands suggests that mice have the potential to have major impacts on invertebrates, plants, and the Farallones' endemic salamander subspecies (*Aneides lugubris farallonensis*). Mouse diet analysis on the Farallones has shown that mice consume a number of invertebrate and plant species (Jones and Golightly 2006). Because invertebrates and plants play critical support roles in most ecosystems, if mice on the Farallones have a major impact on any of these species, then this impact would have the potential to indirectly affect other aspects of the ecosystem as well, possibly severely.

1.3.2. Background: The Problem of Introduced Species on Islands

1.3.2.1. Introduced species and the importance of island ecosystems

It is widely accepted that the natural world is currently facing a particularly high rate of species extinction (Raup 1988), that most recent extinctions can be directly attributed to human activity (Diamond 1989), and that for ethical, cultural, aesthetic, and economic reasons, this current rate of extinction is cause for considerable concern (Ehrlich 1988; Ledec and Goodland 1988). One of the major worldwide causes of anthropogenic extinctions is the introduction of non-native species. Introduced species are responsible for 39 percent of all recorded animal extinctions since 1600 for which a cause could be attributed (World Conservation Monitoring Centre 1992).

Island ecosystems are key areas for biodiversity conservation. While islands make up perhaps only 3 percent of the earth's surface, they are home to 15-20 percent of all plant, reptile, and bird species (Whittaker 1998). However, small population sizes and limited habitat availability make species endemic to islands especially vulnerable to extinction, and their adaptation to isolated environments comparatively safer than most continental ecosystems makes them vulnerable to aggressive introduced species (Diamond 1985; Diamond 1989; Olson 1989). Of the 484 recorded animal extinctions since 1600, 75 percent were species endemic to islands (World Conservation Monitoring Centre 1992). Introduced species were completely or partially responsible for 67 percent of these island extinctions (based on the 147 island species for which the cause of extinction is known, calculated from World Conservation Monitoring Centre 1992).

Islands are high-value targets for conserving biodiversity because:

1. A large percentage of their biota are endemic species and subspecies with small populations, which makes them particularly extinction-prone (Darwin 1859; Elton 2000).
2. They are critical habitat for seabirds and pinnipeds, which feed over thousands of square kilometers of ocean but are dependent on small isolated islands for safe breeding and nesting. Protection of these animals at their island breeding sites is easier and more cost-effective than protecting them from threats at sea (such as plastics pollution and accidental or deliberate entanglement in fishing tackle) that could affect them anywhere along their travels (Wilcox and Donlan 2007; Buckelew 2007).
3. Many islands are sparsely inhabited or uninhabited by humans, keeping the socioeconomic costs of protection low.

1.3.2.2. Non-native house mice

The house mouse, which originated in Southeast Asia, is now among the most widespread of all mammals, a result of its close association with humans and the relative ease with which it can be transported and introduced to new locations. House mice are present on at least 64 island groups in all of the world's major oceans (Atkinson 1989). They are among the vertebrates considered to be "significant invasive species" on islands of the South Pacific and Hawaii, officially reported from 41 islands but having probably reached all inhabited islands in the Pacific and numerous uninhabited islands (Atkinson and Atkinson 2000). The resourcefulness of house mice is evident from their global distribution and their broad habitat range including buildings, agricultural land, coastal regions, grasslands, salt marshes, deserts, forests and subantarctic areas (Atkinson and Atkinson 2000; Efford et al. 1988; Triggs 1991).

1.3.2.3. Impacts of non-native house mice on island ecosystems

House mice on islands are omnivorous, eating a variety of seeds, fungi, insects, other small animals, reptiles and eggs of small birds. They are known to have dramatic negative impacts on endemic arthropods (Cole et al. 2000; Rowe-Rowe et al. 1989). This direct impact on arthropods in turn has the potential to extend throughout the ecosystem, as arthropods are often crucial in the pollination and seed dispersal strategies of plants, the decomposition of dead plant and animal matter, and as a food resource for other native species. On Marion Island in the southern Indian Ocean, for example, house mice are substantially impacting the populations of a number of endemic invertebrates, especially the flightless moth *Pringleophaga marioni*, the single most important decomposer species on the island. Furthermore, house mice may be affecting the amount of food available for the native insectivorous bird *Chionis minor*, the lesser sheathbill. Lesser sheathbill flocks on Marion Island are much smaller than those on nearby, mouse-free Prince Edward Island, suggesting that food competition from house mice is negatively affecting Marion's lesser sheathbill population as well (Crafford 1990; Rowe-Rowe et al. 1989).

House mice can also have a substantial negative impact on island native reptiles and amphibians. On Mana Island in New Zealand, for example, mice were a major contributing factor in the population collapse of the island's rare McGregor's skink (*Cyclodina macgregori*) (Newman 1994).

One of the most surprising effects of mice on islands is their negative impact on seabird and native passerine bird populations through direct predation on eggs and chicks. On Gough Island in the southern Atlantic Ocean, introduced house mice prey on chicks of the rare Tristan albatross *Diomedea dabbenena*, leading to an unusually low breeding success rate of 27 percent in this declining seabird species (Cuthbert and Hilton 2004). Furthermore, mice on Gough Island appear to limit the breeding range of the endemic Gough bunting (*Rowettia goughensis*) to the small amount of mouse-free habitat remaining on the island (Cuthbert and Hilton 2004). Similarly, on Marion Island, where the recent eradication of feral cats (*Felis catus*) left mice as the only non-native mammal on the island, researchers have recorded several wandering albatross (*Diomedea exulans*) killed by mice (Wanless et al. 2007).

1.3.2.4. Apparent competition and hyperpredation on islands

The ecological concept of one prey species contributing indirectly to the decline of another prey species that shares its range, through increased predation by a local predator that is sustained by feeding on both prey species, is referred to as "hyperpredation", a form of apparent competition (Holt 1977; Smith and Quin 1996). The decline of ashy storm-petrels on the South Farallones, driven by the interaction between burrowing owls and non-native mice, is a good example of the impact that introduced species can have on an ecosystem through the mechanism of apparent competition. A number of similar examples, involving one or more non-native species that contribute to declines in native species in island ecosystems, have recently been described.

Allan's Cay in the Bahamas provides an example that is similar to the current situation on the Farallones. Non-native mice on the Cay are attracting much larger numbers of barn owls (*Tyto alba*) than other ecologically similar cays in the region. Because owls also prey on the Audubon's shearwaters (*Puffinus lherminieri*) that have breeding colonies on many of the cays of the region, the shearwater population on Allan's Cay is experiencing a mortality rate that is twice the rate of colonies that are mouse-free, which will likely contribute to the colony's extirpation in the future if conditions do not change (Mackin in review).

Another example comes from Santa Cruz Island in Channel Islands National Park, southern California, where biologists found that golden eagles (*Aquila chrysaetos*) that were sustained by non-native feral pigs (*Sus scrofa*) were occasionally switching their prey preference to the endemic island fox (*Urocyon littoralis*). Eagle predation has played a major role in the ongoing catastrophic decline of the fox (Roemer et al. 2001). Feral pigs were recently eradicated from Santa Cruz Island, in hopes of breaking this cycle of predation and arresting the many other negative impacts that feral pigs had on the island's resources (Morrison et al. 2007). Biologists have seen a similar pattern on islands where feral cats can maintain high population densities between seabird breeding seasons because they are subsidized by introduced rodents (Atkinson 1985) or rabbits (Apps 1983; Courchamp et al. 2000). In all of these examples, the presence of a non-native prey animal led to substantial declines in native prey species through predation by an opportunistic local predator that was sustained at artificially high population levels.

1.3.3. Benefits of House Mouse Eradication

The best scientific evidence available to the Service indicates that if mice are removed from the South Farallones, the burrowing owls that arrive on the island in the fall would unlikely stay for the winter, and unlikely to survive if they attempt to stay. Studies conducted on seasonal fluctuations in owl diet have lent support to the theory that owls depend on mice for survival on the Farallones during the fall (Mills 2006). Furthermore, there have been no confirmed accounts, current or historical, of burrowing owls successfully breeding on the islands (DeSante and Ainley 1980), indicating the long-term unsuitability of the Farallones environment for burrowing owls, even with the seasonal availability of mice as a food resource.

Ashy storm-petrels visit the islands more frequently during their breeding season, which generally starts in late winter. Two decades of data show that burrowing owls are overwhelmingly more likely to arrive on the South Farallones in the fall and early winter than in any other season (Richardson 2003). Therefore, it is reasonable to assume that if mice are removed from the South Farallones, then owls that arrive on the islands would be very unlikely to stay more than a few days, and thus ashy storm-petrels would no longer be at risk of predation by owls when they arrive later in the winter.

[Insert graphic depicting seasonal cycles of mice, burrowing owls, and ashy storm-petrels]

House mouse removal can lead to noticeable increases in invertebrate populations (Newman 1994; Ruscoe 2001). This was the case on Mana Island where populations of the Cook Strait giant weta *Deinacrida rugosa*, an insect native to New Zealand that is similar to a giant grasshopper, increased noticeably after mouse eradication (Newman 1994).

House mouse eradication would also remove competitive pressure on the island's salamanders, which are insectivores, and could have a positive effect on their population. After successful mouse eradication on Mana Island in New Zealand the populations of McGregor's skinks and goldstripe geckos (*Hoplodactylus maculates*), which were both under similar competitive and predation pressures from mice as the Farallones' salamanders are today, increased substantially (Newman 1994).

1.4. Authority and Responsibility to Act

The eradication of non-native house mice from the South Farallon Islands is authorized and in many cases mandated by several federal laws requiring land managers to conserve and restore wildlife and habitats under their jurisdiction.

The U.S. Fish and Wildlife Service's mission is to work with others to "conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." The threat that introduced species pose to habitat and native wildlife makes addressing their impacts one of the Service's top management priorities. Lessening or eliminating the impacts of introduced species on the Farallones is essential to the Service's management strategy for the islands.

The Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j, not including 742 d-l, 70 Stat. 1119), as amended, gives general guidance that can be construed to include alien species control, that requires the Secretary of the Interior to take steps "required for the development, management, advancement, conservation, and protection of fish and wildlife resources."

The National Wildlife Refuge System Administration Act of 1966 (NWRSAA) (16 USC 668dd) established the National Wildlife Refuge System, to be managed by the Service. Among other mandates, the NWRSAA requires the Service to provide for the conservation of fish, wildlife, and plants, and their habitats within the System; and to ensure that the biological integrity, diversity, and environmental health of the System are maintained.

The Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531-1544, 87 Stat. 884), as amended, directs the Service to conserve ecosystems upon which threatened and endangered species depend.

The National Wildlife Refuge System Improvement Act of 1997 (NWRSIA), which amends the NWRSAA, serves as an "Organic Act" for the Refuge System and provides comprehensive legislation on how the Refuge System should be managed and used by the public. The NWRSIA clearly establishes that wildlife conservation is the singular Refuge System mission, provides guidance to the Secretary of the Interior for management of the System, provides a mechanism for refuge planning, and gives refuge managers uniform direction and procedures for making decisions regarding wildlife conservation and uses of the System.

The USFWS policy for maintaining biological integrity and diversity and environmental health (601 FW 3, 2001), directs Refuges to "prevent the introduction of invasive species, detect and control populations of invasive species, and provide for restoration of native species and habitat conditions in invaded ecosystems." 601 FW 3 further directs refuge managers to "develop integrated pest management strategies that incorporate the most effective combination of mechanical, chemical, biological, and cultural controls while considering the effects on environmental health."

The USFWS's Regional Seabird Conservation Plan lists mouse eradication from the Farallones as a top seabird conservation priority in the region.

Comprehensive Conservation Plan (CCP) for Farallon National Wildlife Refuge. As mandated by the NWRSIA, the Service is preparing a CCP to guide future management actions on the refuge to meet the missions and purposes of the refuge and the Service. The CCP will include mouse eradication from SFI as a conservation goal.

Presidential Executive Order 13112 on Invasive Species (February 3, 1999): Section 2(a)(2), on Federal agency duties, states: "Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them."

Executive Order 13112 defines "invasive species" as "an alien species [a species that is not native with respect to a particular ecosystem] whose introduction does or is likely to cause economic or environmental harm or harm to human health."

1.5. Scope of the Proposed Action

The Proposed Action and the alternative to the Proposed Action focus on three areas:

1. Activities necessary to eradicate house mice from the South Farallones;
2. Activities necessary to prevent the reintroduction of house mice to the Farallon Islands, and to prevent the new introduction of any vertebrate animals to the Farallones in the future; and

3. Activities necessary to minimize negative impacts to native species and maintain wilderness values on the Farallones during the course of mouse eradication and reintroduction-prevention activities.

1.6. ENVIRONMENTAL ISSUES (IMPACT TOPICS) IDENTIFIED

1.6.1. Summary of Scoping

Section 1501.7 of the CEQ regulations for implementing NEPA requires that agencies implement a process, referred to as "scoping", to determine the scope of issues to be addressed in an environmental impacts analysis and identify the major environmental issues related to a proposed action that need to be analyzed. The scoping process included research in published and unpublished literature, consultations with experts in the ecology of the Farallones and experts in non-native species eradication, consultation with the government agencies that have a stake in the resources of the Farallones and adjacent waters, and invitations for comments from the public. There is a detailed description of the scoping process that the Service conducted for this EA in Chapter 5 of this document. During the scoping process, the Service identified the major environmental issues, or "impact topics," that are described in Sections 1.6.2-6 below. These issues guided the development of the Proposed Action, reasonable alternatives, and the scope and content of the environmental impacts analysis for each alternative found in Chapter 4 of this document.

1.6.2. Impact Topic: Impacts to Biological Resources

1.6.2.1. Sub-topic: Non-target impacts from toxin use

Mouse eradication would need to include the use of a toxin that is lethal to mice in order to have a reasonable chance of success. Toxins should only be used in the environment if the behavior of that toxin can be predicted with some accuracy. The impact of the toxin on species other than mice, and the persistence of the toxin in the environment, is an important environmental issue related to impacts of the action on biological resources because animals other than mice, including birds, could ingest the toxin.

1.6.2.2. Sub-topic: Disturbance to sensitive species

Many of the species that depend on isolated oceanic islands such as the Farallones for habitat are especially sensitive to disturbance. The risk of disturbance to sensitive species from the action is an important environmental issue related to impacts of the action on biological resources, particularly because of the importance of the islands for breeding seabirds and pinnipeds.

1.6.3. Impact Topic: Impacts to Human Activities and Values

1.6.3.1. Sub-topic: Effects on refuge visitors and recreation

The Farallones are closed to the public to protect the Refuge's sensitive biological resources, but the animal species that depend on the Farallones are nevertheless important resources for wildlife enthusiasts visiting the nearshore waters and throughout these species' ranges. Additionally, recreational boaters utilize the marine region surrounding the islands.

1.6.3.2. Sub-topic: Effects on fishing resources

The waters surrounding the Farallones are important recreational and commercial fishing grounds for species such as salmon, albacore tuna, Dungeness crab, halibut, and rockfish (Scholz and Steinback 2006).

1.6.4. Impact Topic: Impacts to Historical and Cultural Resources

There is evidence of past human uses of the South Farallones dating to pre-historical times. The impact of the action on historical and cultural sites, structures, objects and artifacts on the South Farallones is an important environmental issue.

1.6.5. Impact Topic: Impacts to Water Resources

Because the proposed action includes the delivery of a toxin into the Farallones environment, the potential impacts of the toxin on local water quality was identified as an important environmental issue.

1.6.6. Impact Topic: Impacts to Wilderness Character

All of the South Farallones except Southeast Farallon Island is designated as wilderness under the Wilderness Act of 1964 (PL 88-577). Wilderness designation makes the wilderness character of the South Farallones an important environmental issue.

2. Alternatives

2.1. Introduction to Development of Alternatives

As part of the analytical process mandated by NEPA, section 102(2)(E) requires all Federal agencies to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." Based upon the existing site conditions, need for action, constraints and the public concerns identified during the public scoping process, three alternatives were identified – the proposed action, one reasonable action alternative, and the alternative of no action, which is included in NEPA analysis to provide a benchmark with which to compare the magnitude of environmental effects of the action alternatives. The no action alternative will describe the Service's current management regime on the South Farallones with regard to the mouse population and its impacts on the island ecosystem.

The proposed action and one action alternative were developed to focus on the issues identified by resource specialists within the Service, experts in island rodent eradication, government regulatory agencies, and the general public. All individuals, agencies and organizations that provided substantive input regarding the proposed action are listed in Chapter 5.

A number of additional alternatives were initially considered but rejected. In order to be retained for consideration, an alternative had to 1) have a high likelihood of success, 2) have an acceptably low probability for adverse effects on non-target species and the environment, and 3) be permitted under existing regulations governing the refuge. The action alternatives that were dismissed from detailed consideration are also described, with rationale for their dismissal (Section 2.7).

The proposed action that was identified is the eradication of mice using aerial bait broadcast as the primary bait delivery technique. The proposed action is identified as Alternative B (Section 2.3 below).

The alternative to this action is the eradication of mice using enclosed bait stations as the primary bait delivery technique, with limited aerial broadcast. This alternative is identified as Alternative C (Section 2.4 below).

2.2. Alternative A: No Action

Analysis of the no action alternative is required under NEPA. Mice would not be eradicated under this alternative. The other ongoing invasive species management programs on the South Farallones, including non-native vegetation management activities, would continue based on previous agency decisions. Any other related programs or projects, now or in the future, decided and implemented under different authority would also continue. Low-intensity mouse control would continue within and around the residences and buildings on Southeast Farallon Island, but the mouse population on the rest of the South Farallones would not be subject to control efforts.

Taking the course of no action towards eradicating mice would not affect the ongoing or future implementation of other restoration actions on the island, but the continued presence and impacts of mice might compromise the effectiveness of future ecosystem restoration efforts. Because there are currently no specific rodent introduction-prevention protocols for vessels that transport personnel and materials to Southeast Farallon, taking no action would also leave the islands at risk of invasion by other species of rodents such as rats, or additional introductions of mice.

Taking no action to address the impacts of non-native mice would be counter to the purpose of the refuge and other FWS policies for conservation and restoration of natural biodiversity and management of designated wilderness.

2.3. ALTERNATIVE B: MOUSE ERADICATION WITH AERIAL BAIT BROADCAST AS PRIMARY TECHNIQUE (PROPOSED ACTION)

2.3.1. Summary of Actions

- Eradication of house mice from the South Farallon Islands to facilitate restoration of the island ecosystem
- Removal techniques based on successful island rodent eradications elsewhere in the US and globally (Howald et al. 2007)
- Pressed-grain pellets (less than 3 g each average mass, containing 25 parts per million brodifacoum) applied at minimum quantity necessary to achieve mouse eradication, according to Environmental Protection Agency (EPA) approved pesticide label instructions
- Bait applied to every potential mouse territory on the South Farallon Islands, including Southeast Farallon, West End, and all immediately surrounding offshore rocks and islets
- Full-island coverage attempted using helicopters and a specialized bait-spreading bucket
- Supplemental hand application of bait pellets to land adjacent to coastal areas and overhanging cliffs, where automated helicopter spreading would be limited or is not feasible
- Limited supplemental installation of bait stations
- Treatment of buildings with fumigant, traps, and bait stations

2.3.2. Description of Action Operations

2.3.2.1. Rationale for aerial bait broadcast

The overarching technical goal in a successful rodent eradication is to ensure the delivery of a lethal dose of toxicant to every rodent on the island. The bait delivery technique currently used most frequently for island rodent eradications is aerial bait broadcast by helicopter (Howald et al. 2007). Aerial bait broadcast is the safest and most effective way to deliver bait to inaccessible terrain such as steep cliffs, and it is the most cost-effective way to deliver bait to a rodent population. It is often environmentally preferable to using bait stations when a regimen of regular foot traffic on the island would likely cause substantial ecosystem damage (through permanent trails, repeated disturbance to sensitive animals, and trampling of sensitive vegetation). The following sections present a detailed description of the factors involved in aerial broadcast bait delivery as the primary method for eradicating mice from the South Farallones.

2.3.2.2. Introduction to broadcast bait application

Aerial broadcast operations would be conducted using a single-primary-rotor/single tail-rotor helicopter. Helicopter models that would be used for the operations are small, 2-4 passenger aircraft. Models considered for use in the operations would include Bell 206B Jet Ranger, Bell 206L4 Long Ranger, or other small- to medium-sized aircraft. Bait would be applied from a specialized bait hopper (see Section 2.3.2.6) slung beneath the helicopter by 49-66 ft (15-20 m). Helicopter operations would necessitate low-altitude overflights of the entire land area of the South Farallones and adjacent islets. The helicopter would fly at a speed ranging from 25-50 knots (29-58 mph or 46-93 km/hr) at an average altitude of approximately 164 ft. (50 m) above the ground.

To make bait available to all possible mouse home ranges on the island, bait would need to be applied evenly across emergent land area, with every reasonable effort made to prevent bait spread into the marine environment (see Section 2.3.2.10). The baiting regime would follow common practice in which overlapping flight swaths are flown across the interior island area and overlapping swaths with a deflector attached to the hopper (to prevent bait spread into the marine environment) flown around the coastal perimeter. Flight swaths would be defined by the uniform distance of bait broadcast from the hopper, ranging from 164-246 ft (50-75 m). Each flight swath would overlap the previous by approximately 25-50 percent to ensure no gaps in bait coverage.

During one application all points on the South Farallones would likely be subject to two helicopter passes. Within each bait application, there should be no more than three consecutive operating days, and it is likely that there would be two separate applications. The entire helicopter operations window for bait application would be no longer than 20 days and could be as short as half that time.

2.3.2.3. Bait pellet composition

The bait used would be registered with the EPA in compliance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The bait product would be designed to be highly attractive to mice, and colored blue to minimize attractiveness as a food item for granivorous birds (Pank 1976; Tershy et al. 1992; Tershy and Breese 1994; Buckle 1994; H. Gellerman, unpubl. data). The bait would be a compressed grain pellet, less than 3 g in weight, containing 25 parts per million brodifacoum. All ingredients in bait pellets would be non-germinating grains (either sterile or crushed). Any bait not initially consumed would likely remain attractive to mice, including juveniles that newly emerged from the nest. However, frequent rainfall through the winter would likely cause the bait to disintegrate completely before winter is over.

2.3.2.4. Determining application rate

Bait would be applied strictly according to the instructions given on the product's EPA-approved label. If the label instructions provide an acceptable range of application rates, the precise bait application rate would be determined based on bait uptake experiments on the South Farallones prior to the eradication. These experiments would use a non-toxic placebo bait replica to measure an approximate rate of bait uptake (including both consumption and breakdown) on the South Farallones. Soon after application, bait pellets would be consumed or cached by mice as well as other animals. Baits exposed to heavy moisture would degrade faster than baits which fall in drier locations. The application rate would be calculated so an adequate amount of bait is available for consumption by mice for a period of at least four days.

2.3.2.5. Number of bait applications

In order to ensure eradication, it would likely be necessary to conduct two or more bait applications, seven to 10 days apart, to minimize the likelihood of competitively inferior individual mice or juveniles surviving the initial broadcast because they were not given an opportunity to feed on bait. Nevertheless, if project leaders determine that palatable bait is likely to remain available for mouse consumption for longer than 10 days after an initial application, a second application may not be necessary. The environmental impacts analysis in Chapter 4 of this document is based upon two applications of brodifacoum, with the second application conducted at a lower application rate than the first.

2.3.2.6. Bait hopper

Bait would be applied across the South Farallones through the use of a bait hopper suspended from a helicopter. The hopper would be composed of a bait storage compartment, a remotely-triggered adjustable gate to regulate bait flow out of the storage compartment, and a motor-driven broadcast device that can be turned on and off remotely and independently of the outflow gate. The broadcast device would include a deflector that can be easily installed when directional (rather than 360°) broadcast is necessary, such as on the coastline (deflector use is discussed in greater detail below).

2.3.2.7. Equipment calibration

Before bait application, the pilot, helicopter, and hopper combination to be used in the application would be calibrated and tested for consistency and accuracy of application using a placebo bait broadcast. The calibration would occur over a test site off-island in conditions similar to those on the South Farallones.

2.3.2.8. Flight plan

The bait would be applied according to a flight plan that would take into account:

- The need to apply bait relatively evenly and to prevent any gaps in coverage or excessive overlap;

- Island topography;
- The need to avoid bait spread into the marine environment;
- The need to minimize disturbance to native wildlife, especially any pinnipeds hauled out on land and resting in nearshore waters; and
- The need to minimize the substantial costs associated with helicopter flight time.

2.3.2.9. Monitoring bait application

To ensure complete and uniform application:

- The actual application path would be monitored onboard the helicopter using an onboard differential global positioning system (DGPS) and computer to guide the application in order to avoid gaps and unanticipated overlaps in application coverage.
- The application rate would be calculated using the known rate of bait flow from the hopper, the helicopter's reported velocity, and overlaps in the bait swath reported by the helicopter's onboard DGPS tracking system.

Adjustments in bait flow rates, helicopter speed, and flight lines would made as necessary to meet the optimal application rate, stay within the limits legally required on the EPA pesticide label, and comply with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

2.3.2.10. Preventing bait spread into the marine environment

Every reasonable effort would be made to minimize the risk of bait being broadcast into the marine ecosystem. The broadcast deflector would be attached to the hopper for all treatment passes of coastal bluffs and cliffs. The deflector would broadcast bait within approximately 120° of the onshore side of the helicopter, to minimize the risk of bait entering the ocean on the opposite, or seaward, side.

2.3.2.11. Supplemental bait broadcast

As a result of the need for caution near the marine environment, the coastlines of the main islands, and offshore islets, all of which are potential mouse habitat, may not receive the optimal bait coverage with helicopter broadcast. In cases where it is evident or suspected that any land area did not receive full coverage, there would be supplemental systematic hand broadcast either by foot, boat, helicopter, or any combination of the above. All personnel who may participate in supplemental hand broadcasts would be trained and tested in systematic bait application at a target application rate (Buckelew et al. 2005).

2.3.2.12. Supplemental bait station installation

Bait stations would be installed in and immediately surrounding all of the buildings and enclosed structures on the island. The bait used in bait stations would be identical to the bait pellets used for broadcast. The bait stations would have the design specifications listed in Section 2.4.2.2 below. A limited number of bait stations could also be installed elsewhere on the island.

2.3.2.13. Treatment of buildings

All buildings would be treated with a commercially-available fumigant according to EPA pesticide label instructions.

2.3.2.14. Personal protective equipment

All personnel that handle bait or monitor bait application in the field would meet or exceed all requirements for personal protective equipment (PPE) described on the bait's EPA pesticide label.

2.3.2.15. Training & supervision

All bait application activities (aerial broadcast, hand broadcast, and bait station filling) would be conducted by or under the supervision of pesticide applicators licensed by the State of California.

2.3.2.16. Timing considerations

The timing of an aerial broadcast rodent eradication is a critical factor in its ultimate success. Timing an aerial broadcast to maximize the probability of eradication success is dependent on three major factors: 1) the local population biology of mice; 2) the local population biology and migratory patterns of animals other than mice that may be vulnerable to rodenticide exposure; and 3) local weather conditions and seasonal patterns that would affect the feasibility of conducting operations.

2.3.2.16.1. Biology of mice

Mouse eradication from an island is more likely to be successful if it takes place when the mouse population is declining in response to annual resource declines. At this time, mice are typically more food stressed and therefore more likely to eat the bait presented. The probability of success is also increased if bait application takes place when mice are not breeding. During breeding seasons, there is a possibility that weanling mice could still be too young to leave the nest at the time of bait application. These weanling mice could be mature enough to emerge from the nest only after all the bait nearby has been consumed, and could therefore re-populate the island.

While mice in reproductive condition have been trapped on the South Farallones year-round, indicating that breeding may never completely cease, mouse trapping rates decline dramatically between December and April suggesting that the number of mice on the island also declines (Irwin 2006). From the perspective of mouse population ecology, therefore, the best window for mouse eradication would be between the months of December and April.

2.3.2.16.2. Seasonal sensitivity of native wildlife

Effects of the operational activities associated with the proposed action (e.g., helicopter operations) on the native wildlife of the South Farallones, in particular birds and marine mammals, would be reduced by avoiding seasons in which large wildlife populations are present such as breeding and migration.

Specific timing considerations for birds include the following:

- Seabirds generally breed on the South Farallones between mid-March and October.
  - The relative abundance of many of the seabird species on the South Farallones declines after the breeding season, which reduces the number of seabirds that could be exposed to rodenticide.
  - Conducting helicopter operations after October and before breeding resumes in mid-March eliminates the potential for disturbance to these species during the particularly sensitive and critical nesting and brood rearing periods.
- Landbirds, often in mid-migration, stop frequently on the South Farallones during spring and fall. Between November and February, however, landbirds are rarely seen on the islands with the exception of a very small number of overwintering individuals.

Specific timing considerations for marine mammals include the following:

- The breeding seasons for California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), northern fur seals (*Callorhinus ursinus*), and Steller sea lions (*Eumetopias jubatus*) on the South Farallones occur between March and September.
- Northern elephant seal (*Mirounga angustirostris*) pups are born on the South Farallones between late December and March. Pups are weaned at about four weeks old, and pups will remain onshore in groups for up to 12 weeks, before departing for the sea. All pups should have dispersed from the island by the end of June (LeBoeuf and Laws 1994).
- Both harbor seals and northern elephant seals undergo an annual molt using the South Farallon Islands as a haulout site. Molt occurs at the end of the breeding season: for harbor seals from July to mid-September (Daniel et al. 2003), and for northern elephant seals from March to July (LeBoeuf and Laws 1994). During molt northern elephant seals undergo a short period of rapid hair loss during which they may be reluctant to enter the water.

Disturbances to pinnipeds during critical activities such as breeding and molting can be particularly harmful. Conducting aerial bait application operations outside of these sensitive periods would substantially reduce the potential for harm to pinnipeds on the South Farallones.

In conclusion, from the perspective of minimizing risks to native wildlife the best timing for aerial bait application would be in the narrow window of time between the beginning of November, when landbird numbers have trailed off considerably, and the end of December, when female elephant seals begin arriving to give birth.

2.3.2.16.3. Weather considerations

While the climate of the Farallones does not fluctuate dramatically by season, the months of November through March are noticeably more unsettled and stormy (Null 1995). Weather conditions must be fairly calm to safely operate the helicopter. It is important to the success of the eradication that the islands be treated in one continuous pulse rather than in partial-island stages separated by a considerable amount of time. Furthermore, the bait used would not withstand substantial rainfall, so it would be important that the bait application is implemented on a day with no precipitation in the near-term forecast. The likelihood of getting a long enough period of calm weather to complete a full bait application is more uncertain during the winter than during other seasons. However, the biological considerations of both native species and mice indicate that the winter is the only reasonable time to conduct a bait application. While the winter is not ideal from the perspective of helicopter operations and bait integrity, it is nevertheless likely that there would be ample opportunity to complete two complete aerial broadcasts during the time window of November through December.

2.3.2.16.4. Timing of the proposed action

Based on the considerations above, the most reasonable time period to conduct eradication operations on the South Farallones would be during the mouse population's annual winter decline, after bird activities on the islands have abated for the winter season, but before elephant seals begin their peak breeding activities in January.

The actual dates of the application window for the proposed action would not be determined until project leaders can determine, with reasonable certainty, the anticipated seasonal patterns discussed above for that particular year. Bait broadcast will be completed within a 20-day window, allowing for anticipated weather contingencies.

2.3.3. Impact Mitigation

2.3.3.1. Mitigation measures to protect cultural resources

Project personnel would exercise caution in order to avoid disturbing the cultural or historical resources that have been identified on the South Farallones. Personnel would be briefed on the locations and identification of historical and cultural resources that may be present on the island. Field personnel would be prohibited from disturbing sites of historical or cultural importance.

2.3.3.2. Wildlife impact mitigation measures

This environmental analysis focuses on determining whether or not any impacts to wildlife on the South Farallones may be significant. Regardless of the determination made, the Service recognizes the need to minimize disturbance and loss of individual animals whenever possible during this operation, to ultimately restore native populations. The eradication project would be designed to ensure the protection of native wildlife. The seasonal timing chosen for the aerial application described in this alternative, the use of only enough bait to achieve success, the use of a bait that biodegrades and becomes unattractive to non-targets quickly in the moist maritime environment, and the use of a grain-based bait to selectively limit primary exposure risk are all examples of ways the proposed action is designed to minimize impacting native wildlife.

2.3.3.2.1. Mitigating for rodenticide exposure risks

Mitigation considerations as part of the planning to minimize non-target wildlife exposure to bait pellets would include the following:

- Temporal considerations: As discussed above, aerial bait application operations would avoid peak breeding and migration seasons for the region, when the greatest numbers of individuals and the largest diversity of species could potentially be exposed to rodenticides.
- Pellet size: Pellets would be designed to be too large for small passerines to easily consume, but too small to be an object of interest for larger scavengers.
- Inert ingredients: The grain base of the bait pellets would be attractive as a food item only to granivorous and opportunistic omnivorous animals. Pellets may be attractive to highly curious birds such as gulls, but this would occur regardless of the inert "matrix" of the bait.
- Bait color: Pellets would be dyed blue, which has been suggested to make pellets less attractive to some birds (Pank 1976; Tershy et al. 1992; Tershy and Breese 1994; Buckle 1994; H. Gellerman unpubl. data).
- Operational aspects: A bait deflector would be used when making helicopter passes along the coastline, and when necessary the target application rate would be met by supplemental hand-broadcasting in areas where aerial application must be limited to minimize accidental bait drift into the marine environment.

2.3.3.2.2. Mitigating for disturbance risk

The primary mitigation that would be incorporated into planning is timing the eradication activities to occur outside of the peak periods of breeding activity as described in Section 2.3.2.16. Outside of the breeding season, species that inhabit the South Farallones are comparatively less sensitive to disturbance. Before eradication operations begin, personnel would be briefed on strategies and techniques for avoiding wildlife disturbance whenever possible and these techniques would be implemented during actual eradication operations.

2.4. ALTERNATIVE C: MOUSE ERADICATION WITH BAIT STATION DELIVERY AS PRIMARY TECHNIQUE

2.4.1. Summary of Actions

This alternative outlines a bait station-based bait delivery technique. The primary objective of this alternative is to reduce primary exposure impacts to birds that would be attracted to bait pellets if they were broadcast directly onto the ground (granivorous passerines and naturally curious gulls).

Major aspects of this alternative include:

- Removal techniques based on successful island house mouse eradications elsewhere in the US and globally (Bell 2002; Burbridge and Morris 2002; Hayes et al. 2004; Clout and Russell 2006)
- All bait application activities conducted according to EPA-approved pesticide label instructions
- Bait stations installed in a grid pattern with between 10 m and 20 m spacing between stations
- Pressed-grain pellets (less than 3 g each average mass, containing 25 parts per million brodifacoum)
- Bait station grid over all island areas accessible by foot
- For all areas not covered by bait station grid, including all immediately surrounding vegetated offshore rocks and islets, bait pellets applied by hand or by helicopter at minimum quantity necessary to achieve mouse eradication, according to EPA-approved pesticide label instructions
- Bait stations to be loaded first, followed by hand/helicopter bait broadcast of inaccessible areas, and bait stations to be maintained until verification of eradication
- Treatment of buildings with fumigant, traps, and bait stations

2.4.2. Description of Action Operations

2.4.2.1. Introduction to bait station delivery

Bait stations were the first method of bait delivery to be used for rodent eradication, and they are still used frequently (Howald et al. 2007). Bait stations are box-like enclosures with small entryways designed to be attractive to rodents but difficult to navigate for other species such as birds. Bait stations reduce (but do not eliminate) the risk of rodenticide exposure in non-target species by making bait more difficult to access and reducing the total amount of bait introduced into the ecosystem. Relying primarily on bait stations for bait delivery also decreases the intensity of wildlife disturbance from helicopters, although on the Farallones helicopters would still need to be used to deliver bait to inaccessible terrain. Because bait must be available for every mouse on the island, bait stations must be installed in a closely-spaced grid, covering as much of the island as possible. Any areas in which bait station installation and maintenance would be extremely difficult (e.g. cliff areas) need to be treated with an aerial bait broadcast to ensure that all rodents on the island have access to the bait.

2.4.2.2. Bait station design and construction

The primary justification for the bait station technique is to prevent non-target animals from consuming bait while still effectively delivering the bait to the target species. The bait station design for the Farallones would need to include the following characteristics:

- An entryway small enough to make entry by songbirds or cavity-nesting seabirds difficult, but large enough to allow for easy passage by mice
- An interior bait placement scheme that makes it very difficult for gulls or other curious larger birds to access the bait inside, but provides minimal difficulty for mice. This can be accomplished by placing the bait behind a baffle near the entryway that would block a gull's bill or foot.
- A "lockable" access panel that resists tampering by gulls but is easy to open by project personnel for station re-filling and maintenance

A number of commercially-available bait stations fit these criteria and will be assessed for the best choice prior to implementation. Alternatively, bait stations could be fabricated specifically for this project.

2.4.2.3. Bait composition

The bait that would be used in bait stations is the same as described in Alternative B, Section 2.3.2.3 above.

2.4.2.4. Bait station installation

Since bait stations would need to be accessed frequently during bait dispersal, sufficient access would have to be ensured for each bait station. In some cases, access would not pose substantial difficulties, but depending on the local placement of each station, a number of landscape modifications and/or installations may be necessary. Examples of these modifications could include:

- Paths and clearings cut in vegetation;
- Installation of boardwalks to avoid trampling seabird burrows or other sensitive resources;
- Anchor points, ladders, and fixed lines to allow for safe access to bait stations placed on steep and/or unstable terrain.

Each bait station would be secured to the ground with anchors placed into the soil or drilled into the rock as appropriate. The anchors would be durable enough to hold the stations in place for up to two years, but they would be removable and not a permanent fixture on the islands. Some bait stations may also require modification (e.g. additional covering) to prevent rain/moisture from entering the box and damaging the bait.

2.4.2.5. Grid design

The goal of rodent eradication is to deliver bait to every rodent territory on the island. Therefore, determining the spacing of bait stations on the island is critical. Since determining the actual territory delineations for individual mice on the island is unrealistic, bait stations would need to be placed on a grid that covers the entire island, except for inaccessibly steep cliffs. The average mouse home range on the South Farallones has not been established, but research from other islands indicates that mice most frequently travel less than 15 m (Ruscoe 2001).

To maximize the probability of delivering bait to each and every mouse, station spacing should estimate range size conservatively. Data on mouse home range size and results of successful mouse eradications on other islands indicate that bait stations should be spaced 10 m or 20 m apart to ensure bait delivery to every mouse on the island. The total land area of the South Farallones is 120 acres (49 ha), but at least 25 percent of that land area is not accessible by foot. Assuming, then, that a bait station grid would cover 90 acres (36 ha), a 10 m spacing would require a ballpark estimate of 3,600 individual stations, and a 20 m spacing would require an estimated 900 stations.

Since bait station spacing is so important, the grid pattern would need to be carefully designed and installed taking the complex topography of the island into account.

2.4.2.6. Bait station arming

Each bait station would be armed as soon as possible once the program is initiated, with a standard number of pellets. Each station would be visited daily or on alternate days, checked, and bait replenished as necessary until activity ceases (activity includes bait chewed or taken by mice). Project crew would collect data (number of pellets taken, chewed, added, or replaced) from each station and enter it into a database for analysis. Bait application rates would be adjusted, if necessary, in response to these data to ensure that bait is always available to mice throughout the bait station grid.

2.4.2.7. Broadcast treatment of inaccessible terrain

While much of the South Farallones is accessible by foot and therefore treatable using bait stations, there are numerous areas throughout the island and along the coastlines which are inaccessible without putting personnel at unacceptable risk. Furthermore, the Service may determine that some areas of the island are too biologically or culturally sensitive to disturbance to allow bait station installation. Any areas of the South Farallones that cannot be treated within the bait station grid would be treated by bait broadcast. Whenever feasible, hand broadcast would be conducted by foot or by boat, but some inaccessible areas would require the use of a helicopter. Helicopter broadcast methods and considerations in Alternative B would be similar to those described in Alternative A, Section 2.3.2. Broadcast delivery would be conducted strictly according to the instructions given on the product's EPA-approved label.

2.4.2.8. Operational timing

Initial bait station installation would be timed outside of the summer season, when nesting seabirds utilize large tracts of the island. Bait stations would be loaded with bait immediately after installation and checked and re-armed frequently. When activity (bait removal or consumption) ceases, bait stations would be checked and re-armed bi-weekly then monthly for up to two years, documenting bait take and mouse sign in stations.

Broadcasting bait by hand or helicopter would take place according to the timing specifications described in Alternative B (the proposed action), Section 2.3.2.16. However, the combination of the two bait delivery techniques that would be necessary in Alternative C would require special considerations. Because bait would only be available in broadcast-treated areas for a limited period of time, it is important that mice have already been eliminated from adjacent bait station-treated areas before broadcast treatment to eliminate the possibility that mice could migrate into broadcast areas after all the bait had already disappeared. In addition, the borders of broadcast and bait station treatment areas would need to overlap to ensure adequate bait delivery in the transition zone between treatment areas.

2.4.2.9. Personal protective equipment

All personnel that handle bait would meet or exceed all requirements for PPE described on the bait's EPA pesticide label.

2.4.2.10. Training & supervision

All bait application activities (bait station filling, hand broadcast, and aerial operations) would be conducted by or under the supervision of pesticide applicators licensed by the State of California.

2.4.3. Impact Mitigation

2.4.3.1. Mitigation measures to protect cultural resources

Planning for the final layout of the bait station grid would be conducted in consultation with the State Historical Preservation Officer, so as to avoid inadvertently damaging buried resources during bait station installation. In general, project personnel would exercise extreme caution in order not to disturb the cultural or historical resources that have been identified on the South Farallones. Personnel would be briefed on the known locations of, and tips for identifying, archaeological and historical resources that may be present. All known sites of significance would be clearly marked with weather-resistant marking materials that are recognizable to all field personnel. Field personnel would be prohibited from disturbing any sites of historical or cultural importance.

2.4.3.2. Wildlife impact mitigation measures

2.4.3.2.1. Mitigation measures for rodenticide risks

Using bait stations would address the risk to native birds on the Farallones associated with bait broadcast. Birds that are likely to consume the bait product would be exposed to less bait in Alternative B than in Alternative A. However, bait stations would not completely eliminate the possibility that birds would eat bait, because mice would likely carry fragments of bait away from the stations each time they visited to feed. Bait stations would also fail to protect predators of mice from secondary exposure to brodifacoum through mice that consumed the bait.

All bait broadcast activities associated with Alternative C would be planned with the mitigation considerations listed in Section 2.3.3.

2.4.3.2.2. Mitigation measures for disturbance risk

The initial installation of bait stations would be timed to avoid peak breeding season, according to the considerations in Section 2.3.2.16. As stated above, bait broadcast activities would also be planned to avoid peak wildlife breeding seasons. Bait stations would need to be visited continuously, including during peak breeding seasons. As a result, some access pathways may need to cross especially sensitive habitat such as colonies of seabird burrows. Whenever possible, access paths would be routed around sensitive biological habitat, or temporary platforms, walkways, or other temporary infrastructure would be installed to avoid trampling. Additionally, all personnel would be briefed on strategies and techniques for avoiding wildlife disturbance whenever possible.

2.5. ASPECTS COMMON TO ALTERNATIVES B AND C (ACTION ALTERNATIVES)

2.5.1. Use of Techniques with High Likelihood of Success

The high cost and high complexity of non-native mouse eradication from the South Farallones make successful eradication especially critical. As stated in Section 1.2, the purpose of this project is to protect and restore the ecosystem of the South Farallones by eradicating damaging non-native house mice. The established record of successes (as well as failures) in the nearly 30 previous island mouse eradication attempts across the globe indicates that, if implemented correctly, both action alternatives would have a high likelihood of successfully eradicating mice (Howald et al. 2007; Witmer and Jojola 2006).

2.5.2. Rodent Introduction Prevention and Response to Rodent Detection

The benefits of a successful eradication could be lost with the introduction of even one pregnant female rodent. Rodents can be accidentally transported to islands and escape from:

- Watercraft moored directly to the island or anchored nearby
- Cargo containers such as food boxes, fishing gear, or other bulk materials
- Debris washed ashore from the mainland
- Sinking or disabled vessels
- Aircraft

2.5.2.1. Prevention

The Service currently obligates personnel, partners, and contractors traveling to the island to abide by a rodent and invasive plant exclusionary plan, which includes the following measures:

- Insuring through physical inspection that all materials and equipment transported to the island are free of seeds, plant materials, or rodents;
- Managing any mainland staging/storage areas so as not to attract rodents;
- Using only new materials for construction projects;
- Transporting materials in rodent proof containers

The implementation of these measures would be thoroughly reviewed before mouse eradication is complete, with a goal of 100 percent compliance among all island visitors.

In addition, a combination of rodent traps and poison bait would be maintained at the island landing area, and at any additional landing areas that may be utilized in the future.

2.5.2.2. Response

After it has been determined that the eradication operation has concluded, personnel remaining on the island would continue to monitor the island for new rodent introductions or the possibility that some mice remained after eradication operations. In the event that rodents are detected after eradication operations have ended, a rodent response plan would be implemented immediately. The response plan would include, at minimum, the installation of bait stations in an area immediately surrounding the site of a rodent sighting. If necessary, bait would also be hand- or aerially broadcast within the seasonal constraints described in Section 2.3.2.16.

2.5.3. Use of the Rodenticide Brodifacoum

Brodifacoum is a coumarin-based anticoagulant. It is a vertebrate toxicant that acts by interfering with the blood's ability to form clots, causing sites of even minor tissue damage to bleed continuously. Brodifacoum is the most commonly-used rodenticide in the United States (Erickson and Urban 2004). It is currently available for household consumers, although its use is limited to indoor applications, and the EPA is currently considering further restricting its use to professional pest control operations (72 FR 10 pp. 1992-3, 2007). Brodifacoum is also the most extensively utilized and best-understood rodenticide for rodent eradication from islands – out of the 332 known island rodent eradication efforts worldwide reported as successful, 71 percent of them used brodifacoum (Howald et al. 2007).

In order for the toxin to have physical effects, brodifacoum levels in the liver must reach a toxic threshold; this level can vary widely between species. The relative threshold level for mice to experience toxic effects from brodifacoum exposure is very low, but for other vertebrate species the threshold level is much higher. In other words, some vertebrates can consume large amounts of brodifacoum before experiencing physical symptoms of toxicity.

2.5.4. Public Information

All of the Farallon Islands are off-limits to the general public, but the waters surrounding the islands are productive fishing grounds and provide recreational opportunities for the nearby San Francisco Bay Area. Informational posters describing the eradication actions taking place on the South Farallones would be distributed to nearby ports from which ships might embark for the vicinity of the islands. Researchers with an interest in the South Farallones would also be directly informed about eradication activities and timing.

For the purpose of educating approved island users such as research biologists and technicians, contractors, and volunteers, signs would be posted in the island's researcher housing and at all reasonable access points to the island stating that brodifacoum is present on the island, describing its appearance, and its intended purpose. These signs would remain visible for a period of at least nine months after bait application has been completed.

2.5.5. Monitoring Eradication Efficacy and Ecosystem Response

During and after bait application activities, the mouse population on the South Farallones would be monitored to assess effectiveness of eradication effort. Monitoring activities would include:

- During the eradication operations, radio transmitters attached to individual mice, which would allow project personnel to track mouse activity and confirm 100 percent mortality within a sample of mice on the island; and
- During and after eradication, rodent detection devices such as traps, chew indicators, and special tracking surfaces to capture mouse tracks and bite marks.

Biological monitoring on the South Farallon Islands, conducted primarily by PRBO Conservation Science in cooperation with the Service, has been an integral part of the management of the islands for over 30 years. The Refuge's current monitoring activities fall outside the scope of this specific action, and are slated to continue independent of the results of mouse eradication, so their environmental impacts are not analyzed here. The ongoing monitoring programs would provide valuable information on the ecosystem's response after mouse eradication, using baseline data from before the mouse eradication for comparison in order to detect any positive or negative changes.

The additional monitoring activities that would be necessary to determine the success of the eradication would largely be incorporated into ongoing monitoring activities for other aspects of the ecosystem, without adding more than a small amount of additional environmental disturbance. The current ongoing monitoring activities fall outside the scope of analysis of this document, and thus post-eradication monitoring activities will not be analyzed in detail here.

2.5.6. Other Ecosystem Management Activities Beyond the Scope of this Action

Some of the nest sites used by seabirds on the Farallones are the result of human habitat modification, both incidental to and for the specific purpose of creating new nest habitat. For example, there is a habitat "sculpture" constructed to provide habitat for crevice-nesting seabirds that could be easily and surreptitiously observed. As this document is being prepared, the Service is repairing and reinforcing the stone trail to the top of Lighthouse Hill, which will provide substantial additional nesting habitat for crevice nesters, including threatened species such as the ashy storm-petrel. Similar habitat construction is anticipated in the future.

The Service currently removes invasive plants through hand-pulling and herbicide applications. Additionally, native plants are being planted to encourage the suppression of non-natives. Finally, vegetation on the islands is being closely monitored to allow for quick response to new invaders or spreading populations of current pests.

When possible, the Service currently relocates burrowing owls that are overwintering on the island to protect ashy storm-petrels from predation. While mouse eradication is anticipated to deter owls from overwintering in the future, if some owls continue to return to the islands in the winter the Service may continue relocating them.

Because Western gulls are likely the most common predator of ashy storm-petrels, there have been efforts in the past to deter gulls from nesting in prime storm-petrel habitat, but these efforts have been sporadic. The Service is considering the possibility for targeted control of "problem" gulls that specialize in preying on storm-petrels, but there are currently no active gull control measures on the islands.

All of these current or planned management activities fall outside the scope of this analysis, and would continue independent of any decisions about mouse eradication.

2.6. Comparative Summary of Actions by Alternative

	Primary bait delivery method	**Secondary bait delivery methods**
Alternative A (no action)	NA	NA
Alternative B (proposed action)	Aerial broadcast	Hand broadcast; bait stations
Alternative C	Bait stations	Hand broadcast; aerial broadcast

2.7. Alternatives Dismissed from Detailed Analysis

2.7.1. Use of a First-Generation Anticoagulant (Diphacinone)

The rodenticide brodifacoum, which is classified as a "second-generation" anticoagulant, has been used in 71 percent of documented successful rodent eradication operations (Howald et al. 2007). However, due to the potency of brodifacoum, there is interest in the conservation community for the examination of less-toxic alternative compounds for rodent eradication purposes. Diphacinone, a "first-generation" anticoagulant, is the most commonly considered alternative compound because it has been used for localized rodent control for conservation purposes (e.g. Nelson et al. 2002; VanderWerf 2001). However, diphacinone has been used only rarely on islands to eradicate rats (e.g. Wingate 1985; Donlan et al. 2003; Witmer et al. 2007), has only been distributed through bait stations, and has never been successfully used to eradicate mice (see review in Howald et al. 2007).

The toxicity of diphacinone to mice is unclear; rats are considered to be fairly sensitive to diphacinone but experiments have shown a wide range of sensitivity for house mice, from relatively low to very high (Erickson and Urban 2004). In addition, due to the poorer physiological binding properties of diphacinone, rodents have to feed on diphacinone bait multiple times over a period of several days in order to achieve mortality. By comparison, both rats and mice are very susceptible to brodifacoum which will result in high mortality after only a single dose. While there are differences in toxicity between taxa, relative potency is better illustrated by comparing the amount of rodenticide bait that must be eaten in order to reach a roughly 50 percent probability of mortality, known as an LD50 dose. House mice would need to eat at least 60 percent of their bodyweight for up to five days in order to achieve an LD50 dose of 50 ppm diphacinone. In comparison, house mice would need to eat only between 1 percent and 2.6 percent of their bodyweight in a single dose to achieve the same level of mortality with 20 ppm brodifacoum (Fisher 2005).

In experimental trials with wild-caught house mice, diphacinone pellets did not kill any of the mice after three days of exposure in a captive laboratory situation (Witmer 2007). After seven days of exposure, diphacinone pellets still only killed 40 percent of the treatment mice. By comparison, brodifacoum pellets resulted in 80 percent and 100 percent efficacy (two different brodifacoum formulations were tested) after three days of exposure.

Because of the low toxic threshold of diphacinone to mice, the large amount of bait that mice would need to eat to achieve that threshold, and the typically sporadic feeding habits of mice (Rowe 1973), which would reduce the probability that mice would feed consistently on the bait, the risk of failure of an eradication operation using diphacinone is very high. For this reason, use of diphacinone as an alternative bait has been dismissed in this evaluation.

2.7.2. Use of Other Toxins

The use of other rodenticides registered with the EPA was dismissed from further consideration, for one or more of the following reasons: 1) lack of proven effectiveness in island mouse eradications; 2) potential for development of bait shyness in the mouse population; and 3) the lack of an effective antidote in case of human exposure. Each of these issues and the associated rodenticides are discussed below.

The vast majority of documented island-wide rodent eradication programs (226) have used brodifacoum or similar “second-generation” anticoagulants, while only 29 have used “first-generation” anticoagulants such as diphacinone (Howald et al. 2007). Nine additional eradications have used non-anticoagulant toxins including zinc phosphide, strychnine, and cholecalciferol. Acute rodenticides, such as zinc phosphide and strychnine, have the ability to kill mice quickly after a single feeding. However, because poisoning symptoms appear rapidly, the acute rodenticides can induce future bait avoidance if animals consume a sub-lethal dose. Studies with zinc phosphide have demonstrated that rodents associate toxic symptoms with bait they had consumed earlier if the onset of symptoms occur even six to seven hours after consumption (see Lund 1988). Thus, any individual consuming a sub-lethal dose is likely to avoid the bait in the future (Record and Marsh 1988). Also, acute rodenticides are often extremely toxic to humans and there are not always effective antidotes. The combination of these factors disqualifies the acute rodenticides from detailed consideration.

Cholecalciferol, which is classified as a “subacute” rodenticide, has the ability to kill mice more quickly than the anticoagulant rodenticides, but most often more slowly than the acute rodenticides. Cholecalciferol has a lower level of toxicity to birds. It has been used successfully to eradicate rodents (rats) from very small islands (Donlan et al. 2003). While these characteristics show potential as a candidate for eradications, the effectiveness of cholecalciferol in eradicating mice has not been tested. Furthermore, in experimental trials with wild-caught house mice, oral cholecalciferol killed only 20 percent of treatment mice after three days of exposure in a captive laboratory situation (Witmer 2007). After seven days of exposure, cholecalciferol was still only 20 percent lethal. Cholecalciferol’s dubious efficacy for mice disqualifies it from detailed consideration.

2.7.3. Use of Disease

While there is ongoing research focused on the development of taxon-specific diseases that can control populations of non-native species (such as by the Australian agency CSIRO, www.cse.csiro.au/research/rodents/publications.htm), there are no pathogens with proven effectiveness at eradicating rodents (Howald et al. 2007). Even a highly lethal mouse-specific pathogen would be ineffective at eradicating mice from the South Farallones, because if the mouse population rapidly declined, the introduced disease would likely disappear before being able to affect the few remaining individuals. Furthermore, the introduction of novel diseases into the environment carries tremendous potential risks to non-target species.

2.7.4. Trapping

This alternative would call for the use of live traps and/or lethal (“snap”) traps to eradicate mice. This action is highly unlikely to succeed on the South Farallones. The use of live traps and/or lethal traps to remove mice from an area is a strong selection agent in favor of mice that are “trap-shy”. Thus, after extensive trapping the only mice that would remain would be those that are behaviorally less likely to enter a trap, and these mice will be very difficult to remove without the introduction of alternate methods such as toxins. Furthermore, the widespread use of traps is not feasible because of the extensive effort and considerable personnel risk required to set and monitor traps. Therefore, this alternative would not be feasible to implement.

2.7.5. Biological Control

The introduction of predators on mice, such as snakes and cats, was dismissed because biological control most often only reduces, rather than fully eliminates the target species and thus fails to achieve the desired ecological benefit gained through complete mouse removal. There is no known effective biological control agent for mice on islands, and some forms of biological control would result in unreasonable damage to the environment. The introduction of cats to islands in order to control introduced rodents has been attempted numerous times since European explorers began crossing the Atlantic and Pacific Oceans. The introduction of a rodent predator, such as cats, generally results in a greater combined impact on birds than if one or the other were present alone. When seabirds are present, cats have been shown to prey heavily on seabirds (Keitt 1998; Atkinson 1985), consuming fewer rodents during these times. When seabirds migrate off the islands following the breeding season, cats switch prey to rodents, which allows the island cat population to remain stable at a higher level than if no rodents were present on the island (Atkinson 1985). Thus, birds are impacted not only by rodents but the larger number of cats that are sustained by rodent presence on the island. Introduction of another species onto an island can have severe and permanent consequences to the ecosystem (see Quammen 1996).

2.7.6. Fertility Control

Fertility control has been used with limited success as a method of pest management in a few species. Experimental sterilization methods have included chemicals and proteins delivered by vaccine, and genetically-modified viral pathogens. However, the effectiveness of these experimental techniques in the wild, as well as their impacts on non-target animals, are unknown. Aerial application of rodenticide is a more practical, effective, and safer method to eradicate mice than repeated baiting of oral contraceptives on a remote island across seasons or capturing, vaccinating, and releasing every member of one gender of the South Farallones' mouse population. This lack of data and tools disqualifies the use of fertility control from detailed consideration (see Tobin and Fall 2005).

2.7.7. Mouse Removal with the Goal of "Control"

The net conservation gain achieved by mouse control (i.e. reducing and maintaining mouse populations at extremely low levels), rather than complete eradication, is comparatively small, yet the risks to non-target wildlife are nearly the same. Mice can reproduce rapidly and re-colonize areas from which they were previously eliminated. The constant maintenance of an ecologically beneficial mouse control program (i.e. control of mouse populations to levels low enough island-wide to eliminate them as a reliable food source for migrating burrowing owls) is far less cost-effective and does not result in the permanent conservation benefits of entire-island eradication.

2.7.8. Alternative Methods for Restoration of Ashy Storm-Petrels, Without Mouse Eradication

2.7.8.1. Burrowing owl translocation

Because ashy storm-petrels are suffering heavy predation from burrowing owls, the Service has explored the option of burrowing owl capture and translocation to sites on the mainland. However, attempts to capture burrowing owls on the Farallones have proven only partially successful and very time-consuming, especially when mice are abundant on the island and owls are consequently unresponsive to baited traps (J. Barclay pers. comm.). Additionally, a burrowing owl translocation program would have to continue in perpetuity in order to contribute meaningfully to storm-petrel protection. Finally, burrowing owl translocation would not address the other likely impacts of mice on the island ecosystem. While burrowing owl relocation can protect ashy storm-petrels in the short term, it cannot alone adequately meet the purpose and need for action.

2.7.8.2. Control of Western gulls

Western gulls, which nest on the South Farallones in large numbers, are responsible for substantial ashy storm-petrel mortality due both to gulls attacking storm-petrels that encroach on their nesting territories, and gulls preying on storm petrels. The Service has explored options for reducing the size of the Farallones Western gull colony, which is much larger today than in historical records, including installing a wire grid to make gull nesting more difficult. Additionally, the Service has considered the possibility of targeted lethal control of gulls that have been observed "specializing" in preying on small seabirds. While options for reducing the gull population on the Farallones may be appropriate as a short-term action that might mitigate for high predation rates by gulls on storm-petrels, and might also complement mouse eradication, gull control without mouse eradication would not fully fulfill the ecosystem-wide restoration objective identified in Chapter 1. Therefore, this alternative was eliminated from further consideration.

2.7.8.3. Nesting habitat enhancement

The Service conducts its ongoing management activities with special consideration for protecting and enhancing seabird nesting habitat on the South Farallones, particularly for crevice- and burrow-nesting species such as ashy storm-petrels. Additionally, the Service may conduct restoration projects in the future that are designed specifically to enhance nesting habitat, such as the construction of artificial nests or nesting structures (Southeast Farallon currently has one such structure, known as a "habitat sculpture"). Enhancement of ashy storm-petrel nesting habitat, without mouse eradication, would contribute partly towards the seabird restoration component of the South Farallon Islands' restoration needs, but would not fully fulfill the ecosystem-wide restoration objective identified in Chapter 1. Other impacts of non-native house mice on the ecosystem would continue if nest habitat was enhanced without mouse eradication. Therefore, this alternative was eliminated from further consideration.

Chapter 3: Affected Environment

3.1. Introduction

Farallon National Wildlife Refuge was established in 1909, and expanded to its current size in 1969. It includes all of the islands in the Farallon group. Within the Refuge, all of the emergent land except the island of Southeast Farallon is also designated wilderness under the Wilderness Act of 1964. The Service has cooperative agreements with PRBO Conservation Science and the U.S. Coast Guard to facilitate protection and management of the Refuge.

The waters around the Farallones below the mean high tide line are part of the Gulf of the Farallones National Marine Sanctuary. This Sanctuary is one of three contiguous Marine Sanctuaries, with Cordell Bank National Marine Sanctuary to the north and Monterey Bay National Marine Sanctuary to the south, which together convey special protected status to the biological resources of almost 7,000 square miles of ocean from Cambria to Bodega Bay and out to sea well past the continental shelf.

The Farallones' isolated nature makes them an ideal breeding and roosting location for wildlife, especially seabirds and marine mammals. The Refuge comprises the largest continental seabird breeding colony south of Alaska, and supports the world's largest breeding colonies of ashy storm-petrel, Brandt's cormorant (*Phalacrocorax penicillatus*), and Western gull.

The Farallones have also had extensive human activity beginning in the early 1800's when seals were harvested for fur and food, as an egg gathering venture in the mid to late 1800's, a military outpost during two world wars, and until the 1970's as a manned US Coast Guard light station. Wildlife populations were heavily exploited in the late 18th and early 19th centuries for meat, hides and eggs. Over-fishing of sardines may have reduced seabird food supplies. Some species were extirpated or declined drastically. An active Coast Guard station further impacted island wildlife and habitat until the full automation of the light station in 1972. Under FWS stewardship, extirpated species have re-colonized the islands, and wildlife populations as a whole are slowly recovering. Still, wildlife remains vulnerable to the impacts of pollution, oil spills, gill-net fisheries and global climate change.

3.2. General Description of the South Farallones

3.2.1. Geographical Setting

The South Farallon Islands are situated just inland of the continental shelf, 28 miles west of the Golden Gate and the city of San Francisco, CA, at 37°42'N latitude and 123°00'W longitude. The South Farallones are made up of two islands that are separated by a narrow channel: Southeast Farallon and West End. A number of offshore islets and rock stacks immediately surround the main islands, the largest of which is Saddle Rock.

The Farallon Island group and the Farallon National Wildlife Refuge also includes a number of islets and rock stacks that extend to the northwest, including the North Farallones, Middle Farallon, and Noonday Rock, some of which become completely submerged in large swells. These islets to the northwest are stark, extremely difficult to access, and would not be included in the mouse eradication actions described and analyzed in this document.

3.2.2. Size and Topography

The South Farallones have a land area of approximately 120 acres (49 ha) and rise to a peak, 370 feet (113 m) above sea level. The topography is generally rocky and uneven, with comparatively flat terraces at the lower elevations of Southeast Farallon. The coastline is generally extremely steep, rocky and difficult to access.

3.2.3. Geology and Soils

The Farallones are composed primarily of granitic rock, evidence of the ancient marine terraces of which they are a part. During the last ice age, the coastline of California extended beyond the Farallones, and the islands were part of a coastal range of hills that is now almost entirely submerged. The Refuge is primarily made up of rocky surfaces with little soil coverage. However, the flat part of Southeast Island is covered with dark brown soil up to 8 inches thick (Vennum et al. 1994). Soil examination indicates that the composition is largely made up of decomposing guano and granitic sand and lesser amounts of feather, bone fragments, vegetation, possible fish teeth and human-made detritus (Vennum et al. 1994).

3.2.4. Climate

The following information is adapted from Null 1995.

Summertime in the San Francisco Bay region is characterized by cool marine air and persistent coastal stratus and fog, with average maximum temperatures between 60° F and 70° F, and minima between 50° F and 55° F. Rainfall from May through September is relatively rare, with an aggregate of less than an inch, or only about 5 percent of the yearly average total of approximately 21.5 inches. Off-season rains that do occur usually consist of brief showers or thundershowers spreading into the area. Considerable moisture, although rarely measurable as precipitation, is due to drizzle when the marine layer deepens sufficiently.

Winter temperatures in the San Francisco Bay region are quite temperate, with highs between 55° F and 60° F and lows in the 45° F to 50° F range. Over 80 percent of San Francisco's seasonal rain falls between November and March, occurring over about 10 days per month. Winter thunderstorms occur on the average only twice per season. Snow is extremely rare in San Francisco, with only 10 documented instances of measurable snow at the official observing site in the past 143 seasons. Snow has fallen on a number of other occasions, but usually only in trace amounts.

Spring and fall are transition periods, usually producing the most cloud-free days between the overcast days of summertime stratus and the rain laden clouds of winter. The region's hottest days are typically during the spring and fall when high pressure builds into the Pacific Northwest and Great Basin, and dry offshore winds replace the Pacific seabreeze. The three hottest days in the city of San Francisco occurred in September and October. The occurrence of rainfall during the early spring and fall is infrequent, with only about 5 days per month on the average. While most storms during these periods produce light precipitation, there are occasional heavy rainfall events. On the Farallon Islands, spring and early summer are characterized by strong northwesterly winds.

3.3. BIOLOGICAL RESOURCES

3.3.1. Introduction

All of the alternatives described and analyzed in this document, including the alternative of No Action, have the potential to affect the biological resources of the South Farallones. The no action alternative would allow the direct and indirect impacts that non-native house mice currently have on the native species of the South Farallones to continue. The proposed mouse eradication would have three basic types of impacts on biological resources: impacts from the use of rodenticide, impacts from disturbance caused by the personnel activities and machinery operation necessary for bait application, and subsequent ecosystem response to the removal of mice from the ecosystem. This section will describe the status, trend, and biology of animals and plants on the Farallones as they relate to the potential for each of the alternatives to have a noticeable effect.

3.3.2. Birds on the South Farallones

Appendix ## contains a full list of birds that breed on the South Farallones. Appendix ## contains a list of birds that are likely to visit or reside at the South Farallones at some point during the year.

3.3.2.1. Seabirds and other marine birds

The Farallones are the largest seabird breeding colony in the lower 48 states. Twelve marine bird species are known to breed on the islands. During the peak of the summer breeding season there may be more than 250,000 breeding birds present. Most habitat types on the Farallones are occupied by breeding seabirds between mid-March and mid-August. Cormorants, murres, and oystercatchers inhabit rocky ledges. Vegetated plateaus and slopes are dense with nesting gulls. Even below the surface, rock crevices and burrows house storm-petrels, auklets, guillemots, and puffins.

The Farallones are the breeding site for half of the world's population of the ashy storm-petrel, which occurs only in the waters off the coast of southern Oregon, California, and northern Baja California, Mexico. The Farallones also host the world's largest colonies of Brandt's cormorants and Western gulls, as well as one of the southernmost major colonies for rhinoceros auklets (*Cerorhinca monocerata*) and tufted puffins (*Fratercula cirrhata*) on the west coast of North America.

The onset of breeding activity varies considerably between seabird species. The earliest egg-laying occurs in March, with Cassin's auklets (*Ptychoramphus aleuticus*). While most eggs have been laid by early July, some ashy storm-petrels may not lay until as late as August. While the length and dynamics of each species' breeding season differ, there is a clear seasonal pattern among nearly all seabirds in which chicks have fledged by September or earlier. The only major exception to this is the ashy storm-petrel, some chicks of which may not fledge until December (Ainley 1990; Ainley and Boekelheide 1990; PRBO unpubl. data).

Some of the seabird species that nest on the Farallones are extremely sensitive to disturbance – they will frighten and take flight readily, and in the process either knock their eggs from their precarious perch or leave them exposed to be eaten by roaming gulls. Disturbance becomes a comparatively smaller concern during the non-breeding season.

All of the seabirds on the South Farallones can generally be characterized as slow-reproducing. Many species only lay one clutch of eggs each year, and some species only lay a single egg in each clutch. Because they cannot reproduce quickly to counteract negative impacts to their populations, seabirds are especially vulnerable to factors that reduce the survival of breeding adult birds. Small decreases in adult survival can result in population declines and hamper recovery. As a result, factors that increase mortality in adults can seriously jeopardize seabird populations, especially if population levels are already low (USFWS 2005).

A plethora of factors affect each of the seabird species that are present on and around the South Farallones, both at the islands and elsewhere in their ranges. The Service's 2005 Seabird Conservation Plan for the Pacific Region describes current threats, management goals and detailed information of seabirds. The most serious human-caused threats to seabirds in the region involve 1) invasive species; 2) interactions with fisheries (both direct and indirect); 3) oil and other pollution; 4) habitat loss and degradation; 5) disturbance; and 6) global climate change. In addition, all of the species that forage in the waters surrounding the South Farallones are affected by changes in the productivity of the marine ecosystem, which can occur over many different spatial and temporal scales. Researchers are often able to draw a direct correlation between years of particularly high or low marine productivity and corresponding breeding productivity in the Farallones' seabird species (USFWS 2005; Warzybok et al. 2005).

The productive waters surrounding the Farallones provide foraging grounds for a number of additional waterbird species, including seabirds and other marine waterbirds such as grebes, scoters, and phalaropes, most of which remain in the water or in flight but a few of which also use the islands for roosting. Additionally, the islands' intertidal habitat supports a number of shorebird species such as plovers and turnstones. Finally, many other species of freshwater and estuarine waterbirds have been sighted on the Farallones during migration, and some have occasionally overwintered. The community makeup of these additional waterbirds varies substantially, both seasonally and annually. With the exception of black oystercatchers (*Haematopus bachmani*), no marine birds other than seabirds have been known to breed on the Farallones.

3.3.2.2. Landbirds

There are no permanently resident landbirds on the Farallones, but the islands are well known for the number and diversity of landbirds that arrive on the island during spring and fall migrations (DeSante 1983; Pyle and Henderson 1991). More than 400 species of landbirds have been recorded for the Farallon Islands (Richardson et al. 2003; USFWS unpubl. data). DeSante and Ainley (1980) conclude that the vast majority of these arrivals are birds that are in the process of returning to the mainland after veering off their migratory course along California's coast. During the spring and fall large numbers of migrants may be present on the island, often concentrated in and around the small trees that were planted near the residences on Southeast Farallon. While nearly all landbirds spend little time on the islands before departing, perhaps 100 or fewer remain through the winter. There are no landbird species that consistently breed on the Farallones, although there are occasional historical nesting records from a few species (DeSante and Ainley 1980).

3.3.2.3. Seasonal patterns in the avian communities of the South Farallon Islands

The following section is adapted from DeSante and Ainley's *Avifauna of the South Farallon Islands* (1980).

The greatest density and diversity of visitant bird species occurs during fall. Shorebirds, rock intertidal species predominating, begin arriving in July and gradually increase to maximum visitation rates in September, when the generally rare estuarine and freshwater species also occur.

Pelagic seabirds likewise reach maximum diversity during September although maximum numbers of sooty shearwaters (*Puffinus griseus*) often occur during summer, and phalaropes are often most abundant in August. With the exception of pelicans and gulls, none of these visitant seabirds land on the islands but rather stay on or above the surrounding waters. The seabirds that breed on the South Farallones are mostly absent from the island during fall.

Landbird migrants, primarily species breeding in western North America and wintering in the tropics, begin arriving in early August and also reach maximum visitation rates in September. Nocturnal migrants greatly predominate. Vagrant landbirds, primarily from Canada and eastern North America, begin to appear in mid-summer and occur in maximum numbers from mid-September to early October. The maximum diversity usually occurs at this time. The maximum number of individuals visit in late September or early October, when the major arrival of landbirds wintering in coastal California occurs. Landbird visitants decline during late October and dwindle to very low numbers by late November.

Neritic seabirds, including those species inhabiting both inshore and offshore waters, begin arriving in very late September or October and reach maximum diversity during November. With the exception of pelicans and gulls, none of these visitant seabirds land on the islands but rather stay on or above the surrounding waters. Fall resident nonbreeding brown pelicans (*Pelecanus occidentalis californicus*) are present in maximum numbers in October, often roosting on the islands.

Besides the year-round resident breeding seabirds, neritic seabirds, particularly eared grebes (*Podiceps nigricollis*), surf scoters (*Melanitta perspicillata*), and large *Larus* gulls, frequent the waters around the island during winter. Rocky intertidal shorebirds also winter in low numbers, although other shorebirds, estuarine and freshwater species, and pelagic seabirds are generally very rare. Comparatively few landbirds winter on the island. Those that do are species that prefer rather open, treeless habitats such as sparrows, meadowlarks, rock wrens, and starlings. Most overwintering landbirds arrive during the fall migration period, primarily October and November, and depart in March and April.

Early spring migrants may first appear in late February but usually arrive in March. Spring migration is generally quite sporadic and unpredictable, especially during March and April. At this time, however, the immense numbers of breeding seabirds begin their nesting activities. Nearly all waterbirds, including most pelagic and neritic seabirds and virtually all estuarine and freshwater species and shorebirds, are very rare during the spring migration. Large numbers of small gulls and phalaropes, however, sometimes pass by the island.

One and occasionally two major waves of visitant landbirds usually occur in early and/or late May. Different populations are probably involved in each of these flights but most are of species that breed in western North America and winter in the tropics. Very few western landbirds visit after late May or very early June. Spring vagrant landbirds may first appear in mid-May but reach maximum diversity during the first half of June.

3.3.2.4. Special legal protection for birds on the South Farallones

The birds that reside at or visit the South Farallones are protected from harm by the Migratory Bird Treaty Act (MBTA). Additionally, the California brown pelican (*Pelecanus occidentalis californicus*), which does not breed on the Farallones but roosts on the islands in large numbers, is listed as Endangered under the Endangered Species Act (ESA). More detailed information on the status and trend of California brown pelicans can be found in Section 3.3.6.2 below.

3.3.3. Terrestrial Species of the South Farallones

3.3.3.1. Seabirds and the South Farallon ecosystem

Breeding seabirds are a major driving force in the terrestrial ecosystem of the South Farallones. Seabirds trample, burrow, and substantially alter the chemical content of the soil (through guano deposition) across most of the island, which makes the growing environment for plants highly specialized and generally less productive than similar habitat on the mainland. While the effects of seabirds on the island soil prevent some species from thriving, they simultaneously provide ideal habitat for many other species. The island's ubiquitous maritime goldfields (*Lasthenia maritima*), a small herbaceous composite, exists only on seabird breeding colonies. In turn, Western gulls and Brandt's cormorants at the South Farallones rely heavily on maritime goldfields for nesting material (Coulter 1971). With increasing seabird populations the overall use of maritime goldfields by seabirds has also likely increased (PRBO unpubl. data). Similarly, seabird burrows provide habitat for subterranean animals such as the Farallon arboreal salamander (*Aneides lugubris farallonensis*) and numerous invertebrate species. Finally, the inevitable abundance of seabird carcasses that comes with any seabird colony provides a reliable food resource for a host of decomposer invertebrates.

3.3.3.2. Salamanders

The arboreal salamander subspecies *A. l. farallonensis* is endemic to the Farallones. In the most habitat-rich areas of the islands, salamander densities can reach 2,000 animals per hectare (Boekelheide 1975). Farallon arboreal salamanders are nocturnal insect predators. Like many salamanders, they are lungless, respiring through their skin. While they are most active when the surrounding environment is moist, they are not dependent on water for any part of their lifecycle and are more tolerant of dry conditions than other salamander species (Cohen 1952). They actively breed during the summer (Boekelheide 1975), but the length and timing of their breeding season is unknown. Salamanders are a major predator on the endemic camel cricket *Farallonophilus cavernicola* (Steiner 1989).

3.3.3.3. Bats

There are no breeding or resident bats on the South Farallones. However, similar to birds, a number of bat species are known to land on the islands during spring and fall migrations. These include hoary bat (*Lasiurus cinereus*), western red bats (*Lasiurus blossevillii*), free-tailed bat (*Tadarida brasiliensis*), little brown bat (*Myotis lucifugus*), and Eurasian pipistrellus (*Pipistrellus* sp.).

3.3.3.4. Invertebrates

Many of the insects on the South Farallones are most commonly associated with seabird carcasses (Schmieder 1992). This is not surprising given the inevitably high number of carcasses usually found on any seabird colony, including the Farallones. Globally, insects play a major role in processing detritus, and the role of invertebrates in the decomposition of carcasses on the Farallones is particularly critical given the paucity of larger detritivores on the islands compared with ecosystems on the mainland.

Few insect studies have been conducted on Southeast Farallon Island. The most well-described invertebrate endemic is the camel cricket (Steiner 1989), but a unique island form of the flightless intertidal beetle *Endeodes collaris* has been described as well (Giuliani 1982).

3.3.3.5. Vegetation

The vegetation diversity on the Farallon Islands is low compared to the nearby mainland due to the harsh open-ocean environment. Sparse soil coverage further limits the extent of vegetation on the Farallones. The islands' flora includes at least 44 species, 26 of which are non-native (Coulter and Irwin 2005). Maritime goldfields cover much of the island. Maritime goldfields are specialized for life on offshore seabird colonies, occurring on islands and sea stacks along the Pacific coast of North America from northern Baja California to Vancouver Island, British Columbia. They are tolerant of the caustic soil conditions that are characteristic of guano-covered seabird habitat (Crawford et al. 1985).

Several individual California native trees (Monterey cypress *Cupressus macrocarpa* and Monterey pine *Pinus radiata*) were planted on Southeast Farallon Island, before the island was added to the Refuge. There are three Monterey cypress individuals (planted in 1982 – Pyle and Henderson 1991) near the housing. There are also three "cultivated patches" of bush mallow (*Lavatera arborea*), a non-native species, all within 200 m of the housing units (also Pyle and Henderson 1991). The islands' few passerine landbirds largely congregate in the immediate vicinity of these larger plants.

Much of the vegetation on the Farallones senesces or dies by the summer and rebounds in the early winter and spring when seasonal rainfall begins.

3.3.3.6. Non-native animals

When the Service incorporated SFI into FNWR in 1969, there were introduced rabbits, feral cats, and house mice present on the islands. Although island managers do not know when mice were first introduced to SFI, anecdotal evidence suggests that they arrived early in the sequence of human activities, which began in the early 1800's. Russian sealers, egg collectors, lighthouse keepers, the Navy and the Coast Guard all inhabited the island before the Service assumed management and any of these previous occupants could have introduced mice, presumably by accident. Shortly after the Service assumed management they implemented a management program to remove rabbits and cats, which ended successfully in 1975 leaving house mice as the only non-native vertebrate on the Farallones.

House mice are small rodents, around 15-20 g in mass. They are prolific breeders, with females commonly producing six to eight litters a year, each with four to seven young which mature within three weeks and are reproductively active soon after (Witmer and Jojola 2006). Individual house mice most frequently travel no further than 15 or 20 m from a burrow, although occasional forays of longer distances do occur (Triggs 1991; Ruscoe 2001). House mice are omnivorous; mice on the Farallones eat both vegetation and invertebrates year-round and have been found with eggshell fragments and seabird feathers in their stomachs during the seabird breeding season (it is possible that these seabird remains came from scavenged carcasses) (Jones and Golightly 2006).

The population of non-native house mice on the South Farallones is highly cyclical, growing steadily and rapidly throughout the summer to a peak in October and then crashing just as rapidly as food resources decline through the winter to a low in April (Irwin 2006; Jones and Golightly 2006). Mice are the primary prey item for burrowing owls during the fall and winter months. As discussed in Section 1.3.1, the presence of mice as a seasonal food resource for burrowing owls has enabled these owls to subsequently prey heavily on small seabirds such as the ashy storm-petrel each spring when mouse numbers are low. Partly as a result of the presence of mice on the South Farallones, the islands' ashy storm-petrel population has been declining steadily and unsustainably.

While mice are the only permanent non-native vertebrate residents on the South Farallones, non-native landbirds such as starlings (*Sturnus vulgaris*), house sparrows (*Passer domesticus*), and rock pigeons (*Columba livia*, commonly known simply as "pigeons") may be present during some seasons. Starlings and house sparrows have also bred on the South Farallones in the past, but not in the past decade. Non-native birds are unlikely to have any impact on the small avian landbird community of the islands.

3.3.3.7. Non-native plants

In the most recent study conducted in 2005, 26 different non-native plants were recorded (Coulter and Irwin 2005), several of which are harmful pests. These include two non-native grass species which currently dominate Southeast Farallon's southeast end (*Bromus diandrus* and *Hordeum murinum*), New Zealand spinach (*Tetraagonia tetragonioides*), mallow (*Malva parviflora*), and plantain (*Plantago coronopus*). Most non-native plants are found on the marine terrace in the south and southeast portion of Southeast Farallon and up the slopes of Lighthouse Hill and Little Lighthouse Hill. The spread of some of these non-native plants to the northern side of the island could pose a further threat to native species. New Zealand spinach has been identified as a particularly serious threat to the Farallones ecosystem because its impenetrable mats of growth degrade seabird burrowing and nesting habitats (USFWS 2005).

3.3.4. Pinnipeds

*3.3.4.1. California sea lion (*Zalophus californianus*)*

California sea lions are the most abundant pinniped to haul out on the South Farallones. There are probably roughly between 1,000 and 3,000 animals present on the island and in surrounding waters year-round, with peak numbers during the spring (Ainley and Allen 1992; PRBO unpubl. data). California sea lions breed during the summer months of May through September, but the South Farallones are not a major breeding site. Most California sea lions at the Farallones are thought to breed either in the Channel Islands or on sites further north (Sydeman and Allen

1997). California sea lion abundance has increased substantially at the South Farallones during the last quarter century.

*3.3.4.2. Northern elephant seal (*Mirounga angustirostris*)*

Northern elephant seals are present in the waters surrounding the South Farallones year-round, but they are more abundant, particularly hauled out on the islands, during breeding and molting seasons (Sydeman and Allen 1997; LeBoeuf and Laws 1994). In December, adult males begin arriving on the South Farallones, closely followed by pregnant females on the verge of giving birth. Females give birth, nurse their pups, and copulate (conceiving pups that will not be born until the following winter) until March, when they leave the islands to forage in deep offshore waters. The spring peak generally occurs in April and May, when females and juveniles (animals one through four years old) arrive again at the colony to molt. The year's new pups remain on the colony through both of these peaks, generally leaving by the end of April. In May, the majority of animals leave the colony to forage during summer and fall, although small numbers of adult males are present to molt during the summer and a smaller peak of juveniles arrives to molt in the fall (LeBoeuf and Laws 1994).

The current-day elephant seal colony at the Farallones was established in 1972, as the population of elephant seals throughout the region was recovering from its near extinction, due primarily to overharvesting, in the 19th century. The colony grew rapidly during the 1970's, and in 1983 a record 475 pups were born on the South Farallones (Stewart et al. 1994). Since then, the size of the South Farallones colony has declined, but the population currently appears stable. In 2007, a total of 179 cows were counted on the South Farallones, and 132 pups were weaned (Lee 2007).

*3.3.4.3. Pacific harbor seal (*Phoca vitulina richardsi*)*

Pacific harbor seals are also present on or around the South Farallones year-round; the average number of animals observed hauled out or in nearby waters is generally highest in the summer and currently fluctuates between roughly 30 to slightly more than 100 (PRBO unpubl. data). Harbor seal abundance at the Farallones appears to fluctuate largely based on food availability in waters closer to shore; harbor seals are generally most abundant directly off the mainland coast, but they venture out to the Farallones when food near the coast is scarce (Sydeman and Allen 1997). Harbor seals breed between March and June, but similar to California sea lions, few harbor seal pups have been born on the South Farallones. Harbor seal abundance has increased at the South Farallones during the last quarter century. This increase in abundance is thought to be largely the result of immigration from coastal waters where food availability has declined (Sydeman and Allen 1997).

*3.3.4.4. Northern fur seal (*Callorhinus ursinus*)*

Northern fur seals are also present year-round in the waters surrounding the South Farallones. They are most commonly seen during the fall and winter seasons, although the monthly average number of northern fur seals sighted is generally less than 20 (PRBO unpubl. data). Although the Farallones are believed to have been a major northern fur seal breeding area before the arrival of hunters in the early 19th century, the species was essentially extirpated from the region by second half of the century. Not until 1996 did northern fur seals begin breeding again on the Farallones (Pyle et al. 2001), and each year since then they have bred in generally small numbers on West End Island during the summer. These numbers have increased dramatically in recent years, with nearly 200 animals observed in 2006 (PRBO unpubl. data).

*3.3.4.5. Steller sea lion (*Eumetopias jubatus*)*

Steller sea lions are primarily a species of the far north Pacific, and their colony on the Farallones is near the southern end of their breeding range (Steller sea lions also currently breed at Año Nuevo and previously bred at the Channel Islands as well). Steller sea lions are present on and around the South Farallones year-round, but their numbers are considerably greater during the summer breeding season and again in late fall (Hastings and Sydeman 2002). Monthly averages of Steller sea lion counts range very roughly between 20 and 100 animals (PRBO unpubl. data). Steller sea lion breeding sites on the South Farallones are currently restricted to two sites on West End Island. The South Farallones breeding colony has become less productive over the past quarter century; generally only between five and 10 pups are born here annually compared with 20 to 30 pups annually during the 1970's (Sydeman and Allen 1997). In general, the Steller sea lion population utilizing the South Farallones for breeding and resting has undergone a major decline in the past quarter century. The reasons for this decline are unclear; it is possible that some adult animals have merely shifted their geographic range northwards (Hastings and Sydeman 2002). Regardless, the status of Steller sea lions on the South Farallones is precarious, in contrast to the other pinnipeds that utilize the islands.

The eastern Distinct Population Segment (DPS) of Steller sea lions, which includes habitat in California (including the South Farallones), Oregon, Washington, Canada and southeast Alaska, is listed as Threatened under the Endangered Species Act (ESA). More detailed information on the status and trends of Steller sea lions throughout this range can be found in Section 3.3.6.1 below.

3.3.4.6. Other marine mammals in the Gulf of the Farallones

In addition to the marine mammals discussed above, Guadalupe fur seals (*Arctocephalus townsendi*) and southern sea otters (*Enhydra lutris nereis*) are occasionally spotted in the waters surrounding the Farallones (Brown and Elias 2008). The rarity with which these species occur precludes them from detailed analysis in this document.

There are also a number of cetacean species that inhabit the Gulf of the Farallones, but they are very unlikely to be affected by any of the actions described and analyzed in this document, because all project activities would occur on or directly above the islands themselves and not in the surrounding marine environment.

3.3.4.7. Special legal protection for marine mammals at the South Farallones

All of the marine mammals discussed here are protected from harm under the Marine Mammal Protection Act (MMPA) (in the case of the Steller sea lion, this protection is in addition to its listing under the ESA).

3.3.5. Intertidal and Nearshore Ecosystems

This section was compiled with information from J. Roletto (NOAA – Gulf of the Farallones NMS), pers. comm.

Gulf of the Farallones National Marine Sanctuary is contiguous with the Farallon National Wildlife Refuge at the mean-high tide. The Sanctuary has conducted long-term monitoring of the rocky intertidal habitats of the Farallon Islands since 1992. Data include percent cover, density counts, and species inventories. Surveys are conducted annually during late summer (August), fall (November) and winter (February) months.

The intertidal habitat between the low and high tides is characterized by extreme conditions caused by wind, waves, and the fluctuation of tides. Organisms living in the intertidal face many challenges that are unique to living at the edge of the ocean, including threat of desiccation, physical wave action, and limited space. The intertidal areas of the islands are also highly biologically productive and diverse, supporting diverse assemblages of algae, plants and animals. Researchers have found over 200 taxa; five are rare and seven were extended ranges. See Appendix ## for the rocky intertidal species list. The mean annual percent cover for algae and sessile macroinvertebrates at the South Farallones ranges from 148-255 percent.

Perennial macrophytes exhibit conspicuous zonation in the rocky intertidal community. Microscopic algae are common in the splash zone in winter months when large waves produce consistent spray on the upper portions of the rocky shore. Descending into the intertidal are several zones dominated by (1) ceramial algae in the high intertidal; (2) a dense turf of erect coralline and gigartinal algae in the mid-intertidal; and (3) beds of rhodymenials and laminarials in the low intertidal zone. The presence of the seagrass *Phyllospadix* is a good indicator of the mean low water level. In general, the rocky intertidal areas on the South Farallones are predominated with red-turf and coralline algae. The most common genera at the Farallon Islands include *Corallina*, crustose corallines, *Cryptopleura*, *Egregia*, *Endocladia*, *Gastroclonium*, *Gelidium*, *Mastocarpus*, *Mazzaella*, *Neorhodomela*, *Petrocelis*, *Prionitis*, and *Ulva*.

Intertidal invertebrates also exhibit conspicuous zonation. The periwinkle *Littorina keenae*, and the barnacle *Balanus glandula* can be used as an indicator of the splash zone. The barnacle *B. glandula* and red algae *Endocladia muricata* and *Mastocarpus papillatus* are used as indicators of the high intertidal zone, but these species are also found in other areas of the rocky shore. At wave-exposed sites, the mussel *M. californianus* can dominate the available attachment substratum in the mid-intertidal zone. Intertidal predators generally include whelks, sea stars, sea urchins, octopus, fishes, and shore crabs. Overall on the South Farallones, the most common invertebrates include *Anthopleura* and *Mytilus*.

Kelp forests, which include the giant kelp species bull kelp *Nereocystis luetkeana*, are important habitat and food for many invertebrate and finfish species. Kelp forests are common along the nearby mainland coast but do not dominate the sub-tidal areas of the South Farallones.

Black oystercatchers and black turnstones (*Arenaria melanocephala*) are the most common birds along the rocky shoreline. These birds are most abundant during fall and winter, and during this period, are accompanied by small numbers of ruddy turnstones, surfbirds, and wandering tattlers. A variety of species commonly considered landbirds also feed along rocky shores, including black phoebes (*Sayornis nigricans*), Brewer's blackbirds (*Euphagus cyanocephalus*) and European starlings.

The heads of coves on Southeast Farallon and Maintop (West End) Islands include sandy beaches. These areas are prime haul-out locations for elephant seals and sea lions. Over the past two decades the elephant seals have caused erosion of the sand from these coves, thus reducing their use as haul-outs. The diversity of intertidal algae and invertebrates are greatest at some of these sandy coves, bordered by rocky walls and substrate. Examples can be found at the sandy coves near Dead Sea Lion Flat and Low Arch on Southeast Farallon Island.

Oil spills pose a major threat to the health and balance of life on the South Farallones' rocky shores. Past spills, such as the November 2007 *Cosco Busan* oil spill in San Francisco Bay, have deposited oil on nearby rocky shores on the mainland. Oil can smother mussel beds and kill acorn barnacles, and limpets and cause disruption in reproductive processes in invertebrates and algae. Monitoring programs are vital in addressing the potential impacts, restoration and recovery rates from spills.

Non-native species have also made their way to the South Farallones' intertidal zones. These introductions are a major concern, due to the sanctuary's close proximity to the highly invaded San Francisco Bay. To date, almost 150 species of introduced marine algae, plants and animals have been identified in the Gulf of the Farallones National Marine Sanctuary. Invasive invertebrates, such as the green crab *Carcinus maenas*, make up more than 85 percent of all introductions in Gulf waters. They threaten the abundance and/or diversity of native species, disrupt ecosystem balance and threaten local marine-based economies.

3.3.6. Threatened and Endangered Species

3.3.6.1. Steller sea lion

The Steller sea lion was listed as Federally Threatened under the ESA in 1990 due to an 80 percent decline in the U.S. population between the 1950s and 1990. In 1997, after new genetic information revealed the existence of significant stratification between regional populations, management of Steller sea lions under the ESA was split among two distinct population segments (DPS), the western DPS and the eastern DPS. The western DPS, which is primarily composed of Steller sea lions in the Aleutian Islands, was up-listed to Endangered at that time. The eastern DPS, which includes Steller sea lions on the South Farallones, remained listed as

Threatened. The South Farallon rookery and waters around the islands are listed as designated Critical Habitat under the ESA, according to 50 CFR 226.202; the colony sites at the South Farallones are protected within a radius of 300 feet, including the air space above the islands. However, the South Farallones no longer qualify under the NMFS definition of a rookery site, which requires that more than 50 pups be born annually.

Over the past 20 years, the eastern DPS overall has been increasing, but most of this increase has occurred in southeast Alaska and British Columbia, with population counts in California remaining stagnant or decreasing. The reasons for ongoing declines in California are unclear; the growing population of California sea lions in this region may be out-competing Steller sea lions, possibly in combination with changing oceanic conditions that are negatively affecting food availability for Steller sea lions but not for California sea lions.

3.3.6.2. California brown pelican

The brown pelican has been Federally listed as Endangered since 1970 (originally under the Endangered Species Conservation Act of 1969, which was later superseded by the Endangered Species Act of 1973). Brown pelican populations were severely reduced throughout the U.S. during the 1960’s as a result of exposure to organochlorine pesticides such as DDT. Many pelican breeding colonies experienced total reproductive failure for multiple consecutive years. After DDT’s use as an agricultural pesticide was banned in the U.S. in 1972, pelican populations began to recover. Although DDT and related compounds are still present in low levels in the marine ecosystem, especially in southern California where the Montrose chemical company discharged large amounts of DDT into the ocean during the late 1960’s and early 1970’s, these chemicals no longer appear to have population-level effects on the California brown pelican. The pelican population in California is now considered stable and healthy, with numbers at or near historic levels. The Service recently initiated the process to remove brown pelicans, including the California subspecies, from the Endangered Species list. However, the ESA regulations will continue to apply to pelicans on the South Farallones until the de-listing process is complete, which may not be until after the proposed mouse eradication is implemented.

3.4. Human Activities and Values

3.4.1. Ownership/Management/Major Stakeholders

The South Farallones are managed as the Farallon National Wildlife Refuge, part of a national system of Federal lands managed by the Service for the primary benefit of wildlife and their habitats. However, the U.S. Coast Guard’s authority to use Southeast Farallon Island for a navigational light station pre-dates and supersedes the Service’s jurisdiction. Coast Guard personnel visit the island several times a year to maintain the automated, solar-powered light at the top of Lighthouse Hill, and rarely become involved in management of the island. The surrounding waters are managed primarily by NOAA as the Gulf of the Farallones National Marine Sanctuary. The islands and waters surrounding them out to a distance of one mile are also designated a Game Refuge by the California Department of Fish and Game.

Access to the South Farallones and the waters immediately surrounding them is strictly monitored and essentially limited to FNWR and PRBO Conservation Science staff, approved contractors and collaborators, and special-use-permit holders, due to the sensitive nature of the wildlife and the difficulty in landing on the islands.

The South Farallones are within San Francisco County limits, but the islands do not provide any employment opportunities for the general public. Wildlife-viewing charter boats, none of them operated by the Service, generate income for the region by capitalizing on the wildlife-viewing opportunities that the South Farallones provide.

3.4.2. Commercial Fisheries

Scholz and Steinback (2006) conducted an in-depth examination of the use of the adjoining National Marine Sanctuaries that span the coast of central California as fishing resources. Currently, the most important fisheries in the study area — the Cordell Bank and Gulf of the Farallones and adjacent port communities from Bodega Bay to Pillar Point (Half Moon Bay) — are Dungeness crab, groundfish (including several nearshore species), herring, salmon, squid, tuna and urchins. Between 1981 and 2003, these seven fisheries yielded an average of nearly 35 million pounds of landings worth over $31 million per year (in constant 2003 dollars).

In general, the fisheries in the study area are more valuable than in the state as a whole. Over the past 23 years, the proportion of revenues derived from commercial fisheries' landings in study-area ports has increased, from 5 percent of the state total in 1981 to several times that number in recent years.

Overall, commercial fisheries are conducted with fewer vessels than a generation ago. Since the most recent peak of commercial fisheries in 1981, the number of fishing vessels in California has declined steadily. The number of vessels making landings in study-area ports has similarly declined, from 2,200 in 1981 to 603 in 2004. Fewer than half of these vessels are responsible for 90 percent of landed catch. The fisheries are not just losing vessels. In general, fishermen report that there are fewer young people entering the fisheries.

3.4.3. Recreational and Aesthetic Uses

There are currently no recreation opportunities available to the public on land due to the presence of sensitive wildlife. However, the immediate surrounding waters provide an estimated 3,500 "wildlife viewing visitor days" annually (USFWS unpubl. data). Several wildlife-viewing boats conduct natural history tours throughout the year (weather permitting) out to the waters surrounding the islands. These tours focus on seabirds, marine mammals, and sharks. The wildlife-viewing opportunities associated with the Farallones extend to the nearby mainland coast as well, as some of the seabird species that breed on the Farallones forage near the mainland, to the advantage of land-bound bird enthusiasts.

For several major species – notably nearshore rockfishes, surfperches, greenlings, lingcod, flatfishes, salmonids, and sculpins – north-central California accounts for a majority of the statewide recreational catch. Generally speaking, recreational fisheries provide considerable value to coastal economies. Based on the average annual number of fishing trips of residents and nonresidents in 1998-99, aggregate annual expenditures related to marine recreational fishing, including costs for gear, licenses, and other supplies, amounted to $570 million (in 2003 dollars), $200 million of which derived from fishing activity in north-central California (Scholz and Steinback 2006).

In addition to guided tours and recreational fishing, there are other private pleasure boats that use the waters surrounding the South Farallones. However, due to the often-unsettled nature of the weather and seas, general recreational boating is much less common outside of the Golden Gate than it is within the protected waters of the San Francisco Bay.

3.5. Historical & Cultural Resources

The South Farallones have had extensive human activity beginning as a marine mammal hunting ground, an egg gathering site, a military outpost and more recently, a manned Coast Guard light station. These past activities have left behind many remnant elements that may possess some level of cultural significance. Thus, the entire Southeast Farallon Island was listed on the National Register of Historic Places in 1977. This designation did not specifically identify significant structures or other elements. Instead, structures and elements are evaluated for their historic significance when the structure is being considered for rehabilitation or renovation. Not every element on the islands has been evaluated. Specific structures that have been determined to be culturally significant include the two residences, a carpenter's shop, the lighthouse trail, and the rail cart system.

The oldest remaining structure on the South Farallones is thought to be the Russian House foundation, which was used for seal hunting. The area surrounding the Russian House foundation also has the highest concentration of historical-origin marine mammal bones on the island. In addition, the infamous Farallon Egg Wars were fought here (Wake and Graesch 1999). Another area with significant egging history is the stone enclosures and wall south of North Landing. These structures were used by eggers for cleansing and storage of eggs (Wake and Graesch 1999). Russian era shelters and eggers barracks also contain a high frequency of surface artifacts and mid-19th century bottle glass. Sewer Gulch served as a dump site in the later part of the 19th century. Many archaeological deposits are present in this area that help to provide insight into early human occupation on the island.

The two existing residences were built in 1860 to accommodate lighthouse crews, which were limited to men and then eventually families. The architect is unknown, but the houses are good examples of 19th century institutional architecture. These residences were extensively altered around 1959, but renovations in 1999 returned them closer to their original appearance. The two residences are considered culturally significant and are included in the National Register of

Historic Places. Moreover, the function of these houses as residences still continues for Refuge staff and researchers today. Rock features in front of one of the houses could potentially represent a prepared butchering area for preparation of marine mammals and other prey (Wake and Graesch 1999).

During habitation by the lighthouse crew, the rail cart system on Southeast Island was an important vehicle for transporting goods from ships to the main structures. The rail cart system is estimated to have been built in about 1878 to connect the North Landing with the residences and coal storage. The line was later extended to the East Landing. The system carried coal and other freight from the landing to the quarters by mule power and was never motorized. The last mule was used in 1913 and since then, carts have been powered by residents. This system is considered culturally significant because it represents a certain function during a historic period (1878-1939). Due to harsh environmental conditions and replacement by other means, the rail cart system has not been maintained.

The building now called the carpenter shop was constructed by the Navy in 1905 as barracks and occupied from 1905 until about 1945. The structure was evaluated in 2005 and is considered a significant cultural element because it is the only standing building that represents the Navy period.

While the water catchment area is not considered culturally significant, the area surrounding it may contain high potential sub-surface artifacts and features that should be carefully traversed to prevent potential damage (Valentine 2000).

The wooden water tanks and foghorn remnants have not been evaluated to determine their historical significance. However, the foghorn should be noted as the island's first attempt at providing a navigation warning.

A limited amount of aboriginal artifacts are present on the Southeast Island. Some artifacts are ascribed to Aleut or Northwest Coast origin, while others are associated with California Native Americans. Those items that were manufactured by Native Americans were thought to be associated with the Russian fur traders and their various Native American employees. Other cultural pieces include bones from elk, deer, and pig indicates that occupants relied on meat from the mainland.

3.6. WATER RESOURCES

Since 1998 a rainwater collection, filtration, and distribution system has supplied all of the field station's water needs. Water samples are tested three to four times a year by Alameda County Water District for coliform and nitrates. Results have been below levels of concern.

Marine water quality within the surrounding Gulf of the Farallones NMS is generally good (MMS 1996) due to the rural nature of the coastline with no major industrial discharges and exposure of the coastline to the strong currents of the open ocean. Factors affecting marine water quality in the region include municipal sewage outfall and riverine input. Selected contaminants (heavy metals, petroleum, and chlorinated hydrocarbons) generally produce only localized degradation.

The waters surrounding the South Farallones have also been designated a State Water Quality Protection Area (SWQPA). California regulations prohibit any waste discharge into SWQPA's. A septic system on Southeast Farallon treats all wastewater generated by the field station, and disperses it into a leach field located a sufficient distance away from the ocean to avoid pollution of the surrounding waters and to ensure compliance with California marine water quality regulations.

Between 1946 and 1970, nearly 50,000 drums of hazardous and radioactive wastes were dumped over a 350 square nautical mile area that overlaps the boundaries of the Gulf of the Farallones NMS. However, precise locations of these drums are unknown, with only 15 percent of the potentially contaminated area mapped. The extent of contamination to the waters surrounding the islands is unknown (USGS 2003).

3.7. WILDERNESS CHARACTER

West End Island, is designated Wilderness as regulated by the Wilderness Act (PL 88-577). Under the Wilderness Act, an area's wilderness character is defined by the following qualities:

1. Untrammeled by human impacts;
2. Undeveloped, without permanent structures or habitations;
3. Influenced primarily by natural forces; and
4. "Has outstanding opportunities for solitude or a primitive and unconfined type of recreation."

The overall goal of wilderness management under the Wilderness Act is to keep lands as wild and natural as possible, including restoring the wilderness character where it has been severely damaged by human use or influence. Because one of the major components of wilderness character is that it be untrammeled by human activities, one of the most important stipulations of the Wilderness Act is that all necessary wilderness management work should be conducted with the "minimum tool" required for the job. The "minimum tool" has the least discernible impact on the land and is the least manipulative or restrictive means of achieving a management objective. Under this principle, the use of vehicles, motorized tools, and other mechanized devices is generally discouraged, but in some instances the use of mechanized tools or equipment is necessary for the managing agency to effectively administer designated wilderness areas. The Wilderness Act and other related agency-specific guidance provide a general framework for determining the minimum tool necessary to complete a restoration action in a wilderness area. See Appendix ## for a detailed "Minimum Requirements Analysis" for non-native house mouse eradication on the South Farallones.

4. Environmental Consequences

4.1. Purpose and Structure of this Chapter

Chapter 4 analyzes the environmental consequences of the proposed action and one reasonable action alternative as presented in Chapter 2. For comparative purposes, Chapter 4 also includes a similar analysis of the consequences of taking no action to address the problem of non-native house mice on the South Farallones. The purpose of the analysis in this chapter is to determine whether or not any of the environmental consequences identified may be significant.

The concept of significance, according to CEQ regulations (40 CFR 1508.27), is composed of both the *context* in which an action will occur and the *intensity* of that action on the aspect of the environment being analyzed. "Context" is the setting within which an impact is analyzed, such as a particular locality, the affected region, or society as a whole. "Intensity" is a measure of the severity of an impact. Determining the intensity of an impact requires consideration of the appropriate context of that impact as well as a number of other considerations, including the following:

1. Impacts may be both **beneficial and adverse**. A significant effect may exist even if on balance the effect will be beneficial.
2. The degree to which an action affects **public health or safety**.
3. **Unique characteristics of the geographic area** (e.g. historical or cultural significance, specially protected lands, ecologically critical areas).
4. The degree to which the impacts of an action are likely to be **highly controversial**. The courts have since elaborated on this consideration, stating that controversy would be in the form "substantial dispute" as to "the size, nature or effect of the major Federal action rather than to the existence of opposition to a use [e.g. eradication of mice], the effect of which is relatively undisputed" (*Hanly v. Kleindienst,* 471 F.2d 823, 830 [2d Cir. 1972]).
5. The degree to which the possible impacts of an action are **highly uncertain,** or involve unique or unknown risks.
6. The degree to which an action may i) **establish a precedent** for future actions with significant effects; and/or ii) **represents a decision in principle** about a future consideration.
7. Whether an action is related to other actions with individually insignificant but **cumulatively significant** impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment.
8. The degree to which an action may adversely affect properties listed in or eligible for listing in the National Register of Historic Places, or may cause loss or destruction of significant **scientific, cultural, or historical resources**.
9. The degree to which an action may adversely affect an endangered or threatened species or critical habitat as listed under the **ESA**.
10. Whether the action threatens a **violation of Federal, State, or local law** or requirements imposed for the protection of the environment.

4.2. Environmental Issues (Impact Topics) Addressed

4.2.1. Scoping for Environmental Issues (Impact Topics)

The Service compiled a list of major environmental issues, or impact topics that warranted specific consideration in this analysis. The compilation of this list of issues was informed by a scoping process that included informal discussions with representatives from numerous government agencies, private groups and individuals with relevant expertise or a stake in the Farallon Islands, and solicitation of public comments (see Section 1.6.1 and Sections 5.3-4).

In the analysis below, the potential significance of impacts of each action alternative and the no action alternative will be discussed on a case-by-case basis for each environmental issue considered.

4.2.2. Impact Topics

The impact topics analyzed in this document include:

- Impacts to physical resources
    - Air quality
    - Water resources
    - Soil/geology
    - Vegetation (move here)
    - Wilderness resources
- Impacts to biological resources
    - Non-target impacts from toxin use
    - Disturbance to sensitive species
- Impacts to the social and economic environment
    - Effects on local population
    - Effects on local economy (which should include commercial fisheries)
    - Effects on public use (recreation)
    - Effects on cultural resources
    - Environmental justice

Brief descriptions of each of these topics can be found in Section 1.6.

4.3. Description of Analysis Framework (By Impact Topic)

4.3.1. Impacts on Biological Resources

4.3.1.1. Introduction

In order for the project to be considered a restoration success, the long-term benefits of mouse eradication must outweigh the long-term ecosystem costs. The eradication of mice is expected to have benefits for a number of animals and plants that are currently being negatively affected by mouse presence. However, it is also critical to identify the potential biological impacts of the actual eradication operations, including mortality and injury to sensitive wildlife species as a result of ingestion of rodenticide and/or disturbance from project operations. Furthermore, it is important to identify any biological resources that are currently dependent on the non-native mice in some way and may be negatively affected once mice are removed. This document's analysis of impacts to biological resources will identify both the likely and potential benefits (positive impacts) of mouse eradication and the likely and potential costs (negative impacts).

The impacts of each alternative on the biological resources of the South Farallon Islands will be examined in two different contexts: First, this document will analyze the risks as well as the benefits that mouse eradication would bring to individual animals that utilize the South Farallones. Second, and most essential from the perspective of environmental analysis according to NEPA regulations, this document will analyze whether impacts to a particular resource (species or taxonomic group) could be considered significant according to the general significance criteria described in Section 4.1. The concept of significance will be defined separately for each topic analyzed below. In some cases, after all relevant considerations are taken into account, impacts at the individual level (i.e. causing mortality or behavior changes to individual animals) must be considered significant. One example of this case is species that are listed under the ESA. However, in the case of many of the taxa analyzed here, impacts to individual organisms, however major, may not qualify as significant impacts in the context of population-level impacts to species utilizing the South Farallones. In other words, for species that have large populations, a wide range, and are capable of rapidly recovering from losses, impacts to individuals are usually unlikely to harm the population as a whole. The results of risk analyses for individual animals will contribute to the overall analysis of significance for each biological taxon considered, but should not be considered interchangeable with the significance determination for each impact topic considered.

While the impacts of each alternative can be analyzed with considerable confidence over the short term, it is more difficult to accurately predict specific long-term responses to mouse eradication. While the overall determination of the overall ecosystem response to mouse eradication on the South Farallones includes too many variables to analyze with precision in this document, data from other island mouse eradications can be used to predict long-term ecosystem responses. Whenever possible, these data will be used to help determine long-term effects in the analysis sections below.

4.3.1.2. Non-target impacts from toxin use

The risk of impacts from brodifacoum or any other rodenticide to individual animals is determined by two factors:

1. the toxicity of the compound to that individual; and
2. the likelihood of that individual's exposure to the compound (Erickson and Urban 2004).

4.3.1.2.1. Toxicity

The toxicity of a particular compound on an individual animal is often expressed in a value known as the "LD50" – the dosage (D) of a toxin that is lethal (L) to 50 percent of animals in a laboratory test. The EPA has compiled laboratory data on the LD50 quantity of brodifacoum for a number of species. However, due to the difficulty and expense of obtaining extensive laboratory data, the LD50 values for most species remain unknown. Therefore, for the purpose of estimating individual impacts, this document will use the following LD50 values to generalize potential toxicity for birds and mammals respectively (adapted from Erickson and Urban 2004):

- For birds, an LD50 value of 0.26 mg/kg will be used – this is the average LD50 value for the mallard (*Anas platyrhynchos*).
- For mammals, an LD50 value of 0.4 mg/kg will be used – this is the average LD50 value for the laboratory rat (*Rattus norvegicus*)

In comparison to real-world values that toxicologists have obtained from a wide class of species, the values used in this document are conservative; the output of this toxicity model would most likely under-estimate the amount of bait that an individual animal would need to consume to have a 50 percent chance of mortality. This model assumes that an animal's body mass is the primary determinant of how much brodifacoum is required for that animal to reach an LD50 threshold, within each taxonomic category (in this case, birds and mammals). In reality, there are other variables that affect LD50 as well, but using conservative LD50 values such as those above decreases the possibility that the model will under-estimate the risk to individual animals. Regardless, the EPA has determined that the toxicity of brodifacoum to all birds and mammals in general is high (Erickson and Urban 2004). Therefore, the value that is most informative for this analysis is an estimate of the amount of toxin an individual animal would need to ingest to reach the hypothetical LD50 threshold set above, based on body weight.

Erickson and Urban (2004) use another general model to determine the amount of bait needed to reach an LD50 threshold for birds at a mass of 25 g, 100 g, and 1000 g, compared to average daily food intakes for each of these size classes. See Table 4.1.

Table 4.1. Generalized proportion of daily food intake that must be bait for birds to reach an LD50 threshold (adapted from Erickson and Urban 2004, using a brodifacoum concentration of 25 ppm)

Bird size class:	**Amt of bait for LD50:**	**% of daily food intake:**
25 g	0.26 g	4.2
100 g	1.04 g	10.8
1000 g	10.4 g	19.2

Erickson and Urban use a similar model to determine the amount of bait needed to reach an LD50 threshold for mammals, using the same size classes as Table 4.1 above. However, pinnipeds are the only mammals other than mice (and project personnel) that are likely to be present in baited areas for much of the project, and the large size of each of these animals (orders of magnitude larger than 1000 g) makes it difficult to apply this particular model. Therefore, mammal toxicity will be analyzed primarily using the generalized mammal LD50 of 0.4 mg/kg, (as described above) with an extrapolation of the amount of bait needed to reach an LD50 threshold, but without an estimate of the proportion of daily food intake that this amount represents.

Predatory and scavenging animals can also be exposed to toxic levels of brodifacoum through the consumption of other animals that have previously been exposed (see Section 4.3.1.2.2). It is much more difficult to predict the amount of brodifacoum that would be present in these prey animals, and therefore it is very difficult to predict how much a particular predator or scavenger would need to consume to reach a toxic threshold. However, comparative levels of overall risk from brodifacoum in predators and scavengers on the South Farallones can still be estimated. See Table 4.2, at the end of Section 4.3.1.2.2 below, for more detail.

Besides lethal toxicity, there are other effects from ingestion of anticoagulants. Erickson and Urban (2004) report that individual birds and mammals that are exposed to anticoagulants and survive may nevertheless experience internal hemorrhaging, external bleeding, and other physical symptoms of anticoagulant toxicity. The dosage of toxin necessary to produce visible non-lethal effects is known as the lowest observable effects level (LOEL). For brodifacoum, few LOEL levels have been established.

4.3.1.2.2. Exposure

Exposure to brodifacoum is essentially dependent on two factors:

1. Any food habits, behavior patterns, and other specific characteristics that increase or decrease an animal's exposure to the rodenticide; and
2. The availability of rodenticide in the local environment.

In the form used for rodent control or eradication, brodifacoum can only effectively be delivered through oral ingestion: animals can either ingest brodifacoum by consuming bait pellets (known as "primary exposure"), or by preying or scavenging on other animals that have previously consumed bait pellets (known as "secondary exposure"). Brodifacoum molecules adhere strongly to the bait pellet grains, and are unlikely to be leached away in moisture or precipitation. Once the pellets disintegrate to particles too small for most foraging animals to consume, brodifacoum is essentially unavailable within the environment. Eventually even the sub-measurable quantities of brodifacoum remaining from a fully disintegrated pellet break down to non-toxic component compounds including carbon dioxide and water.

Primary exposure – Because the bait is composed primarily of grains, herbivorous and omnivorous species are more likely to consume bait (primary exposure) than carnivorous species, including insectivores.

Secondary exposure – Mice, and any other animals that directly consume bait, can also transfer some of the brodifacoum in their systems to their predators or scavengers (secondary exposure). Once consumed, brodifacoum is retained in the body of the consumer for an amount of time that varies considerably between taxa. For vertebrates that are exposed sub-lethally, brodifacoum can be retained in the liver for many months – in rats dosed sub-lethally, brodifacoum concentrations in the liver took 350 days to be reduced by 50 percent (Erickson and Urban 2004). Brodifacoum retention times for birds have not been determined. The exact mechanisms of brodifacoum retention in invertebrates are unclear, but the general understanding is that most invertebrates do not retain brodifacoum in body tissues (Booth et al. 2001).

The most substantial difference between the two action alternatives considered in this EA lies in the extent, duration, and major exposure pathways of brodifacoum availability for organisms on the South Farallones. A detailed characterization of brodifacoum exposure risk for both the proposed action (Alternative B) and the alternative (Alternative C) follows.

Exposure under Alternative B (proposed action) – Under Alternative B (the proposed action), in which bait would primarily be broadcast directly into the environment over a period of approximately 20 days, the toxicant would be directly available to any animal that would be apt to ingest the pellets (granivores, omnivores, or the highly curious). Bait would be applied according to EPA-approved label instructions, which set specific application rate values, ranges, and/or limits for the bait product used. For the purpose of risk modeling in this document, application rates will be used based on the maximum application rate allowed on the EPA label instructions for brodifacoum pellets for conservation purposes: 16 lb/acre (18 kg/ha). Given an estimated individual pellet weight of .08 oz (2.40 g), these application rates equate to a target application rate of 0.66 pellets/yd^2 (or one pellet every 1.51 yd^2) (0.75 pellets/m^2; one pellet every 1.33 m^2).

Assuming that two consecutive bait applications are necessary, as described in Section 2.3.2.5, the concentration of pellets in the terrestrial environment (including the coastline) would be about one pellet every 1.51 yd^2 immediately after bait application, and would decline steadily for a period of seven to 10 days through consumption by mice, other species, and through pellet degradation. Concentrations would spike again with a second bait application, but at a lower concentration than the initial application, and then decline steadily again until only trace numbers of bait pellets remain 30 days after bait application is completed. Bait concentrations would decrease on the coastline at a faster rate than in the island interior, due to tidal shifts and sea spray. The precise bait application rate would be calculated, based on experimental bait uptake results, to provide only enough bait to last four days with minimal bait remaining. As long as some bait is available in the environment, wildlife would be at some risk of exposure. The majority of the brodifacoum would be made unavailable due to pellet disintegration within 30 days of the final bait application (up to 50 days from the start of bait application), although a very small amount of the toxicant could remain in pellets and fragments on the ground for up to a few months.

Under Alternative B (the proposed action), brodifacoum would also be available to animals that prey on bait consumers, particularly on mice (“secondary exposure”). Poisoned mice would be available to predators starting the day that bait application begins and possibly continuing for up to three weeks after the final bait application is complete, although there would probably be too few mice to detect within two weeks after the first bait application is complete. Any mouse carcasses or other poisoned animals that are exposed to scavengers would be largely decomposed and thus unavailable as food items within 30 days of the final bait application (up to 50 days from the start of bait application). After this period, a very small number of birds and invertebrates on the island may continue to register measurable levels of brodifacoum for as long as bait pellets are available in the environment, up to a few months after bait application.

Bait would not be broadcast directly into the marine environment, but a limited number of pellets are likely to drift into the intertidal or nearshore zones. During a rat eradication on Anacapa Island in southern California, project personnel monitoring bait drift into the intertidal environment reported 72 bait pellets in the water over a 598 yd^2 (500 m^2) area, which equates to 0.12 pellets/yd^2 (0.14 pellets/m^2) (Howald et al. 2005). Bait pellets that enter the water would be available for consumption for a short period of time after entry. In bait disintegration experiments and observations in New Zealand (Empson and Miskelly 1999) and California (Howald et al. 2005), observers found that pellets similar to those planned for use on the South Farallones sank almost immediately and disintegrated completely in as little as fifteen minutes. Brodifacoum's water solubility is very low (Primus et al. 2005; US EPA 1998), making the risk of brodifacoum contaminating the water column also very low. Hypothetically, even if brodifacoum was highly water soluble, and bait was broadcast at the rate of 16 lb/ac (18 kg/ha) into water only 3.3 ft (1 m) deep, the resultant brodifacoum concentration in the water – about 0.04 parts per billion – would still be nearly 1000 times less than the measured LC50 value for trout (0.04 parts per million) (Syngenta 2003). Similar in concept to an LD50 value, this LC50 value represents the concentration of brodifacoum dissolved in water that will be lethal to 50 percent of the trout within 96 continuous hours of exposure in a laboratory test.

Environmental testing during rodent eradications and eradication trials in the California Current marine system and elsewhere have failed to detect brodifacoum in any water samples taken after bait application (Howald et al. 2005; Buckelew et al. 2008; Island Conservation, unpubl. data). Furthermore, post-application sampling in the Anacapa Island rat eradication did not detect any brodifacoum residue in any of the intertidal invertebrates tested (Howald et al. 2005). Even in a "worst-case scenario," brodifacoum availability in the intertidal and marine environments has proven extremely low. An estimated equivalent of 0.79 lb (360 g) of pure brodifacoum (from 17.7 tons of total bait) was accidentally spilled in the tidal environment in New Zealand (Primus et al. 2005). The brodifacoum was measurable in the water at the spill location for only 36 hours and was undetectable afterwards (measuring less than .020 parts per billion). Additionally, brodifacoum was undetectable in sediment samples taken from the ocean floor nine days after the spill. In terms of intertidal invertebrates, brodifacoum concentrations peaked in mussels one day after the spill but averaged just above detectible after Day 29 and lasted in limpets for up to 80 days. Based on these results from other sites, brodifacoum availability in the intertidal and marine environments of the South Farallones after bait application would almost certainly be extremely low. Nevertheless, limited bait uptake by filter feeders may occur over the very short term, and therefore the potential consequences of this exposure pathway will be analyzed.

Exposure under Alternative C – Under Alternative C, bait would be available to mice in enclosed bait stations over most of the islands. In steep areas that bait stations could not be effectively installed or maintained, bait would be aerially broadcast or broadcast by hand. As compared with Alternative B (the proposed action), under Alternative C there would be less bait available for direct consumption by species larger than mice, although bait stations would not completely prevent bait from being transported into the open by mice or other animals.

Because mice and other animals often carry food away before eating it, some bait and bait fragments would likely be available on the ground after being transported by mice or other animals. The amount of bait on the ground in areas treated with bait stations would always be much lower than areas treated with bait broadcast, but bait would be available for much longer than in Alternative B. Bait stations would need to be kept armed for up to two years, during which time bait would be available to any animals that could enter or vandalize the bait stations, and small amounts of bait could be transported outside of stations and left in the open.

The precise locations and extent of bait station coverage under Alternative C have not been determined, but over 25 percent of the island surface area is inaccessible by foot and this area would need to be treated with a bait broadcast. In areas that are treated by broadcast, bait would be available according to the same characteristics as in Alternative B, described immediately above. Much of the area that would need to be treated by broadcast is along the shoreline, so the likelihood of bait entering the intertidal environment in Alternative C is similar to Alternative B. Within terrestrial areas that are treated by bait broadcast, bait would be available for a similar duration of time as in Alternative B, with the majority of the brodifacoum unavailable within 30 days of the final broadcast application (up to 50 days after the start of broadcast application).

As with Alternative B, brodifacoum would also be available to animals that prey on bait consumers under Alternative C. While less bait would be available in the environment for primary consumption under Alternative C, brodifacoum would be available in small quantities for a considerably longer duration of time than in Alternative B because bait stations would stay armed for up to two years.

Table 4.2. Likelihood of exposure to brodifacoum based on food habits and other characteristics

Food habits/habitat	**Exposure risk: Alternative B (proposed action)**			**Exposure risk: Alternative C**			**Taxon examples (*not* exhaustive)**
	Primary	*Secondary*	*Risk window*	*Primary*	*Secondary*	*Risk window*	
Terrestrial foragers							
Granivorous primarily	High	Negligible	A few months	Low	Negligible	Up to two years	Geese; finches; pigeons
Carnivorous primarily							
Eats mice	Negligible	High	A few months	Negligible	High	Up to two years	Owls; hawks
Eats birds primarily	Negligible	Low	A few months	Negligible	Low	Up to two years	Peregrine falcon; merlin
Eats invertebrates primarily	Negligible	High	A few months	Negligible	High	Up to two years	Sandpipers; warblers; wrens; salamanders
Omnivorous	High	High	A few months	Low (except mice)	High	Up to two years	Gulls; turnstones; sparrows; mice
Intertidal foragers							
Herbivorous primarily	Low	Negligible	50 days	Low	Negligible	50 days	Geese
Carnivorous primarily	Negligible	Low	50 days	Negligible	Low	50 days	Most shorebirds
Omnivorous	Low	Low	50 days	Low	Low	50 days	Gulls; turnstones; mice
Marine foragers							
Herbivorous primarily	Low	Negligible	20 days	Low	Negligible	20 days	Some geese
Carnivorous primarily	Negligible	Negligible	N/A	Negligible	Negligible	N/A	Grebes; most seabirds; osprey
Omnivorous	Low	Negligible	20 days	Low	Negligible	20 days	Gulls
Intertidal organisms*	Low	Negligible	50 days	Low	Negligible	50 days	Mussels; crabs; intertidal fish
Pinnipeds	Negligible	Negligible	N/A	Negligible	Negligible	N/A	Seals; sea lions
Benthic and pelagic fish**	Low	Negligible	20 days	Low	Negligible	20 days	Anchovies; rockfish

* Invertebrate exposure data is only relevant for extrapolations of secondary exposure likelihood for predators on intertidal invertebrates
** Fish are not considered in detail. See Section 4.3.6.1 for rationale.

4.3.1.2.3. Assessing overall risk from brodifacoum use

The risk of brodifacoum poisoning is a function of both exposure and toxicity. In other words, the theoretical toxicity of a compound is only relevant if the species of concern has an actual risk of exposure. The toxicity of brodifacoum to each species analyzed here, as well as that species' likelihood of exposure (Table 4.2), will be considered together. For example: A 0.65 oz (18.5 g) house mouse (the average size of adult house mice on the South Farallones, Jones and Golightly 2006) would only need to consume approximately 0.01 oz (0.3 g) of bait to have a 50 percent risk of mortality. Because house mice have a high likelihood of primary exposure to the rodenticide (as opportunistic omnivores in concert with the design of the bait to be a mouse attractant), and would therefore be highly likely to consume at least 0.01 oz of bait, mice are highly likely to be at risk of brodifacoum poisoning.

Because there are so few data on sublethal effects of brodifacoum in wildlife, it is not possible to precisely predict their likelihood or their characteristics. Furthermore, it is even more difficult to predict whether or not sublethal effects, if they do occur, would lead to measurable decreases in the fitness of individual animals. This analysis will assume that the likelihood of adverse sublethal effects increases in proportion to the likelihood of lethal exposure to the toxin. In other words, animals that are considered likely to be exposed to lethal quantities of brodifacoum (e.g. ingesting bait pellets or animals that have ingested bait pellets) will likewise be considered likely to experience some adverse sublethal effects. Animals that are considered likely to be exposed to at least some brodifacoum, but probably not a lethal quantity, would be noted as special cases, and the unquantifiable likelihood of sublethal effects would be taken into account in determining the intensity of brodifacoum impacts on that particular species.

Usually, the likelihood of discovering all of the individual nontarget deaths attributable to island rodent eradications is very small. In most instances, the Service does not expect to discover a precise number of dead or sublethally affected species attributable to brodifacoum. Because of the highly mobile nature of all of the bird species on the South Farallones, for example, it is highly unlikely that the Service would be able to record all of the individual deaths. Therefore, it is difficult to establish an anticipated level of take. In those situations where the discovery of a carcass of a particular species is likely, we have established a specific level of take which might occur as a result of the action (i.e. number of individuals). In those situations where the Service believes take may occur but is not able to assign a specific number to that take, an "unquantifiable" level of take has been assigned. This indicates that the Service believes that take is unavoidable but unquantifiable.

4.3.1.3. Disturbance to sensitive species

4.3.1.3.1. Disturbance under Alternative B (Proposed Action, primarily aerial broadcast)

Helicopter operations – The operation of low-flying aircraft throughout the South Farallones would be likely to result in disturbance to wildlife from sound, the sudden appearance of an aircraft, or a combination of both (Efroymson et al. 2001). Wildlife would be exposed to noises that exceed background levels. The relatively low altitude at which helicopters would fly would result in a narrow focus of the narrow “cone” of peak noise underneath the helicopter (Richardson et al. 1995), minimizing disturbance of marine mammals or birds in nearshore marine waters or on offshore rocks.

During one application pulse, all points on South Farallon Island would likely be subject to two helicopter passes. Within one bait application pulse, there should be no more than three consecutive operating days. Over the course of bait application operations, which may entail multiple pulses, there could be up to 20 days of occasional and unpredictable flyovers. The responses of animals to aircraft disturbance, and the adverse effects of this disturbance, vary considerably between species and between different seasons.

Personnel activities – Additional wildlife disturbance could result from personnel traveling by foot across the island (e.g., when hand broadcasting bait, surveying for non-target mortality, and collecting mouse carcasses), or traveling in small boats in the nearshore waters. Personnel dedicated to mouse eradication would be based on the South Farallones for around one month under Alternative B. Following eradication, there will be monitoring visits to the island for at least two years. There are personnel on the South Farallones conducting ongoing research, monitoring, and other management activities year-round, but mouse eradication would increase the number of personnel on the island and the extent of impact: most current monitoring activities take place in discrete and often small areas of the island, whereas mouse eradication operations would require personnel to travel throughout the South Farallones. Personnel would be briefed on strategies and techniques to reduce wildlife disturbance whenever possible, but some level of disturbance would still be likely to occur.

Disturbance from personnel movements and activities is anticipated to be much lower than that caused by helicopter operations.

4.3.1.3.2. Disturbance under Alternative C (bait station grid, limited hand and aerial broadcast)

Bait station installation and maintenance, and general personnel presence – Bait stations would need to be placed on a grid that covers the entire island, except for inaccessibly steep cliffs, spaced 10.93 to 21.87 yd (10-20 m) apart. Paths and vegetation clearings, boardwalks, and in some cases anchor points, ladders, or fixed lines could be installed to make each station accessible over the course of two years of visits. Each bait station would be secured to the ground with anchors placed into the soil or drilled into the rock as appropriate. The anchors would be durable enough to hold the stations in place for up to two years, but they would be removable and not a permanent fixture on the islands. Personnel would then visit stations, primarily to refill them with fresh bait but also to conduct maintenance on the stations or other infrastructure, first at least bi-weekly and then more sporadically over the course of up to two years. Personnel would be briefed on strategies and techniques to reduce wildlife disturbance whenever possible, but personnel presence and activities during bait station installation and maintenance would nevertheless likely contribute to some level of occasional wildlife disturbance.

Helicopter operations – Helicopter operations in Alternative C would be limited to land areas that cannot be reached with the bait station grid. However, this may include 25 percent or more of the total land area. Disturbance within these areas would be similar to that described above in Section 4.3.1.3.1, but the total extent and duration of helicopter disturbance would be less than in Alternative B.

4.3.1.4. Assessing cumulative impacts to biological resources

Impacts to biological resources that occur as a result of mouse eradication on the South Farallones, even if they are individually minor, could nevertheless contribute to cumulatively significant effects when combined with other unrelated impacts that are occurring simultaneously to those resources, impacts that have occurred in the past, or impacts that are likely to occur in the foreseeable future. The continued presence of mice is likely impacting many of the species on the island, but there are no other clear localized impacts known to be occurring today. Furthermore, there are no foreseeable future actions that are likely to occur that will affect the island's biological resources, because the land is being managed in perpetuity as a National Wildlife Refuge. However, in the past, the Farallones were home to introduced rabbits, which likely reduced available nesting habitat for the island's bird populations. There were also likely hunters that visited the island and culled seabird eggs. Also, many of the species that utilize the South Farallones have large ranges and may be currently experiencing unrelated impacts, perhaps severe, elsewhere in their ranges. Furthermore, many of these far-ranging species have experienced impacts in the recent past that are still affecting their populations today. These and other unrelated impacts will be considered for each biological resource analyzed.

4.3.1.5. Limited analysis of invertebrates

Arthropods are not thought to be susceptible to brodifacoum toxicity (Booth et al. 2001). Molluscs may be affected, but the evidence for this is still scarce (Booth et al. 2001). During a catastrophic accidental spill of nearly 20 tons of brodifacoum into nearshore waters in New Zealand (Primus et al. 2005), a peak concentration of the toxicant measured in mussels occurring at the spill site was 0.41 parts per million one day after the spill; this equates to approximately 1/60th of the brodifacoum found in one bait pellet. Within 30 days, the concentration had dropped to just above 0.002 parts per million or 200 times less than the peak. Brodifacoum was measurable in the water at the spill location for only 36 hours and was undetectable afterwards (measuring less than .020 parts per billion). Additionally, brodifacoum was undetectable in sediment samples taken from the ocean floor nine days after the spill. Post-application sampling during a 2006 bait trial study in the Aleutian Island, Alaska, did not detect brodifacoum in the water (Buckelew et al. 2007; Island Conservation, unpubl. data), and post application sampling in the Anacapa Island rat eradication did not detect any brodifacoum residue in intertidal mussels or shore crabs (Howald et al. 2005). The similar sampling results of the Bay of Islands trial and the Anacapa eradication, in concert with the results of the accidental spill event in New Zealand, demonstrate the low solubility of brodifacoum in water and its lack of accumulation or persistence in filter feeders such as mussels. None of the invertebrates are anticipated to be measurably affected by helicopter operations or personnel activities. However, because invertebrates are known to consume bait pellets, they will be considered in this document in reference to their function as intermediate carriers of brodifacoum.

4.3.1.6. Limited analysis of plants

Plants are not known to be susceptible to toxic effects from brodifacoum, nor are they anticipated to be significantly affected by helicopter operations. However, the impact of bait station installation and the presence of personnel on the island on the South Farallones plant communities will be analyzed.

4.3.1.7. Assessing significance of impacts to biological resources

The purpose of the proposed project is to restore the biological diversity and environmental health of the South Farallones through mouse eradication. While the precise effects of mouse eradication on individual species is unknown, data from around the world indicate that mouse eradication has the potential to contribute to beneficial effects in a wide variety of birds, among other species (Wanless et al. 2007). At the same time, the use of brodifacoum, the operation of helicopters, and the movement of personnel throughout the island all have the potential to cause short-term negative impacts to individual animals. Therefore, the relationship between potential short-term risks to individual animals and the long-term benefits to animal species must be examined, and for the proposed project to be considered a successful conservation effort, the long-term benefits to the island ecosystem must outweigh the potential risks to individual animals.

As described in Section 4.1, the concept of significance is shaped by both the context of an action and the intensity of the effects. In the case of the action alternatives analyzed here, the action itself has a very limited, site-specific context. However, many of the species that utilize the South Farallones have large ranges or interact, at a population level, with other individuals that may be spread out over an area much larger than the South Farallones. Therefore, the most generally appropriate context within which to consider impacts to biological resources is at the level of populations rather than individual organisms. The intensity of effects is dependent on numerous variables that are different for each taxon. This analysis will focus on additional legal protection (ESA listing and MMPA listing) as the primary defining criterion for determining the intensity of an impact to a species; in other words, impacts to species that have been assigned specific legal protection under ESA or MMPA will be considered for the purpose of this analysis “more intense” than similar impacts would be to unlisted species.

For all biological resources analyzed below, except those identified in the “special considerations” below, the potential for significance will be determined using the following guidelines:

- Is there a high likelihood that the population of a species will experience noticeable changes that will not be counteracted by in-migration?
- Is there a high likelihood that impacts on animals at the South Farallones will be measurable elsewhere in the region?
- Is the species being analyzed protected by special legislation such as ESA or MMPA?

4.3.1.8. Special significance considerations for ESA-listed species

There are two species that are likely to occur on the South Farallones that are on the U.S. government's Endangered Species list, the eastern DPS of the Steller sea lion (Threatened), and the California brown pelican (Endangered). Listing under ESA provides a context for impacts analysis which lowers the threshold of significance. The ESA regulations require any Federal agency that believes an action it is planning may affect a species listed under ESA to initiate a formal process of consultation with either FWS's Ecological Services division (for pelicans) or NMFS (for Steller sea lions) to determine whether or not the action will put the potentially affected species in jeopardy of continued survival. Additionally, if individual animals that are listed under ESA may be affected by the agency's action, the Service must apply for an Incidental Take Permit. This analysis will identify any ESA-listed species and any ESA-designated critical habitat that may be affected by the proposed action. The significance of these impacts will be determined separately, but the ESA-listed status of the species affected will be given special weight.

For Steller sea lions, the significance threshold for effects will be set at an action that causes the significant potential for mortality in an individual animal.

For California brown pelicans, the significance threshold for effects will be set at an action that is likely to cause the mortality of one or more pelicans.

4.3.1.9. Special significance considerations for marine mammals

Listing under MMPA provides a context for impacts analysis which lowers the threshold of significance. The MMPA regulations generally prohibit the killing, injury or disturbance of marine mammals, but permits can be granted allowing exceptions to this prohibition for actions that may impact a marine mammal if the impact is incidental to rather than the intention of the action. This analysis will identify the potential for impacts to marine mammals that may require additional permits under MMPA.

The significance of these impacts will be determined separately, but the MMPA-listed status of the species affected will be given special weight. For marine mammals, the significance threshold threshold for effects will be set at an action that causes the significant potential for mortality in an individual animal. MMPA regulations prohibit "disturbance" of marine mammals, which is a lower threshold of impact than mortality. Disturbance according to the MMPA definition will not alone constitute a significant impact in this analysis, but other potential circumstances (including cumulative impacts analysis) may nevertheless contribute to an overall determination of significant impacts.

4.3.2. Impacts on Human Activities and Values

The CEQ guidelines at 40 CFR 1508.14 include the human relationship with the natural environment as a category of potential impacts that should be considered in a NEPA analysis. This is interpreted to mean that a NEPA analysis needs to examine potential effects on any economic and/or social values.

4.3.2.1. Effects on Refuge visitors and recreation

Although public access to the South Farallones is prohibited, the waters surrounding the islands are popular with tour boats and private boaters for wildlife viewing as well as recreational fishing. Furthermore, the islands themselves are a high-quality scenic panorama. This analysis will examine the likely changes to visitor experience as a result of both of the action alternatives. The Service would consider any major, long-term changes to the visitor experience to be potentially significant.

4.3.2.2. Effects on fishing resources

The Service would consider any noticeable, long-term changes to fishing resources surrounding the South Farallones that could be attributable to the mouse eradication to be potentially significant.

4.3.3. Impacts on Historical and Cultural Resources

The categories of historical and cultural resources are broad and impacts to these resources are usually difficult to quantify, especially in the context of NEPA's requirement to identify "significant" impacts. The National Historic Preservation Act (NHPA) defines the concept of an "adverse impact" to historical resources, but the regulations make clear that "a finding of adverse effect on a historic property does not necessarily require an EIS under NEPA" (36 CFR 800.8(a)(1)). Regardless, Section 106 of the NHPA requires agencies to consult with the appointed regional Historic Preservation Officer(s) if adverse impacts to historical or cultural resources are possible. This analysis will describe the potential impacts to historical and cultural resources on the South Farallones as a reference for consultation with the appropriate Historic Preservation Officers.

4.3.4. Impacts on Water Resources

Water quality in the State of California is regulated by the State Water Recources Control Board, which requires all state waters to meet minimum criteria for a number of designated uses. The only reasonably foreseeable potential impact to water quality on or around the South Farallones would involve the incidental introduction of rodenticide into the marine water column. While the federal Clean Water Act (CWA) prohibits the discharge of "pollutants" into waters of the United States, the EPA recently clarified its interpretation of the term "pollutant" to exclude pesticides that may unavoidably enter the water while being applied to control pests that occur "over, including near" water bodies (71 CFR 227 pp. 68483-68492). As mice on the South Farallones frequently utilize habitat at the shoreline, the application of a rodenticide to eliminate mice according to the techniques described in the action alternatives and as permitted by rodenticide label requirements under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) may include areas immediately adjacent to water bodies without additional compliance requirements under CWA. The potential for significant environmental impacts of the action alternatives on water quality, irrespective of other water quality regulations, will be analyzed as an examination of the potential for biologically adverse quantities of brodifacoum to be introduced into the marine water column surrounding the South Farallones including persistent tidepools.

4.3.5. Impacts to Wilderness Character

Areas of the South Farallones are designated Wilderness as regulated by the Wilderness Act (PL 88-577). In some instances the use of mechanized tools or equipment is necessary for the managing agency to effectively administer designated wilderness areas. Section 4(c) of the Wilderness Act provides for an administrative exception for some specific uses. When the use of tools otherwise prohibited by the Wilderness Act is necessary for an agency to administer a wilderness area, a Minimum Requirements Analysis (MRA) is completed. The MRA process determines whether or not the proposed activity is necessary within the wilderness area and if so, which least intrusive action or "minimum tool" is needed to achieve the objective. The MRA is documented through the Minimum Requirements Decision Guide, which demonstrates how the agency arrived at the decision to conduct a specific administrative action.

Preservation of wilderness character is not a category of analysis required under NEPA regulations, but the special designation of segments of the South Farallones as Wilderness will be considered through an analysis of the impacts of each action alternative. Under the Wilderness Act, an area's wilderness character is defined by the following qualities:

1. Untrammeled by human impacts;
2. Undeveloped, without permanent structures or habitations;
3. Influenced primarily by natural forces; and
4. "Has outstanding opportunities for solitude or a primitive and unconfined type of recreation."

The impacts of each alternative that relate to Wilderness Act will be discussed according to their benefit or harm to each of the above four qualities that characterize wilderness.

4.3.6. Aspects of the Environment Excluded from Detailed Analysis (with Rationale)

4.3.6.1. Marine fish

Potential impacts of mouse eradication activities to fish in the waters surrounding the South Farallones will not be analyzed in this EA, because the likelihood of the either of the action alternatives having measurable impacts on fish populations is negligible:

- The number of bait pellets that would enter the marine environment as a result of aerial bait broadcast, across the full island (as in Alternative B) or in limited areas (as in Alternative C), would be low as a result of the mitigation measures described in the Alternatives chapter (Chapter 2) for avoiding bait application into the ocean;
- The bait pellets would disintegrate rapidly upon contact with the water;
- In tests conducted by researchers in southern California, as well as in Alaska, Hawai'i, and the equatorial Pacific, marine fish species have demonstrated almost no interest in

placebo bait pellets that entered the water nearby (Buckelew et al. 2007; Howald et al. 2005; USFWS 2005; A. Wegmann, pers. obs.).

4.3.6.2. Exclusively marine mammals (e.g. cetaceans)

Potential impacts of mouse eradication activities to cetaceans (whales, dolphins, and their close relatives) in the waters surrounding the South Farallones will not be analyzed in this EA. Except for small boat traffic, which would be limited in duration and concentrated immediately offshore of the island, all of the activities described in the action alternatives would be terrestrial, and the likelihood of the these activities having measurable impacts on cetaceans is negligible.

4.4. CONSEQUENCES: BIOLOGICAL RESOURCES

4.4.1. Consequences of Alternative A: No Action

4.4.1.1. Introduction

If no action is taken regarding non-native house mice on the South Farallones, the impacts that mice are having on the islands' biological resources would continue. This section will summarize the impacts that are known and suspected on numerous aspects of the South Farallones environment. Additionally, this section will describe the possibility of new environmental impacts from mice emerging in the future, as has occurred on other islands where house mice were introduced. This section has a different structure than other sections within Chapter 4, because mouse impacts are concentrated in a more limited spectrum of the South Farallones environment than the analysis above. In other words, mice are not known to have impacts on aspects of the environment such as marine mammals, and therefore not all analysis topics are included in this section.

4.4.1.2. Mouse impacts on seabirds

Non-native house mice are negatively impacting the populations of burrow- and crevice-nesting seabirds on the South Farallones, particularly the ashy storm-petrel. Researchers have observed introduced house mice preying on seabird eggs and chicks on other islands (see Wanless et al. 2007; Cuthbert and Hilton 2004), and there are occasional records of mouse predation on ashy storm-petrels on the South Farallones (Ainley et al. 1990). Mice likely also cause disturbance to storm-petrels as well as all the other crevice- and burrow-nesting seabirds breeding on the islands by repeatedly entering their burrows, leading to decreased breeding success.

Another negative impact of house mice on the South Farallones' rare seabirds about which the Service is particularly concerned is that mice are indirectly responsible for a substantial portion of an ongoing decline in the breeding population of the ashy storm-petrel due to predation by burrowing owls (Sydeman et al. 1998). Burrowing owls are not considered island residents, but each year burrowing owls dispersing from their resident habitat in California's interior lowlands overshoot the coast, and land on the South Farallones to rest while returning to the mainland (DeSante and Ainley 1980). This kind of "accidental" arrival of migrating or dispersing landbirds onto the Farallones is actually quite common; over 400 different landbird species have been recorded on the islands since 1968 (Richardson et al. 2003). Very nearly all landbirds that arrive on the Farallones return to the mainland within a few days (DeSante and Ainley 1980). However, the South Farallones' mouse population, which is at an annual peak during the fall, makes the Farallones appear to be suitable hunting grounds for some of the burrowing owls that arrive in the fall. The owls that choose to overwinter on the islands can survive on mice for the fall season and into the early winter, but by mid-winter the mouse population has plummeted – the cyclical counterpart to its fall peak. As a result, the overwintering burrowing owls are forced to find an alternative food source, and they subsequently begin to prey on adult ashy storm-petrels that arrive on the islands in mid-winter to breed. This predation accounts for substantial annual mortality in breeding ashy storm-petrels, estimated from counts of bird remains near owl roosts at roughly 67 ashy storm-petrels each year (PRBO unpubl. data). There are other predatory landbirds that are recorded to have visited the South Farallones, including a number of other owl species, but none have consistently overwintered on the islands or had as noticeable an impact on the local biota as the burrowing owl.

Most seabirds, and ashy storm-petrels in particular,

- are long-lived – ashy storm-petrels are known to live at least 35 years;
- mature slowly – ashy storm-petrels do not begin breeding until they are 5 years old; and
- have a low rate of reproduction – ashy storm-petrel pairs almost always produce only one egg per year (Ainley 1995).

These characteristics make each breeding adult storm-petrel especially valuable to the reproductive success of the species. Unfortunately, researchers on the Farallones found that during a recent 20-year period, the population of breeding adult storm-petrels on the South Farallones decreased 42 percent (Sydeman et al. 1998). Sydeman et al. identify owl predation, along with the more difficult-to-measure risk of predation in the burrow by mice, and the unavoidable threat of Western gull predation and territorial aggressiveness, as the major causes of this precipitous decline in the South Farallones ashy storm-petrel colony.

4.4.1.3. Mouse impacts on burrowing owls

Unfortunately, the same burrowing owls that prey on ashy storm-petrels on the Farallones ultimately fare no better than the storm-petrels. The burrowing owls that have been documented overwintering on the South Farallones and preying on ashy storm-petrels have largely been juveniles. Although burrowing owls of all ages arrive on the islands accidentally during their fall migration, most leave shortly after and usually only a small number of burrowing owls ultimately remain into the winter. Island biologists tracking these owls find most of them dead by the spring. While some of these owls are killed by Western gulls, which become extremely territorial during their spring breeding season, others are found dead of probable malnutrition (PRBO pers. comm.). The presence of mice on the Farallones thus makes the islands a population sink for burrowing owls. The California Department of Fish & Game has designated the burrowing owl as a Species of Special Concern. On its own, burrowing owl mortality on the Farallones is unlikely to have population-level effects on burrowing owls, but it may contribute to cumulative negative impacts on the species along with other threats on the mainland.

4.4.1.4. Mouse impacts on Farallon arboreal salamanders

The endemic Farallon arboreal salamander has a diet similar to house mice on the South Farallones, so when the mice are abundant each summer and fall on the island they likely limit the amount of food available to salamanders. Furthermore, the food preferences of introduced mice on other islands (Newman 1994) indicate that mice on South Farallones could prey directly on salamanders.

4.4.1.5. Mouse impacts on terrestrial invertebrates

Invertebrates comprise a major portion of the diet of mice on the South Farallones (Jones and Golightly 2006). Comparisons to other islands with introduced house mouse populations (Cole et al. 2000; Crafford 1990; Rowe-Rowe et al. 1989) suggest that mice probably have a substantial impact on the South Farallones invertebrate community, especially during the annual mouse population boom of the late summer and fall. In New Zealand, researchers have estimated that one house mouse would need to consume 4.4 g (0.16 oz) of invertebrate prey each day, if no other foods were available, to meet its daily energy requirements (Miller 1999 as cited in Ruscoe 2001). Invertebrates perform numerous important ecosystem functions on the South Farallones including pollination and decomposition, and they are a food resource for the Farallon arboreal salamander. Consequently, mouse impacts on invertebrates have the potential to reverberate throughout the South Farallones ecosystem.

4.4.1.6. Mouse impacts on native plants and competition from weeds

Most of the non-native plants that have been introduced to the South Farallones originally evolved under grazing pressure from small mammals such as rodents on the mainland, so mice are less likely to negatively impact them in their adopted island habitat. The endemic plants of the Farallones, on the other hand, have evolved with no pressure from rodents and mice are thus a potential threat to native plants. Seeds of the endemic maritime goldfields, in particular, are a common food item for mice on the South Farallones (Jones and Golightly 2006).

The Service currently recognizes non-native plants as a major threat to the South Farallones ecosystem. The presence of mice increases the likelihood that introduced plants that have an adaptation to dispersal by rodents will successfully establish and spread on the islands.

4.4.1.7. Irreversible and irretrievable commitment of resources of the no action alternative

Pressure from non-native house mice could contribute to declines in the native biological resources of the South Farallones to below the level of population viability. For ashy storm-petrels in particular, their apparent ongoing population decline indicates a risk for an irreversible decline in the future. However, at this time there is no strong evidence to support this possibility.

4.4.2. Consequences Common to Both Action Alternatives

4.4.2.1. Brodifacoum toxicity

The risk of impacts from brodifacoum to individual animals is determined by two factors:

1. the toxicity of the compound to that individual; and
2. the likelihood of that individual's exposure to the compound (Erickson and Urban 2004).

From the perspective of risks from the rodenticide, the two action alternatives differ primarily in individual animals' likelihood of exposure. Since the same rodenticide would be used in either action alternative, the toxicity values would be similar for each taxon in either alternative. Analyses of the toxicity of brodifacoum to the biological resources of the South Farallones follow.

4.4.2.1.1. Brodifacoum toxicity to Steller sea lions

No brodifacoum LD50 value for marine mammals have been established. Using the conservative LD50 figure of 0.4 mg/kg, a small juvenile Steller sea lion weighing 45 kg (100 lbs) would need to ingest the equivalent of approximately 720 g (1.6 lb) of bait to be at a 50 percent risk of mortality. A large male adult, weighing 1, 088 kg (2,400 lbs), would need to ingest more than 17,400 g (17.4 kg; 38.4 lb) of bait. However, these figures are presented for comparative purposes only, because Steller sea lions are carnivorous (almost exclusively piscivorous) and brodifacoum ingestion would need to occur either accidentally or through an intermediate prey species (fish) that previously consumed bait pellets. Fish themselves are extremely unlikely to consume the bait themselves (Section 4.3.6.1).

4.4.2.1.2. Brodifacoum toxicity to California brown pelicans

The brodifacoum LD50 value for California brown pelicans has not been established. Using the conservative LD50 figure of 0.26 mg/kg, a 1.83 kg pelican (the low end of brown pelicans' average mass range, Shields 2002) would need to ingest the equivalent of 19 g of bait to be at a 50 percent risk of mortality. According to Table 4.1, a pelican would need to eat more than 20 percent of its average daily food intake as bait pellets in order to reach an LD50 threshold. However, these figures are presented for comparative purposes only, because brown pelicans are carnivorous (almost exclusively piscivorous) and brodifacoum ingestion would need to occur either accidentally or through an intermediate prey species (fish) that previously consumed bait pellets. Fish themselves are extremely unlikely to consume the bait themselves (Section 4.3.6.1).

4.4.2.1.3. Brodifacoum toxicity to pinnipeds other than Steller sea lions

No brodifacoum LD50 value for marine mammals have been established. The pinnipeds analyzed here have a wide range of body sizes, and it is possible although unlikely that young pups, especially elephant seals, may be present during and after bait application. Using the conservative LD50 figure of 0.4 mg/kg, a newborn northern elephant seal (at the small end of the body size range) weighing 34 kg (75 lbs) would need to ingest the equivalent of approximately 544 g (1.2 lb) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a large male adult elephant seal, weighing 2,300 kg (5,071 lbs), would need to ingest more than 36,800 g (36.8 kg; 81.1 lb) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 554 g and 36,800 lb of bait. However, these figures are presented for comparative purposes only, because all of the pinnipeds analyzed here are carnivorous (almost exclusively piscivorous) and brodifacoum ingestion would need to occur either accidentally or through an intermediate prey species (fish) that previously consumed bait pellets. Fish themselves are extremely unlikely to consume the bait themselves (Section 4.3.6.1).

4.4.2.1.4. Brodifacoum toxicity to marine birds present in nearshore waters

Using the conservative LD50 figure of 0.26 mg/kg, a red phalarope (at the small end of the body size range) weighing 46 g (0.1 lb) would need to ingest the equivalent of approximately 0.48 g (0.02 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a Pacific loon weighing 1,956 g (4.31 lb) would need to ingest 20.34 g (0.72 oz) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 0.48 g and 20.34 g of bait. According to Table 4.1, these birds would need to eat between 4.2 percent and over 19.2 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. However, these figures are presented for comparative purposes only, because these marine birds are carnivorous, feeding exclusively on marine organisms and brodifacoum ingestion would need to occur either accidentally or through an intermediate marine prey species that previously consumed bait pellets.

4.4.2.1.5. Brodifacoum toxicity to marine birds present on land

Using the conservative LD50 figure of 0.26 mg/kg, an ashy storm-petrel (at the small end of the body size range) weighing 38 g (0.08 lb) would need to ingest the equivalent of approximately 0.40 g (0.01 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a double-crested cormorant weighing 2,000 g (4.41 lb) would need to ingest 20.8 g (0.73 oz) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 0.4 g and 20.8 g of bait. According to Table 4.1, these birds would need to eat between 4.2 percent and over 19.2 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. However, these figures are presented for comparative purposes only, because these marine birds are carnivorous, feeding exclusively on marine organisms and brodifacoum ingestion would need to occur either accidentally or through an intermediate marine prey species that previously consumed bait pellets.

4.4.2.1.6. Brodifacoum toxicity to gulls

Using the conservative LD50 figure of 0.26 mg/kg, a Sabine’s gull (at the small end of the body size range) weighing 138 g (0.30 lb) would need to ingest the equivalent of approximately 1.44 g (0.05 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a glaucous gull weighing 1,232 g (2.72 lb) would need to ingest 12.81 g (0.45 oz) of bait. All of the gull species analyzed here have an estimated LD50 threshold that falls between 1.44 g and 12.81 g of bait. According to Table 4.1, these birds would need to eat between 4.2 percent and roughly 19.2 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. Because gulls may be subject to both primary and secondary exposure to brodifacoum, individual birds could reach an LD50 threshold through the consumption of prey animals even if they did not consume this much bait directly.

4.4.2.1.7. Brodifacoum toxicity to shorebirds and waterfowl

Using the conservative LD50 figure of 0.26 mg/kg, a least sandpiper (at the small end of the body size range) weighing 15 g (0.03 lb) would need to ingest the equivalent of approximately 0.16 g (0.006 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a snow goose weighing 2,224 g (4.9 lb) would need to ingest 23.13 g (0.82 oz) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 0.16 g and 23.13 g of bait. According to Table 4.1, these birds would need to eat between less than 4.2 percent and well over 19.2 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. Because some of these birds may be subject to both primary and secondary exposure to brodifacoum, individual birds could reach an LD50 threshold through the consumption of prey animals even if they did not consume this much bait directly.

4.4.2.1.8. Brodifacoum toxicity to birds of prey

Using the conservative LD50 figure of 0.26 mg/kg, a lesser nighthawk (at the small end of the body size range) weighing 50 g (0.11 lb) would need to ingest the equivalent of approximately 0.52 g (0.02 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, an osprey weighing 1,400 g (3.09 lb) would need to ingest 14.56 g (0.51 oz) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 0.52 g and 14.56 g of bait. According to Table 4.1, these birds would need to eat between 4.2 percent and over 19.2 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. However, these figures are presented for comparative purposes only, because birds of prey would only be exposed to brodifacoum indirectly through prey animals.

4.4.2.1.9. Brodifacoum toxicity to passerine birds – invertebrate specialists

Using the conservative LD50 figure of 0.26 mg/kg, an Allen's hummingbird (at the small end of the body size range) weighing only 3 g (0.007 lb) would need to ingest the equivalent of approximately 0.03 g (0.001 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a purple martin weighing 46 g (0.1 lb) would need to ingest 0.48 g (0.02 oz) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 0.03 g and 0.48 g of bait. According to Table 4.1, these birds would not need to more than 4.2 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. However, these figures are presented for comparative purposes only, because the invertebrate-specialist passerines would only be exposed to brodifacoum indirectly through prey animals.

4.4.2.1.10. Brodifacoum toxicity to passerine birds – omnivores and herbivores

Using the conservative LD50 figure of 0.26 mg/kg, a golden-crowned kinglet (at the small end of the body size range) weighing only 4 g (0.009 lb) would need to ingest the equivalent of approximately 0.04 g (0.001 oz) of bait to be at a 50 percent risk of mortality. At the large end of the body size range, a rock pigeon weighing 334 g (0.74 lb) would need to ingest 3.47 g (0.12 oz) of bait. All of the species analyzed here have an estimated LD50 threshold that falls between 0.04 g and 3.47 g of bait. According to Table 4.1, these birds would need to eat between less than 4.2 percent and well over 10.8 percent of average daily food intake as bait pellets in order to reach an LD50 threshold. Because some of these birds may be subject to both primary and secondary exposure to brodifacoum, individual birds could reach an LD50 threshold through the consumption of prey animals even if they did not consume this much bait directly.

4.4.2.1.11. Brodifacoum toxicity to salamanders

Comparatively little is known about the specific effects of brodifacoum on reptiles and amphibians. Because little is known quantitatively about the potential effects of brodifacoum on salamanders, potential impacts to salamanders on the South Farallones will be discussed qualitatively with reference to data from previous island rodent eradications. There is one known case of reptiles found dead after consuming brodifacoum bait, in Mauritius (Eason and Spurr 1995). There are no indications of adverse population-level effects to island reptiles or amphibians as a result of brodifacoum use for rodent eradication. On Anacapa Island, for example, monitoring of slender salamanders showed no changes in population after rats were eradicated using brodifacoum. In fact, in many cases, the removal of non-native rodents from the ecosystem has led to large increases in native reptile/amphibian populations (Eason and Spurr 1995).

4.4.3. Consequences of Alternative B (Proposed Action): Mouse Eradication with Aerial Bait Broadcast as Primary Technique

4.4.3.1. Impacts on species listed under the Endangered Species Act under Alternative B (proposed action)

4.4.3.1.1. Steller sea lion

Brodifacoum exposure risk under Alternative B (proposed action) – Steller sea lions are marine mammals, but they also use terrestrial habitat year-round. Steller sea lions are likely to be present in the waters surrounding the South Farallones, and may be hauled out on beaches or rocky shoreline at any given time during bait application operations. Steller sea lions in the water may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Steller sea lions that are hauled out may encounter bait pellets along the coastline. Steller sea lions are carnivorous (almost exclusively piscivorous) and do not feed while on land, so the only possible routes for bait ingestion are accidental. Pups may experimentally ingest individual pellets, but the low pellet density on land (less than one pellet per yd^2) would make ingestion of multiple pellets unlikely. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to Steller sea lions is likely high. However, the likelihood of Steller sea lions experiencing either primary or secondary exposure to brodifacoum is negligible. Furthermore, due to their large body size, Steller sea lions would need to consume a large dose of brodifacoum in order to be at risk of adverse effects from the toxin. Therefore, the overall risk of Steller sea lion mortality or any sub-lethal effects as a result of brodifacoum use is negligible.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over Steller sea lion coastal habitat approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all Steller sea lion coastal habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Animals on shore would likely be exposed to higher-decibel noise than animals in the water. Personnel activities including boat travel and terrestrial monitoring activities would also expose some Steller sea lions to additional low levels of disturbance. The response of pinnipeds such as Steller sea lions to visual and/or auditory disturbances varies from no discernable reaction to completely vacating haulouts (Calkins 1979; Efroymson and Suter 2001). Approaching aircraft and the sudden appearance of humans generally flush animals into the water. Entering the water is part of Steller sea lions' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on the overall energy balance or fitness of individual animals (Richardson et al. 1995). During breeding season, a disturbance event that led to all or most of the animals on a haulout or rookery entering the water would leave pups vulnerable to crushing from larger animals. However, the actions proposed in Alternative B would occur entirely outside of the Steller sea lion breeding season and any pups that are present would likely be mobile enough to avoid trampling. Overall, the level of disturbance to Steller sea lions from the operations described in Alternative B is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative B (proposed action) –Alternative B would not be likely to lead to any effects in the habitat, prey base, or other ecological interactions of Steller sea lions that would in turn affect them in the short or long term.

Significance of effects to Steller sea lions under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would not be likely to lead to the potential mortality of any Steller sea lions. Therefore, based on the criteria described in Section 4.3.1.8, the effects of Alternative B would not be significant to Steller sea lions.

Special considerations under ESA for Alternative B (proposed action) – Endangered Species Act regulations oblige Federal agencies to ensure that the actions they take are not likely to "jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat" (ESA Section 7(a)2). If a Federal action may adversely affect an ESA-listed species or its designated critical habitat, the action agency must enter a process of formal consultation with either FWS or NMFS, depending on the species in question. Based on the impacts analysis above, Alternative B would not be likely to adversely affect Steller sea lions. However, under NMFS's application of ESA regulations, take of some Steller sea lions through disturbance would likely occur. Furthermore, some project actions would need to occur within Steller sea lion critical habitat. If Alternative B is chosen for implementation, the Service would enter into consultation with NMFS to ensure compliance with

Sections 7 and 9 of the ESA. For Steller sea lions, MMPA regulations would apply in addition to ESA regulations. See Section 4.4.3.2 for more details on MMPA considerations.

4.4.3.1.2. California brown pelican

Brodifacoum exposure risk under Alternative B (proposed action) – California brown pelicans forage and rest in the waters surrounding the South Farallones, and use the islands' terrestrial habitat for roosting. California brown pelicans are likely to be present during bait application operations. Pelicans foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Pelicans that are roosting on the island are likely to encounter bait pellets after bait application. California brown pelicans are exclusively piscivorous and do not feed while on land, so the only possible routes for bait ingestion are accidental. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to California brown pelicans is likely high. However, the likelihood of pelicans experiencing either primary or secondary exposure to brodifacoum is negligible. Therefore, the overall risk of pelican mortality or any sub-lethal effects as a result of brodifacoum use is negligible.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over potential California brown pelican roosting habitat approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all pelican habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some pelicans to additional low levels of disturbance. The response of pelicans to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Leaving the roost is part of pelicans' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to California brown pelicans from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) –Alternative B would not be likely to lead to any effects in the habitat, prey base, or other ecological interactions of California brown pelicans that would in turn affect them in the short or long term.

Significance of effects to California brown pelicans under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would not be likely to lead to the potential mortality of any California brown pelicans. Therefore, based on the criteria described in Section 4.3.1.8, the effects of Alternative B would not be significant to California brown pelicans.

Special considerations under ESA for Alternative B (proposed action) – ESA regulations oblige Federal agencies to ensure that the actions they take are not likely to "jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat" (ESA Section 7(a)2). If a Federal action may adversely affect an ESA-listed species or its designated critical habitat, the action agency must enter a process of formal consultation with either FWS or NMFS, depending on the species in question. Based on the impacts analysis above, Alternative B would not adversely affect California brown pelicans. Regardless, if Alternative B is chosen for implementation, the Service would enter into intra-agency consultation with to ensure compliance with Sections 7 and 9 of the ESA. If California brown pelicans are de-listed before the proposed action is implemented, this consultation may not be necessary but all remaining regulations pertaining to the pelican, including the Migratory Bird Treaty Act, would be followed.

4.4.3.2. Impacts on pinnipeds (other than Steller sea lions) under Alternative B (proposed action)

During and after bait application operations, the following pinnipeds (other than Steller sea lions, discussed above) may be present in the waters surrounding the South Farallones and hauled out on the coast:

- California sea lion
- Northern elephant seal
- Harbor seal
- Northern fur seal

The seasonal window proposed for bait application in Alternative B would close when the first female northern elephant seals arrive to give birth and breed, in mid- to late December. None of the other pinnipeds analyzed here would be breeding during bait application.

Brodifacoum exposure risk under Alternative B (proposed action) – All of the pinnipeds analyzed here use terrestrial habitat year-round, although they forage exclusively in the marine environment. These pinnipeds are likely to be present in the waters surrounding the South Farallones, and may be hauled out on beaches or rocky shoreline at any given time during bait application operations. Pinnipeds in the water may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Pinnipeds that are hauled out may encounter bait pellets along the coastline. The pinnipeds analyzed here are exclusively carnivorous (almost exclusively piscivorous) and do not feed while on land, so the only possible routes for bait ingestion are accidental. Pups that are present may experimentally ingest individual pellets, but the low pellet density on land (less than one pellet per yd^2) would make ingestion of multiple pellets unlikely.The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to pinnipeds is likely high. However, the likelihood of the pinnipeds analyzed here experiencing either primary or secondary exposure to brodifacoum is negligible. Furthermore, due to their large body sizes even at the smallest end of the large range described earlier in this section, pinnipeds would need to consume a large dose of brodifacoum in order to be at risk of adverse effects from the toxin. Therefore, the overall risk of pinniped mortality or any sub-lethal effects as a result of brodifacoum use is negligible.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over coastal habitat approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all coastal habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Animals on shore would likely be exposed to higher-decibel noise than animals in the water. Personnel activities including boat travel and terrestrial monitoring activities would also expose some pinnipeds to additional low levels of disturbance. The response of pinnipeds to visual and/or auditory disturbances varies from no discernable reaction to completely vacating haulouts (Calkins 1979; Efroymson and Suter 2001). Approaching aircraft and the sudden appearance of humans generally flush animals into the water. Entering the water is part of these animals' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on the overall energy balance or fitness of individual animals (Richardson et al. 1995).

During breeding season, a disturbance event that led to all or most of the animals on a haulout or rookery entering the water would leave pups vulnerable to crushing from larger animals. The actions proposed in Alternative B would occur outside of the breeding season for California sea lions, harbor seals, and northern fur seals, and any pups of these species that are present would likely be mobile enough to avoid trampling. The helicopter application would be timed to be complete before northern elephant seal breeding season has begun in mid- to late December. Overall, the level of disturbance to the pinnipeds analyzed here from the operations described in Alternative B is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Alternative B would no be likely to lead to any effects in the habitat, prey base, or other ecological interactions of any of the pinnipeds analyzed here that would in turn affect them in the short or long term.

Significance of effects to pinnipeds under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would not be likely to lead to the potential mortality of any pinnipeds. Therefore, based on the criteria described in Section 4.3.1.9, the effects of Alternative B would not be significant to pinnipeds that use the South Farallones.

Special considerations under MMPA for Alternative B (proposed action) – With the exception of subsistence harvests, the MMPA regulations generally prohibit the killing, injury or disturbance of marine mammals. However, permits can be granted allowing exceptions to this prohibition for actions that may impact a marine mammal if the impact is incidental to rather than the intention of the action. Carrying out an action that is likely to lead to the disturbance of hauled out marine mammals to the point that they enter the water is often considered "harassment" under the

MMPA. Based on the analysis above, some marine mammals would likely be subject to harassment as a result of the activities in Alternative B. In any event, the Service would coordinate with NMFS to apply for an Incidental Harassment Authorization if Alternative B is chosen for implementation.

4.4.3.3. Impacts on birds under Alternative B (proposed action)

Unlike pinnipeds, whose patterns of occurrence and community makeup at the South Farallones are relatively predictable, and non-volant terrestrial species, the seasonal makeup of the South Farallones bird community can be difficult to predict from year to year. The community of breeding seabirds can be predicted reliably, but the presence and distribution of non-breeding bird species varies widely.

Potential impacts to birds will be analyzed according to the types of impacts that would be likely for various bird taxa, but the precise species makeup of many of these taxa will not be examined in detail. Appendices ##-## outline bird occurrence patterns on the South Farallones according to the taxonomic groups analyzed here.

4.4.3.3.1. Marine birds present in nearshore waters only

The productive waters surrounding the Farallones provide foraging grounds for a number of waterbird species, including seabirds and other marine waterbirds such as grebes, scoters, and phalaropes, that do not come ashore.

Brodifacoum exposure risk under Alternative B (proposed action) – Marine birds foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Most marine birds feed exclusively on marine organisms, so the only possible routes for bait ingestion are accidental. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to marine birds is likely high. However, the likelihood of most marine birds experiencing either primary or secondary exposure to brodifacoum is negligible. Therefore, the overall risk of mortality or any sub-lethal effects in most of the marine birds present in nearshore waters around the South Farallones as a result of brodifacoum use is negligible.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would only fly over land, although occasional passes over water would be necessary. These short-duration disturbance events would occur over the course of approximately three weeks. Boat travel around the islands would also expose some marine birds to additional low levels of disturbance. The response of marine birds to visual and/or auditory disturbances varies, but the most common response for birds that are resting on the water is to flush and fly to a new location. This is part of marine birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to most of the marine birds present in nearshore waters from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Alternative B would not be likely to lead to negative effects in the habitat, prey base, or other ecological interactions of the marine birds present in nearshore waters that would in turn affect them in the short or long term.

Significance of effects to marine birds present in nearshore waters under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would not be likely to lead to noticeable changes in the populations of any marine birds foraging in the nearshore waters of the South Farallones which could be considered significant according to the criteria described in Section 4.3.1.7.

4.4.3.3.2. Seabirds present on land

There are a number of species present at the South Farallones that feed exclusively in marine environments, but spend time in terrestrial habitat on the islands as well. Most of these species are seabirds that breed on the South Farallones and visit their nesting sites year-round or roost elsewhere on the islands. Due to their similar feeding habits and habitat usage, these species are analyzed as a group – marine birds present on land – here.

There are a number of *Larus* gull species that are present on land, but due to their unique feeding habits they are analyzed separately in Section 4.4.3.3.3. Pelicans are common on land at the South Farallones as well, but due to their ESA-listed status they are analyzed separately in Section 4.4.3.1.2.

Brodifacoum exposure risk under Alternative B (proposed action) – Marine birds foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Marine birds that are roosting on the island are likely to encounter bait pellets after bait application. Most marine birds feed exclusively on marine organisms and do not feed while on land, so the only possible routes for bait ingestion are accidental. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to marine birds is likely high. However, the likelihood of most marine birds experiencing either primary or secondary exposure to brodifacoum is negligible. Therefore, the overall risk of mortality or any sub-lethal effects in most of the marine birds present on land as a result of brodifacoum use is negligible.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over all land area on the South Farallones approximately twice for each full-island bait application. With two bait application sessions, all marine bird habitat could be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some marine birds roosting on land to additional low levels of disturbance. The response of marine birds to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, leaving the roost is part of marine birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to most of the marine birds present on land from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Alternative B would not be likely to lead to negative effects in the habitat, prey base, or other ecological interactions of most of the marine birds present on land that would indirectly affect them. The removal of mice, which likely currently impact breeding seabirds both directly and indirectly, from the South Farallones ecosystem is expected to have a positive impact on these seabirds, especially ashy storm-petrels and other small burrow- and crevice-nesting seabirds. Mouse removal would be unlikely to have any more than marginal effects on the larger marine birds present on land over the long term.

Significance of effects to marine birds present on land under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would not be likely to lead to noticeable negative changes in the populations of most seabirds on the South Farallones. Mouse removal may eliminate predation on ashy storm-petrel by burrowing owls, which may result in a noticeable positive response in the local ashy storm-petrel population, but too many other variables may be affecting the ashy storm-petrel population to anticipate this positive response with certainty. In summary, the effects of Alternative B would not be significant to the marine birds present on land at the South Farallones according to the criteria described in Section 4.3.1.7.

4.4.3.3.3. Gulls

Gulls in the genus *Larus* are omnivorous generalists in diet, foraging at sea as well as scavenging on land. These feeding habits set them apart from most of the other seabirds that occur on the South Farallones and also increase their risk of exposure to brodifacoum.

Brodifacoum exposure risk under Alternative B (proposed action) – Gulls foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Gulls that are roosting on the island are likely to encounter bait pellets during and after bait application. Gulls may consume bait pellets both at sea and on land. Through predation and/or scavenging, gulls may also consume animals that have been exposed to brodifacoum, especially mice. Gulls would be at high risk for both primary and secondary exposure to brodifacoum during and after bait application. Their risk level would begin to decline rapidly within 30 days of the final bait application session as the mouse population declines and bait pellets are consumed or disintegrated. The likelihood of either primary or secondary exposure would be low within 30 days of the final bait application (up to 50 days after the start of bait application), and negligible within a few months.

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to gulls is high. Furthermore, the likelihood of gulls experiencing both primary and secondary exposure to brodifacoum would be high during and after bait application. Overall, the risk of mortality or sub-lethal effects in gulls on and around the South Farallones as a result of brodifacoum use would be high from the first bait application to approximately 3 weeks after the final bait application. The risk would decline to low within 30 days of the final application (up to 50 days after the start of bait application), and would be negligible within a few months.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over all land area on the South Farallones approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all gull habitat could be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some gulls roosting on land to additional low levels of disturbance. The response of gulls to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, leaving the roost is part of gulls' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to gulls from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – The gull species on the South Farallones occasionally prey on mice and mouse eradication would remove this food source. However, gulls are not currently under food stress and would have ample alternative food sources available on and around the South Farallones even if mice are eradicated. Western gull nesting habitat would be marginally improved if mice are eradicated. Overall, mouse eradication would not indirectly affect gulls on the South Farallones.

Significance of effects to gulls under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would likely lead to numerous individual mortalities of a variety of gull species on the South Farallones. Gull species that may experience individual mortalities may include Western gull, herring gull (*Larus argentatus*), glaucous-winged gull (*L. glaucescens*), California gull (*L. californicus*), Heermann's gull (*L. heermanni*), mew gull (*L. canus*), and Thayer's gull (*L. thayeri*).

The South Farallones host a large Western gull colony, and members of this colony may be present on the island year-round. However, the number of Western gulls present fluctuates dramatically from day to day and the causes for these fluctuations are not well-understood. It is possible, although unlikely, that up to roughly 16,000 Western gulls would be present on the islands at some point during the risk window for Alternative B (Warzybok and Bradley 2007; USFWS pers. comm.). Biologists on the islands note that on some days during the time window identified for Alternative B, nearly all Western gull nest sites appear to be occupied, while on other days the islands are nearly devoid of gulls. On average, PRBO estimates that roughly 42% of the Western gull population is present on each given day during the risk window, but the turnover rate is unknown (D. Lee unpubl. report).

On Anacapa Island in Southern California, which is also home to a large Western gull colony, a rat eradication project with brodifacoum exposure parameters very similar to Alternative B, there were no changes detected in the population size of the gull colony during the subsequent breeding seasons after the operations were complete that could be attributed to the introduction of brodifacoum. The Anacapa project provides the best evidence available for the probable response of the Western gulls on the South Farallones after mouse eradication, which indicates that significant (population-level) effects on Western gulls are unlikely, according to the criteria described in Section 4.3.1.7.

The abundances of other gull species on the South Farallones during the risk window in Alternative B also vary widely, from only a few Thayer's gulls to sometimes over 400 California gulls. None of these gull species, all of which would be at risk of mortality, are numerous enough on the South Farallones to lead to noticeable population changes in their respective source populations that could be considered significant according to the criteria described in Section 4.3.1.7. The gull community on the South Farallones would return to normal patterns of diversity by the next winter with the arrival of other individuals.

4.4.3.3.4. Shorebirds and waterfowl

The South Farallones' intertidal habitat supports a number of shorebird species such as black oystercatchers and turnstones. Additionally, many other species of freshwater and estuarine waterfowl have been sighted on the Farallones during migration, and some have occasionally overwintered. These birds forage in the intertidal zones and in terrestrial environments.

Brodifacoum exposure risk under Alternative B (proposed action) – Birds foraging in the intertidal zone may encounter bait pellets after bait application, likely at a lower concentration than on land. Pellets that enter the water would disintegrate and become unavailable within a few hours. Birds that are foraging on the island are likely to encounter bait pellets during and after bait application. Through predation and/or scavenging, some shorebirds and waterfowl may also consume animals that have been exposed to brodifacoum, including mice. Waterfowl that forage in both terrestrial and intertidal habitats and primarily eat plant matter would be at high risk for primary exposure to brodifacoum during and after bait application. Shorebirds and waterfowl that forage in both terrestrial and intertidal habitats and have a broad, omnivorous diet would be at high risk for both primary and secondary exposure. Birds that forage primarily in the intertidal zone and specialize in intertidal invertebrates would be at low risk of secondary exposure, but exposure could not be ruled out. The risk level for birds initially at high risk (terrestrial-foraging herbivores and omnivores) would begin to decline rapidly within 30 days of the final bait application session as the mouse population declines and bait pellets are consumed or disintegrated. The likelihood of either primary or secondary exposure in these initially high-risk birds would be low within 30 days of the final bait application (up to 50 days after the start of bait application), and negligible within a few months. The likelihood of exposure in intertidal specialists would be negligible within 30 days of the final bait application (up to 50 days after the start of bait application).

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to shorebirds and waterfowl is high. The likelihood of some of these birds experiencing both primary and secondary exposure to brodifacoum would be high during and after bait application. Overall, therefore:

- The risk of mortality or sub-lethal effects from brodifacoum in the waterfowl that are herbivorous or omnivorous and forage on land would be high from the first bait application to approximately 3 weeks after the final bait application, decline to low within 30 days of the final application (50 days after the start of bait application), and become negligible within a few months.
- The risk of mortality or sub-lethal effects from brodifacoum in shorebirds that forage exclusively in the intertidal zone would be low but not negligible from the first bait application, and would become negligible within 30 days of the final application (50 days after the start of bait application).

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over all land area on the South Farallones approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all terrestrial habitat could be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some birds to additional low levels of disturbance. The response of shorebirds and other waterfowl to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, leaving the roost is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to shorebirds and other waterfowl from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Shorebirds and waterfowl that feed on terrestrial invertebrates share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. However, there is no evidence that mouse eradication would lead to effects in the invertebrate community on the South Farallones that would in turn affect shorebirds or waterfowl. Black oystercatcher nesting habitat would be marginally improved if mice are eradicated. Overall, mouse removal would not indirectly affect shorebirds or waterfowl on the South Farallones.

Significance of effects to shorebirds and waterfowl under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would likely lead to individual mortalities of some shorebirds and waterfowl on the South Farallones. Bird species that may experience individual mortalities may include black-bellied plover (*Pluvialis squatarola*), wandering tattler (*Tringa incana*), willet (*Tringa semipalmata*), killdeer (*Charadrius vociferous*), whimbrel (*Numenius phaeopus*), black turnstone, ruddy turnstone (*Arenaria melanocephala*), and black oystercatcher. There may be up to roughly 90 black turnstones present at some point during the risk window, roughly 40 black oystercatchers, and likely less than 10 of each other species. It is unlikely that all of these individuals would be at risk of mortality. Any individual mortalities that do occur would be unlikely to lead to noticeable changes in the populations of any shorebirds or waterfowl on the South Farallones that could be considered significant according to the criteria described in Section 4.3.1.7. This bird community on the South Farallones would return to normal patterns of diversity by the next winter with the arrival of other individuals from the mainland.

4.4.3.3.5. Birds of prey

There are relatively few birds of prey (diurnal raptors and owls) on the South Farallones, but individual birds that are present may be at risk of secondary exposure to brodifacoum.

Brodifacoum exposure risk under Alternative B (proposed action) – Birds of prey on the South Farallones are likely to encounter bait pellets in the terrestrial environment during and after bait application. Birds of prey may consume animals that have been exposed to brodifacoum. The risk level for birds of prey that consume mice and/or invertebrates would initially be high and would decline rapidly within 30 days of the final bait application session (up to 50 days after the start of bait application) as the mouse population declines and bait pellets become less available for invertebrate consumers. The likelihood of secondary exposure for most birds of prey would be negligible within a few months. The risk level for peregrine falcons (*Falco peregrinus*), which almost exclusively feed on birds, would initially be low, and would become negligible within a few months.

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to birds of prey is high. The likelihood of birds of prey that would feed on mice and/or invertebrates experiencing secondary exposure to brodifacoum would be high during and after the bait application. The likelihood of secondary exposure in peregrine falcons, which are specialist bird predators, would be low but not negligible. Overall, therefore:

- The risk of mortality or sub-lethal effects from brodifacoum in birds of prey that eat mice and/or invertebrates would be high from the first bait application to approximately 3 weeks after the final bait application, decline to low within 30 days of the final application (up to 50 days after the start of bait application), and become negligible within a few months.
- The risk of mortality or sub-lethal effects from brodifacoum in peregrine falcons would be low but not negligible for up to a few months after the final bait application.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over all land area on the South Farallones approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all terrestrial habitat could be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some birds to additional low levels of disturbance. The response of birds of prey to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, leaving the roost is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to birds of prey from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Burrowing owls on the South Farallones rely on mice as an important food source during the fall and early winter seasons, and mouse eradication would substantially reduce the quality of habitat for burrowing owls on the islands. There are no permanently resident burrowing owls on the South Farallones; all owls appear to arrive during the fall migration season. The best available evidence indicates that if mice are eradicated, burrowing owls would simply return to the mainland because the islands would not provide adequate foraging habitat, rather than attempting to over-winter on the islands as small numbers of them currently do. Therefore, mouse removal is not expected to have any negative impacts on the mainland burrowing owl populations to which these current island arrivals belong. Mouse eradication would not be likely to lead to negative effects in the habitat, prey base, or other ecological interactions of any other birds of prey that would in turn affect them in the short or long term.

Significance of effects to birds of prey under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would likely lead to individual mortalities of birds of prey on the South Farallones. Species that may experience individual mortalities may include burrowing owl, peregrine falcon, short-eared owl (*Asio flammeus*), barn owl, red-tailed hawk (*Buteo jamaicensis*), Northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), long-eared owl (*Asio otus*), and Northern saw-whet owl (*Aegolius acadicus*). However, mortality in most of these birds except burrowing owls and peregrine falcons would be highly unlikely. Approximately three burrowing owls may be killed, and no more than one or two peregrine falcons would be at risk of mortality. Overall, such a small number of individual mortalities would not be likely to lead to noticeable changes in the breeding populations of birds of prey on the South Farallones that could be considered significant according to the criteria described in Section 4.3.1.7. Peregrine falcons on the South Farallones would quickly return to normal patterns of abundance within months with the arrival of other individuals from the mainland. After mouse eradication, the Service anticipates that burrowing owls would no longer overwinter on on the South Farallones, but the mainland source populations of burrowing owls would not be affected overall.

4.4.3.3.6. Passerines – invertebrate specialists

This section analyzes potential risks to passerine birds on the South Farallones that feed only on invertebrates, and therefore are only at risk of secondary exposure to brodifacoum.

Brodifacoum exposure risk under Alternative B (proposed action) – Birds that are foraging on the South Farallones are likely to encounter bait pellets during and after bait application. Invertebrate specialists may consume prey animals that have been exposed to brodifacoum. The risk of exposure to brodifacoum in these birds would initially be high, and would decline rapidly to a low exposure risk within 30 days of the final bait application session (up to 50 days after the start of bait application) as bait pellets become less available to invertebrate consumers. Exposure risk would be negligible within a few months.

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to passerine birds is high. The likelihood of invertebrate-specialist passerines experiencing secondary exposure to brodifacoum would be high during and immediately after bait application. Overall, therefore, the risk of mortality or sub-lethal effects from brodifacoum in invertebrate-specialist passerines would be high from the first bait application to approximately 3 weeks after the final bait application, decline to low within 30 days of the final application (up to 50 days after the start of bait application), and become negligible within a few months.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over all land area on the South Farallones approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all terrestrial habitat could be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some birds to additional low levels of disturbance. The response of passerine birds to visual and/or auditory disturbances is most commonly to flush from a roost. Outside of the breeding season, this is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to passerine birds from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B – Passerines that feed on invertebrates share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. However, there is no evidence that mouse eradication would lead to effects in the invertebrate community on the South Farallones that would in turn affect passerines. Overall, mouse removal would not indirectly affect passerines on the South Farallones.

Significance of effects to invertebrate-specialist passerines under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would likely lead to individual mortalities of wintering passerine birds on the South Farallones. Invertebrate-specialist species that may experience individual mortalities may include black phoebe (*Sayornis nigricans*) and rock wren (*Salpinctes obsoletus*). There are no passerine bird species that would be present in any numbers larger than approximately 25 individuals during the risk window for Alternative B. Furthermore, it is unlikely that all individuals of any passerine bird species present would be killed. Overall, such a small number of individual mortalities would not be likely to lead to noticeable changes in the breeding populations of any passerines on the South Farallones that could be considered significant according to the criteria described in Section 4.3.1.7. The overwintering passerine bird community on the South Farallones would return to normal patterns of diversity by the next winter with the arrival of other individuals from the mainland.

4.4.3.3.7. Passerines – omnivores and herbivores

This section analyzes potential risks to passerine birds on the South Farallones that are either herbivorous (specializing in seeds and/or fruits) or omnivorous, and therefore may be at risk of both primary and secondary exposure to brodifacoum.

Brodifacoum exposure risk under Alternative B (proposed action) – Birds that are foraging on the South Farallones are likely to encounter bait pellets during and after bait application. Birds that primarily eat plant matter would be at high risk for primary exposure to brodifacoum during and after bait application. Birds that have a broad, omnivorous diet would be at high risk for both primary and secondary exposure. The risk level for birds initially at high risk would begin to decline rapidly within 30 days of the final bait application session (up to 50 days after the start of bait application) as as bait pellets disintegrate or are consumed, and become less available to invertebrate consumers. The likelihood of either primary or secondary exposure in these initially high-risk birds would be low within 30 days of the final bait application (up to 50 days after the start of bait application, and negligible within a few months.

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to passerine birds is high. Furthermore, the likelihood of omnivorous or herbivorous passerines experiencing either primary or secondary exposure to brodifacoum would be high during and after bait application. Overall, the risk of mortality or sub-lethal effects in these birds as a result of brodifacoum use would be high from the first bait application to approximately 3 weeks after the final bait application. The risk would decline to low within 30 days of the final application (up to 50 days after the start of bait application, and would be negligible within a few months.

Risks from disturbance under Alternative B (proposed action) – During helicopter operations for bait application, the helicopter would fly over all land area on the South Farallones approximately twice for each full-island bait application, as well as occasionally passing over water. With two bait application sessions, all terrestrial habitat could be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Personnel activities including boat travel and terrestrial monitoring activities would also expose some birds to additional low levels of disturbance. The response of passerine birds to visual and/or auditory disturbances is most commonly to flush from a roost. Outside of the breeding season, this is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to passerine birds from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Passerines that feed on invertebrates as part of their diet share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. However, there is no evidence that mouse eradication would lead to effects in the invertebrate community on the South Farallones that would in turn affect passerines. Overall, mouse removal would not indirectly affect passerines on the South Farallones.

Significance of effects to omnivorous and herbivorous passerines under Alternative B (proposed action) – Implementation of mouse eradication activities as described in Alternative B would likely lead to individual mortalities of passerine birds on the South Farallones. Omnivorous or herbivorous species that may experience individual mortalities may include hermit thrush (*Catharus guttatus*), American robin (*Turdus migratorius*), varied thrush (*Ixoreus naevius*), starling (*Ixoreus naevius*, a non-native species), yellow-rumped warbler (*Dendroica coronata*), fox sparrow (*Passerella iliaca*), golden-crowned sparrow (*Zonotrichia atricapilla*), dark-eyed junco (*Junco hyemalis*), Western meadowlark (*Sturnella neglecta*), and pine siskin (*Carduelis pinus*). There are no passerine bird species that would be present in any numbers larger than approximately 25 individuals during the risk window for Alternative B. Furthermore, it is unlikely that all individuals of any passerine bird species present would be killed. Overall, such a small number of individual mortalities would not be likely to lead to noticeable changes in the breeding populations of any passerines on the South Farallones that could be considered significant according to the criteria described in Section 4.3.1.7. The overwintering passerine bird community on the South Farallones would return to normal patterns of diversity by the next winter with the arrival of other individuals from the mainland.

4.4.3.4. Other biological resources

4.4.3.4.1. Salamanders

Brodifacoum exposure risk under Alternative B (proposed action) – Salamanders on the South Farallones are likely to encounter bait pellets during and after bait application. Salamanders specialize in invertebrates, and they may consume prey animals that have been exposed to brodifacoum. The risk of exposure to brodifacoum in salamanders would initially be high, and would decline rapidly to a low exposure risk within 30 days of the final bait application session (up to 50 days after the start of bait application) as bait pellets become less available to invertebrate consumers. Exposure risk would be negligible within a few months.

Overall risks from brodifacoum use under Alternative B (proposed action) – The toxicity of brodifacoum to salamanders is unknown. The likelihood of salamanders experiencing secondary exposure to brodifacoum would be high from the first bait application to approximately 3 weeks after the final bait application, decline to low within 30 days of the final application (up to 50 days after the start of bait application), and become negligible within a few months. Based on evidence from rodent eradications elsewhere in the world, brodifacoum use would not be likely to lead to negative population-level effects in salamanders. The risk of individual mortalities in salamanders is unknown.

Risks from disturbance under Alternative B (proposed action) – Helicopter operations would not affect salamanders. Personnel activities including boat travel and terrestrial monitoring activities would also expose some salamanders to low levels of disturbance, but no more than current monitoring activities on the islands. Overall, the level of disturbance to salamanders from the operations described in Alternative B is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative B (proposed action) – Salamanders, which feed exclusively on invertebrates, share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. While this may in turn positively affect the salamander population, as has occurred after mouse eradication from other islands in the world, there is currently no evidence to indicate this possibility on the South Farallones.

Significance of effects to salamanders under Alternative B (proposed action) – Based on evidence from elsewhere in the world, mouse eradication implementation of mouse eradication activities as described in Alternative B would not be likely to lead to noticeable changes in the population of salamanders on the South Farallones which could be considered significant according to the criteria described in Section 4.3.1.7.

4.4.3.4.2. Terrestrial Vegetation

Alternative B would result in minor, temporary, and highly localized direct vegetation impacts from project crews traveling by foot. Mouse eradication could result in positive impacts to the native vegetation of the South Farallones by removing mice as a seasonally major consumer of vegetation, especially maritime goldfields. However, there is currently no evidence to support this possibility on the South Farallones. Overall, Alternative B would not be likely to lead to noticeable changes in the vegetation community which could be considered significant according to the criteria described in Section 4.3.1.7.

4.4.3.5. Irreversible and irretrievable impacts to biological resources under Alternative B (proposed action)

None of the impacts to biological resources from Alternative B would be likely to lead to any population-level changes, although positive population-level changes would be possible in species such as the ashy storm-petrel. Overall, none of the impacts expected on biological resources would be considered irreversible or irretrievable.

4.4.4. Alternative C: Mouse Eradication with Bait Station Delivery as Primary Technique

4.4.4.1. Impacts on species listed under the Endangered Species Act under Alternative C

4.4.4.1.1. Steller sea lion

Brodifacoum exposure risk under Alternative C – Steller sea lions are marine mammals, but they also use terrestrial habitat year-round. Steller sea lions are likely to be present in the waters surrounding the South Farallones, and may be hauled out on beaches or rocky shoreline at any given time during the activities described in Alternative C. Steller sea lions would be unlikely to be exposed to bait that is loaded into bait stations. However, they would likely be exposed to small amounts of bait during and after aerial bait broadcast on areas that are not included in the bait station grid. In fact, because many of the islands' steep cliffs are at or near the coastline, requiring aerial broadcast treatment, Steller sea lion exposure to bait under Alternative C would likely be similar to Alternative B. Steller sea lions in the water may encounter bait pellets that have drifted from the island into the ocean during aerial bait broadcast, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Steller sea lions that are hauled out may encounter bait pellets along the coastline after aerial bait broadcast. Steller sea lions are exclusively carnivorous (almost exclusively piscivorous) and do not feed while on land, so the only possible routes for bait ingestion are accidental. Pups may experimentally ingest individual pellets, but the low pellet density on land (less than one pellet per yd^2) would make ingestion of multiple pellets unlikely. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to Steller sea lions is likely high. However, the likelihood of Steller sea lions experiencing either primary or secondary exposure to brodifacoum is negligible. Furthermore, due to their large body size, Steller sea lions would need to consume a large dose of brodifacoum in order to be at risk of adverse effects from the toxin. Therefore, the overall risk of sea lion mortality or any sub-lethal effects as a result of brodifacoum use is negligible. This risk profile is essentially the same as under Alternative B (the proposed action).

Risks from disturbance under Alternative C – Personnel activities during bait station installation and maintenance would likely lead to low levels of Steller sea lion disturbance in coastal areas that are included in the bait station grid. Areas near persistent Steller sea lion haulouts may be excluded from the bait station grid to minimize disturbance in those areas. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit near potential Steller sea lion habitat could result in disturbance. During aerial bait application of inaccessible areas, the helicopter would fly over Steller sea lion coastal habitat approximately twice for each bait application session. With two bait application sessions, some Steller sea lion coastal habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Animals on shore would likely be exposed to higher-decibel noise than animals in the water.

The response of pinnipeds such as Steller sea lions to visual and/or auditory disturbances varies from no discernable reaction to completely vacating haulouts (Calkins 1979; Efroymson and Suter 2001). Approaching aircraft and the sudden appearance of humans generally flush animals into the water. Entering the water is part of Steller sea lions' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on the overall energy balance or fitness of individual animals (Richardson et al. 1995). However, during breeding season, a disturbance event that led to all or most of the animals on a haulout or rookery entering the water would leave pups vulnerable to crushing from larger animals. Because of the need to visit bait stations year-round, low levels of disturbance to Steller sea lions from personnel presence during breeding season may occur. The bait station grid can be designed to avoid personnel presence near known rookery sites on the islands, minimizing the potential for harming young pups. All aerial bait broadcast activities would occur outside of the Steller sea lion breeding season and any pups that are present would likely be mobile enough to avoid trampling.

Overall, the level of disturbance to Steller sea lions from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Alternative C would not be likely to lead to any effects in the habitat, prey base, or other ecological interactions of Steller sea lions that would in turn affect them over the short or long term.

Significance of effects to Steller sea lions under Alternative C – Implementation of mouse eradication activities as described in Alternative C would not be likely to lead to the potential mortality of any Steller sea lions. Therefore, based on the criteria described in Section 4.3.1.8, the effects of Alternative C would not be significant to Steller sea lions.

Special considerations under ESA under Alternative C – ESA regulations oblige Federal agencies to ensure that the actions they take are not likely to "jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat" (ESA Section 7(a)2). If a Federal action may adversely affect an ESA-listed species or its designated critical habitat, the action agency must enter a process of formal consultation with either FWS or NMFS, depending on the species in question. Based on the impacts analysis above, Alternative C would not be likely to adversely affect Steller sea lions. However, under NMFS's application of ESA regulations, take of some Steller sea lions through disturbance would likely occur. Furthermore, some project actions would need to occur within Steller sea lion Critical Habitat. If Alternative C is chosen for implementation, the Service would enter into consultation with NMFS to ensure compliance with Sections 7 and 9 of the ESA. For Steller sea lions, MMPA regulations would apply in addition to ESA regulations. See Section 4.4.4.2 for more details on MMPA considerations.

4.4.4.1.2. California brown pelican

Brodifacoum exposure risk under Alternative C – California brown pelicans forage and rest in the waters surrounding the South Farallones, and use the islands' terrestrial habitat for roosting. California brown pelicans are likely to be present during the activities described in Alternative C. Roosting pelicans would not have access to bait loaded into bait stations, but they may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Pelicans would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Pelicans foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during aerial bait broadcast, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Pelicans that are roosting on the island are likely to encounter bait pellets after aerial bait broadcast. California brown pelicans are exclusively piscivorous and do not feed while on land, so the only possible routes for bait ingestion are accidental. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to California brown pelicans is likely high. However, the likelihood of pelicans experiencing either primary or secondary exposure to brodifacoum is negligible. Therefore, the overall risk of pelican mortality or any sub-lethal effects as a result of brodifacoum use is negligible. This risk profile is essentially the same as under Alternative B (the proposed action).

Risks from disturbance under Alternative C – Personnel activities during bait station installation and maintenance would likely lead to disturbances to roosting California brown pelicans. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit near roosting pelicans could result in disturbance. During aerial bait application of inaccessible areas, the helicopter would fly over potential California brown pelican roosting habitat approximately twice for each bait application session. With two bait application sessions, some pelican habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of pelicans to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Leaving the roost is part of pelicans' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to California brown pelicans from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Alternative C would not be likely to lead to any effects in the habitat, prey base, or other ecological interactions of California brown pelicans that would in turn affect them over the short or long term.

Significance of effects to California brown pelicans under Alternative C – Implementation of mouse eradication activities as described in Alternative C would not be likely to lead to the potential mortality of any California brown pelicans. Therefore, based on the criteria described in Section 4.3.1.8, the effects of Alternative C would not be significant to California brown pelicans.

Special considerations under ESA under Alternative C – ESA regulations oblige Federal agencies to ensure that the actions they take are not likely to "jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat" (ESA Section 7(a)2). If a Federal action may adversely affect an ESA-listed species or its designated critical habitat, the action agency must enter a process of formal consultation with either FWS or NMFS, depending on the species in question. Based on the impacts analysis above, Alternative C would not adversely affect California brown pelicans. Regardless, if Alternative C is chosen for implementation, FWS would enter into intra-agency consultation with to ensure compliance with Sections 7 and 9 of the ESA. If California brown pelicans are de-listed before the proposed action is implemented, this consultation may not be necessary but all remaining regulations pertaining to the pelican, including the Migratory Bird Treaty Act, would be followed.

4.4.4.2. Impacts on pinnipeds (other than Steller sea lions) under Alternative C

During the course of the operations in Alternative C, the following pinnipeds (other than Steller sea lions) are likely to be present in the waters surrounding the South Farallones and hauled out on the coast:

- California sea lion
- Northern elephant seal
- Harbor seal
- Northern fur seal

Brodifacoum exposure risk under Alternative C – All of the pinnipeds analyzed here use terrestrial habitat year-round, although they forage exclusively in the marine environment. These pinnipeds are likely to be present in the waters surrounding the South Farallones, and may be hauled out on beaches or rocky shoreline at any given time during the activities described in Alternative C. Pinnipeds would be unlikely to be exposed to bait that is loaded into bait stations. However, they would likely be exposed to small amounts of bait during and after aerial bait broadcast on areas that are not included in the bait station grid. In fact, because many of the islands' steep cliffs are at or near the coastline, requiring aerial broadcast treatment, pinniped exposure to bait under Alternative C would likely be similar to Alternative B. Pinnipeds in the water may encounter bait pellets that have drifted from the island into the ocean during bait application operations, at a much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Pinnipeds that are hauled out may encounter bait pellets along the coastline. The pinnipeds analyzed here are exclusively carnivorous (almost exclusively piscivorous) and do not feed while on land, so the only possible routes for bait ingestion are accidental. Pups that are present may experimentally ingest individual pellets, but the low pellet density on land (less than one pellet per yd^2) would make ingestion of multiple pellets unlikely. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to pinnipeds is likely high. However, the likelihood of the pinnipeds analyzed here experiencing either primary or secondary exposure to brodifacoum is negligible. Furthermore, due to their large body sizes even at the smallest end of the large range described earlier in this section, pinnipeds would need to consume a large dose of brodifacoum in order to be at risk of adverse effects from the toxin. Therefore, the overall risk of pinniped mortality or any sub-lethal effects as a result of brodifacoum use is negligible. This risk profile is essentially the same as under Alternative B (the proposed action).

Risks from disturbance under Alternative C – Personnel activities during bait station installation and maintenance would likely lead to low levels of pinniped disturbance in coastal areas that are included in the bait station grid. Areas near persistent pinniped haulouts may be excluded from the bait station grid to minimize disturbance in those areas. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit near coastal habitat could result in disturbance. During aerial bait application of inaccessible areas, the helicopter would fly over coastal habitat approximately twice for each bait application session. With two bait application sessions, some potential pinniped habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. Animals on shore would likely be exposed to higher-decibel noise than animals in the water.

The response of pinnipeds to visual and/or auditory disturbances varies from no discernable reaction to completely vacating haul-outs (Calkins 1979; Efroymson and Suter 2001). Approaching aircraft and the sudden appearance of humans generally flush animals into the water. Entering the water is part of these animals' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on the overall energy balance or fitness of individual animals (Richardson et al. 1995). During breeding season, a disturbance event that led to all or most of the animals on a haulout or rookery entering the water would leave pups vulnerable to crushing from larger animals. Because of the need to visit bait stations year-round, low levels of disturbance to pinnipeds from personnel presence during breeding season may occur. The bait station grid can be designed to avoid personnel presence near known rookery sites on the islands, minimizing the potential for harming young pups. All aerial bait broadcast activities would occur outside of the breeding season for California sea lions, harbor seals, and northern fur seals, and any pups of these species that are present would likely be mobile enough to avoid trampling. The helicopter application would be timed to be complete before northern elephant seal breeding season has begun in mid- to late December. Overall, the level of disturbance to pinnipeds from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Alternative C would not be likely to lead to any effects in the habitat, prey base, or other ecological interactions of any of the pinnipeds analyzed here that would in turn affect them over the short or long term.

Significance of effects to pinnipeds under Alternative C – Implementation of mouse eradication activities as described in Alternative C would not be likely to lead to the potential mortality of any pinnipeds. Therefore, based on the criteria described in Section 4.3.1.9, the effects of Alternative C would not be significant to pinnipeds that use the South Farallones.

Special considerations under MMPA under Alternative C – With the exception of subsistence harvests, the MMPA regulations generally prohibit the killing, injury or disturbance of marine mammals. However, permits can be granted allowing exceptions to this prohibition for actions that may impact a marine mammal if the impact is incidental to rather than the intention of the action. Carrying out an action that is likely to lead to the disturbance of hauled out marine mammals to the point that they enter the water is often considered "harassment" under the MMPA. Based on the analysis above, some marine mammals would likely be subject to harassment as a result of the activities in Alternative C. In any event, the Service would coordinate with NMFS to apply for an Incidental Harassment Authorization if Alternative C is chosen for implementation.

4.4.4.3. Impacts on birds under Alternative C

Unlike pinnipeds, whose patterns of occurrence and community makeup at the South Farallones are relatively predictable, and non-volant terrestrial species, the seasonal makeup of the South Farallones bird community can be difficult to predict from year to year. The community of breeding seabirds can be predicted reliably, but the presence and distribution of non-breeding bird species varies widely.

Potential impacts to birds will be analyzed according to the types of impacts that would be likely for various bird taxa, but the precise species makeup of many of these taxa will not be examined in detail. Appendices ##-## outline bird occurrence patterns on the South Farallones according to the taxonomic groups analyzed here.

One major difference between Alternative C and Alternative B (the proposed action) is that the project activities in Alternative C would take place over a much longer duration. While Alternative B would only take place during winter months when the bird community at the South Farallones is much smaller than in other seasons, Alternative C would require activities over a period of up to two years, which could have effects on seabirds during the breeding season as well as a much larger diversity of migratory birds that visit the islands during the fall and spring seasons.

4.4.4.3.1. Marine birds present in nearshore waters only

The productive waters surrounding the Farallones provide foraging grounds for a number of waterbird species, including seabirds and other marine waterbirds such as grebes, scoters, and phalaropes, that do not come ashore. Due to the longer time period necessary for the implementation of Alternative C, which would span multiple seasons, a larger diversity of marine bird species would be exposed to operational impacts than in Alternative B (the proposed action).

Brodifacoum exposure risk under Alternative C – Marine birds foraging in the nearshore waters would not be exposed to brodifacoum from bait station use. However, they may encounter bait pellets that have drifted from the island into the ocean during bait application operations for areas not included in the bait station grid. Bait pellet concentrations would be much lower concentration than on land. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Most marine birds feed exclusively on marine organisms, so the only possible routes for bait ingestion are accidental. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to marine birds is likely high. However, the likelihood of most marine birds experiencing either primary or secondary exposure to brodifacoum is negligible. Therefore, the overall risk of mortality or any sub-lethal effects in most of the marine birds present in nearshore waters around the South

Farallones as a result of brodifacoum use is negligible. This risk profile is essentially the same as under Alternative B (the proposed action).

Risks from disturbance under Alternative C – Bait station installation and maintenance would not affect marine birds present only in nearshore waters. During aerial bait application of inaccessible areas, the helicopter would ony fly over land, although occasional passes over water would be necessary. These short-duration disturbance events would occur over the course of approximately three weeks. Boat travel around the islands would also expose some marine birds to additional low levels of disturbance. The response of marine birds to visual and/or auditory disturbances varies, but the most common response for birds that are resting on the water is to flush and fly to a new location. This is part of marine birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals. Overall, the level of disturbance to most of the marine birds present in nearshore waters from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Alternative C would not be likely to lead to negative effects in the habitat, prey base, or other ecological interactions of the marine birds present in nearshore waters that would in turn affect them in the short or long term.

Significance of effects to marine birds present in nearshore waters under Alternative C – Implementation of mouse eradication activities as described in Alternative C would not be likely to lead to noticeable changes in the populations of any marine birds foraging in the nearshore waters of the South Farallones which could be considered significant according to the criteria described in Section 4.3.1.7.

4.4.4.3.2. Seabirds present on land

Due to the longer time period necessary for the implementation of Alternative C, which would span multiple seasons, a larger diversity of seabird species would be exposed to operational impacts than in Alternative B (the proposed action). In particular, during peak breeding season there may be over 250,000 seabirds present on the South Farallones, in nearly every habitat type on the islands from marine plateaus to cliffs. Many of these birds leave the islands after breeding has completed, but others visit their nesting sites year-round or roost elsewhere on the islands. Due to their similar feeding habits and habitat usage, these species are analyzed as a group – marine birds present on land – here.

There are a number of *Larus* gull species that are present on land, but due to their unique feeding habits they are analyzed separately in Section 4.4.4.3.3. Pelicans are common on land at the South Farallones as well, but due to their ESA-listed status they are analyzed separately in Section 4.4.4.1.2.

Brodifacoum exposure risk under Alternative C – Marine birds on land, including breeding seabirds, would not have access to bait loaded into bait stations, but they may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Birds would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Marine birds foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during bait application operations for areas not included in the bait station grid. Pellets that enter the ocean would disintegrate and become unavailable within a few hours. Marine birds that are roosting on the island are also likely to encounter bait pellets after bait application. Most marine birds feed exclusively on marine organisms and do not feed while on land, so the only possible routes for bait ingestion are accidental. The likelihood of primary exposure is therefore negligible, and the likelihood of secondary exposure through fish or other prey species is negligible as well (as discussed above in Section 4.3.6.1).

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to marine birds is likely high. However, the likelihood of most marine birds experiencing either primary or secondary exposure to brodifacoum is negligible. Therefore, the overall risk of mortality or any sub-lethal effects in most of the marine birds present on land at the South Farallones as a result of brodifacoum use is negligible. This risk profile is essentially the same as under Alternative B (the proposed action).

Risks from disturbance under Alternative C – Many of the breeding seabirds are particularly sensitive to disturbance during breeding activities, and a single disturbance event can lead to breeding failure in individual birds or even entire colonies. The installation and maintenance of a bait station grid across much of the island would lead to widespread disturbance of hundreds of seabirds during breeding season. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit near breeding birds could result in disturbance.

During aerial bait application of inaccessible areas, the helicopter would fly over potential marine bird roosting habitat approximately twice for each bait application session. With two bait application sessions, some bird habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of marine birds to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, when aerial bait application would occur, leaving the roost is part of marine birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals.

Overall, the operations described in Alternative C would lead to major disturbances to many breeding seabirds on the South Farallones. Some colonies could experience near-complete breeding failure while the bait station grid is in use. Areas that contain an especially high density of breeding seabirds could be excluded from the bait station grid and treated with aerial bait broadcast during the non-breeding season instead, but even with this minimization measure breeding seabirds would experience up to two breeding seasons with major disturbances on the islands. In comparison to Alternative B (the proposed action), Alternative C would result in substantially more disturbance. While this alternative would minimize the disturbance resulting from helicopter overflights of sensitive habitat on the South Farallones, the potentially catastrophic disturbances likely in breeding seabirds would likely make the costs of this alternative much greater than the benefits.

Indirect effects under Alternative C – Alternative C would not be likely to lead to negative effects in the habitat, prey base, or other ecological interactions of most of the marine birds present on land that would indirectly affect them. When examined without consideration of the direct negative impacts from disturbance discussed above, the removal of mice from the South Farallones ecosystem would be expected to have a positive impact on these seabirds, especially ashy storm-petrels and other small burrow- and crevice-nesting seabirds.

Significance of effects to marine birds on land under Alternative C – Due to the major disturbance events as a result of mouse eradication activities as described in Alternative C, seabird populations at the South Farallones would likely be noticeably affected, particularly in the form of reduced breeding success, for up to two breeding seasons. Species affected would include Leach's storm petrel (*Oceanodroma leucorhoa*), ashy storm-petrel, Brandt's cormorant, double-crested cormorant (*Phalacrocorax auritus*), pelagic cormorant (*Phalacrocorax pelagicus*), common murre (*Uria aalge*), pigeon guillemot (*Cepphus columba*), Cassin's auklet, rhinoceros auklet, and tufted puffin. The Service would consider this negative impact to be significant based on the criteria described in Section 4.3.1.7, and if Alternative C is chosen – presumably in order to minimize disturbance from helicopter operations – NEPA regulations would require the preparation of an EIS to examine the negative impacts of this action, particularly on breeding seabirds, in greater detail.

4.4.4.3.3. Gulls

Gulls in the genus *Larus* are omnivorous generalists in diet, foraging at sea as well as scavenging on land. These feeding habits set them apart from most of the other seabirds that occur on the South Farallones and also increase their risk of exposure to brodifacoum.

Brodifacoum exposure risk under Alternative C – Bait stations would reduce the probability that gulls would be able to access bait, but gulls are known for their relative ingenuity and persistence and it is possible that some gulls would be able to pry open the stations. Additionally, gulls roosting on the islands may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Gulls would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Additionally, gulls foraging in the nearshore waters may encounter bait pellets that have drifted from the island into the ocean during bait application operations for areas not included in the bait station grid. Pellets that enter the ocean would disintegrate and become unavailable within a few hours.

Gulls may consume bait pellets both at sea and on land. Through predation and/or scavenging, gulls may also consume animals that have been exposed to brodifacoum, especially mice. Gulls would be at risk for both primary and secondary exposure to brodifacoum as long as bait is available in the environment, for up to two years in the case of bait stations. Gulls' risk of brodifacoum exposure would be particularly high for a period of about six weeks after bait stations are first installed due to the abundance of mice that have been exposed. After the mouse population drops, exposure risk in gulls would drop to low, but it would become high when bait is aerially broadcast on areas that are not included in the bait station grid. Within 30 days of the final aerial bait application (up to 50 days after the start of broadcast application), their risk level would drop to low, and would remain low until bait stations are removed, up to two years after their initial installation.

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to gulls is high. Furthermore, the likelihood of gulls experiencing both primary and secondary exposure to brodifacoum would be vary from low to high over a period of up to two years. Overall, for up to two years there would be at least a low risk, and a high risk during two separate time periods, of mortality or sub-lethal effects in individual gulls on and around the South Farallones as a result of brodifacoum use.

Risks from disturbance under Alternative C – While there are numerous gull species present on the South Farallones, only Western gulls breed on the islands. The Farallones Western gull colony is the largest in the world. Gulls are particularly sensitive to disturbance during breeding activities, and a single disturbance event can lead to breeding failure in individual birds or even large groups of birds. The installation and maintenance of a bait station grid across much of the island would lead to widespread disturbance of hundreds of Western gulls during breeding season. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit near gulls could result in disturbance, and these disturbances would be increased in intensity during breeding season.

During aerial bait application of inaccessible areas, which would occur outside of the Western gull breeding season, the helicopter would fly over potential gull roosting habitat approximately twice for each bait application session. With two bait application sessions, some gull habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of gulls to visual and/or auditory disturbances varies, but the most common response is for them to flush from a roost. Outside of the breeding season, when aerial bait application would occur, leaving the roost is part of gulls' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals.

Overall, the operations described in Alternative C would lead to major disturbances to hundreds of Western gulls on the South Farallones. Areas that contain an especially high density of breeding gulls could be excluded from the bait station grid and treated with aerial bait broadcast during the non-breeding season instead, but even with this minimization measure some gulls would experience up to two breeding seasons with major disturbances on the islands. In comparison to Alternative B (the proposed action), Alternative C would result in substantially more disturbance. While this alternative would minimize the disturbance resulting from helicopter overflights of sensitive habitat on the South Farallones, the potentially catastrophic disturbances likely in breeding seabirds including Western gulls would likely make the costs of this alternative much greater than the benefits.

Indirect effects under Alternative C – The gull species on the South Farallones occasionally prey on mice and mouse eradication would remove this food source. However, gulls are not currently under food stress and would have ample alternative food sources available on and around the South Farallones even if mice are eradicated. When examined without consideration of the direct negative impacts from disturbance discussed above, the removal of mice from the South Farallones ecosystem would be expected to marginally improve Western gull nesting habitat.

Significance of effects to gulls under Alternative C – The use of brodifacoum as described in Alternative C would likely lead to numerous individual mortalities of a variety of gull species on the South Farallones. Gull species that may experience individual mortalities may include Bonaparte's gull (*Larus philadelphia*), Heermann's gull, mew gull, ring-billed gull (*L. delawarensis*), California gull, herring gull, Thayer's gull, Western gull, glaucous-winged gull, glaucous gull (*L. hyperboreus*), and Sabine's gull (*Xema sabini*).

On Anacapa Island in Southern California, which is also home to a large Western gull colony, a rat eradication project with brodifacoum exposure parameters similar in quantity to Alternative C but over a shorter time period, there were no changes detected in the population size of the gull colony during the subsequent breeding seasons after the operations were complete that could be attributed to the introduction of brodifacoum. The Anacapa project provides the best evidence available for the probable response of the Western gulls on the South Farallones after mouse eradication, which indicates that significant (population-level) effects on Western gulls are unlikely, according to the criteria described in Section 4.3.1.7.

The abundances of other gull species on the South Farallones during the risk window in Alternative C – much longer than in Alternative B – also vary widely. None of these gull species, all of which would be at risk of mortality, are numerous enough on the South Farallones to lead to noticeable population changes in their respective source populations that could be considered significant according to the criteria described in Section 4.3.1.7. The non-breeding gull community on the South Farallones would return to normal patterns of diversity by the next winter with the arrival of other individuals.

However, due to the major disturbance events as a result of mouse eradication activities as described in Alternative C, the Western gull population at the South Farallones would likely be noticeably affected, particularly in the form of reduced breeding success, for up to two breeding seasons. The Service would consider this negative impact to be significant, and if Alternative C is chosen – presumably in order to minimize disturbance from helicopter operations – NEPA regulations would require the preparation of an EIS to examine the negative impacts of this action, particularly on breeding seabirds such as Western gulls, in greater detail.

4.4.4.3.4. Shorebirds and waterfowl

Due to the longer time period necessary for the implementation of Alternative C, which would span multiple seasons, a larger diversity of migrating shorebird and waterfowl species would be exposed to operational impacts than in Alternative B (the proposed action).

Brodifacoum exposure risk under Alternative C – In general, shorebirds and waterfowl would not have access to bait loaded into bait stations, but they may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Birds that are foraging on land would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Birds foraging in the intertidal zone may encounter bait pellets after aerial bait application, likely at a lower concentration than on land. Pellets that enter the water would disintegrate and become unavailable within a few hours. Through predation and/or scavenging, some shorebirds and waterfowl may also consume animals that have been exposed to brodifacoum, including mice.

Waterfowl that forage in both terrestrial and intertidal habitats and primarily eat plant matter would be at some risk for primary exposure to brodifacoum as long as bait is available in the environment, for up to two years. Their exposure risk would be low but not negligible as long as bait stations are present and armed with bait. Exposure risk in herbivorous birds would become high when bait is aerially broadcast on areas that are not included in the bait station grid. Within 30 days of the final aerial bait application (up to 50 days after the start of broadcast application), their risk level would drop again to low, and would remain low until bait stations are removed, up to two years after their initial installation.

Shorebirds and waterfowl that forage in both terrestrial and intertidal habitats and have a broad, omnivorous diet would be at high risk for both primary and secondary exposure to brodifacoum as long as bait is available in the environment, for up to two years. Shorebirds and waterfowl that prey or scavenge on mice would be at particularly high risk of brodifacoum exposure for an initial period of about six weeks after bait stations are first installed due to the abundance of mice that have been exposed. After the mouse population drops, exposure risk in these birds would drop to low, but it would again become high when bait is aerially broadcast on areas that are not included in the bait station grid. Within 30 days of the final aerial bait application (up to 50 days after the start of broadcast application), their risk level would drop to low, and would remain low until bait stations are removed, up to two years after their initial installation.

Birds that forage primarily in the intertidal zone and specialize in intertidal invertebrates would not be at risk of brodifacoum exposure until aerial bait broadcast begins. During and immediately after aerial bait application, intertidal foragers would be at low risk of secondary exposure, but it could not be ruled out. The likelihood of exposure in intertidal specialists would be negligible within 30 days of the final bait application (up to 50 days after the start of broadcast application).

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to shorebirds and waterfowl is high. The likelihood these birds experiencing both primary and secondary exposure to brodifacoum would vary from low to high over a period of up to two years. Overall, therefore:

- There would be at least a low risk, and a high risk during two separate time periods, of mortality or sub-lethal effects from brodifacoum in the waterfowl that are herbivorous or omnivorous and forage on land.
- The risk of mortality or sub-lethal effects from brodifacoum in shorebirds that forage exclusively in the intertidal zone would be low but not negligible during and immediately

after aerial bait application to areas not covered by the bait station grid, and would become negligible within 30 days of the final aerial application (up to 50 days after the start of broadcast application).

Risks from disturbance under Alternative C – The installation and maintenance of a bait station grid across much of the island would lead to generally minor disturbances to shorebirds and waterfowl on the South Farallones. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit would have the potential to result in disturbance. For most shorebirds and waterfowl on the island, bait station maintenance would not lead to disturbance that would affect the fitness of any individual animals. The exception to this is for black oystercatchers during their summer breeding season, during which time disturbance to oystercatchers could lead to breeding failure in individual birds or even entire colonies. Areas that contain an especially high density of breeding oystercatchers could be excluded from the bait station grid and treated with aerial bait broadcast during the non-breeding season instead, but even with this minimization measure some oystercatchers would likely experience up to two breeding seasons with major disturbances on the islands.

During aerial bait application of inaccessible areas, the helicopter would fly over terrestrial habitat approximately twice for each bait application session. With two bait application sessions, some bird habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of shorebirds and waterfowl to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, when aerial bait application would occur, leaving the roost is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals.

Overall, the level of disturbance to most of the shorebirds and waterfowl from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals in most shorebird and waterfowl species. The notable exception to this would be black oystercatchers, which would be at risk of major disturbance during breeding season as a result of bait station maintenance. In comparison to Alternative B (the proposed action), Alternative C would result in substantially more disturbance to black oystercatchers.

Indirect effects under Alternative C – Shorebirds and waterfowl that feed on terrestrial invertebrates share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. However, there is no evidence that mouse eradication would lead to effects in the invertebrate community on the South Farallones that would in turn affect shorebirds or waterfowl. When examined without consideration of the direct negative impacts from disturbance discussed above, the removal of mice from the South Farallones ecosystem would be expected to marginally improve black oystercatcher nesting habitat.

Significance of effects to shorebirds and waterfowl under Alternative C – Implementation of mouse eradication activities as described in Alternative C would likely lead to individual mortalities of some shorebirds and waterfowl on the South Farallones. There are more than 50 species of shorebirds and waterfowl that may arrive on the South Farallones or fly by the islands over the course of the year. Many of these birds would not forage on the islands and the species that do land would not be at risk of experiencing mortality at a level that would cause noticeable changes in their populations that could be considered significant according to the criteria described in Section 4.3.1.7.

However, the major disturbance to black oystercatchers during the breeding season would likely affect that species noticeably, particularly in the form of reduced breeding success for up to two breeding seasons. The Service would consider this negative impact to be significant, and if Alternative C is chosen – presumably in order to minimize disturbance from helicopter operations – NEPA regulations would require the preparation of an EIS to examine the negative impacts of this action, particularly on black oystercatchers, in greater detail.

4.4.4.3.5. Raptors

Due to the longer time period necessary for the implementation of Alternative C, which would span multiple seasons, a larger species diversity of birds of prey would be exposed to operational impacts than in Alternative B (the proposed action).

Brodifacoum exposure risk under Alternative C – Birds of prey would not have access to bait loaded into bait stations, but they may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Birds would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Birds of prey may consume animals that have been exposed to brodifacoum.

Most birds of prey would be at least at low risk for both primary and secondary exposure to brodifacoum as long as bait is available in the environment, for up to two years in the case of bait stations. The risk of brodifacoum exposure would be particularly high for a period of about six weeks after bait stations are first installed due to the abundance of mice that have been exposed. After the mouse population drops, exposure risk in most birds of prey would drop to low, but it would again become high when bait is aerially broadcast on areas that are not included in the bait station grid. Within 30 days of the final aerial bait application (up to 50 days after the start of broadcast application), the risk level would again drop to low, and would remain low until bait stations are removed, up to two years after their initial installation.

The risk level for birds of prey that primarily or exclusively feed on other birds would be low but not negligible for as long as bait is available in the environment, for up to two years.

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to birds of prey is high. The likelihood most of the bird-of-prey species experiencing secondary exposure to brodifacoum would vary from low to high over a period of up to two years. The likelihood of secondary exposure in peregrine falcons, which are specialist bird predators, would be low but not negligible for up to two years. Overall, therefore:

- There would be at least a low risk, and a high risk during two separate time periods, of mortality or sub-lethal effects from brodifacoum in birds of prey that eat mice.
- The risk of mortality or sub-lethal effects from brodifacoum in birds of prey that feed primarily or exclusively on other birds would be low but not negligible for up to two years.

Risks from disturbance under Alternative C – The installation and maintenance of a bait station grid across much of the island would lead to generally minor disturbances to birds of prey on the South Farallones. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit would have the potential to result in disturbance. Bait station maintenance would not lead to disturbance that would affect the fitness of any individual animals.

During aerial bait application of inaccessible areas, the helicopter would fly over terrestrial habitat approximately twice for each bait application session. With two bait application sessions, some bird habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of birds of prey to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, when aerial bait application would occur, leaving the roost is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals.

Overall, the level of disturbance to most of the birds of prey from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Burrowing owls on the South Farallones, and likely other birds of prey as well, rely on mice as an important food source during the fall and early winter seasons. Mouse eradication would substantially reduce the quality of habitat for burrowing owls on the islands, and would likely reduce habitat quality to a lesser degree for other birds of prey as well. There are no permanently resident burrowing owls on the South Farallones; all owls appear to arrive during the fall migration season. The best available evidence indicates that if mice are eradicated, burrowing owls would simply return to the mainland because the islands would not provide adequate foraging habitat, rather than attempting to over-winter on the islands as small numbers of them currently do. Therefore, mouse removal is not expected to have any negative impacts on the mainland burrowing owl populations to which these current island arrivals belong. Larger birds of prey likely feed on a wider variety of animals on the islands including seabirds, and the removal of mice would not likely have noticeable effects on these species. Similarly, there is no reason to believe that mouse eradication would lead to negative effects in the habitat, prey base, or other ecological interactions of birds of prey that feed primarily on other birds that would in turn affect them in the short or long term.

Significance of effects to birds of prey under Alternative C –
Implementation of mouse eradication activities as described in Alternative C would likely lead to individual mortalities of birds of prey on the South Farallones. Species that may experience individual mortalities may include osprey, Northern harrier, sharp-shinned hawk, red-tailed hawk, rough-legged hawk, American kestrel, merlin, peregrine falcon, barn owl, burrowing owl, long-eared owl, short-eared owl, Northern saw-whet owl, and lesser nighthawk. However, mortality in most of these birds except burrowing owls and peregrine falcons would be unlikely. Overall, the small number of individual mortalities possible would not be likely to lead to noticeable changes in the breeding populations of birds of prey on the South Farallones that could be considered significant according to the criteria described in Section 4.3.1.7. Most birds of prey would quickly return to normal patterns of abundance within months with the arrival of other individuals from the mainland. After mouse eradication, the Service anticipates that burrowing owls would no longer overwinter on on the South Farallones, but the mainland source populations of burrowing owls would not be affected overall.

4.4.4.3.6. Passerines – invertebrate specialists

This section analyzes potential risks to passerine birds on the South Farallones that feed only on invertebrates, and therefore are only at risk of secondary exposure to brodifacoum.

Brodifacoum exposure risk under Alternative C – In general, passerines would not have access to bait loaded into bait stations, but they may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Birds that are foraging on land would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Invertebrate specialists may consume prey animals that have been exposed to brodifacoum. These birds would be at high risk for secondary exposure to brodifacoum as long as bait is available in the environment, for up to two years, because at least some invertebrates on the island would continue to consume bait pellets from bait stations.

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to passerine birds is high. The likelihood of invertebrate-specialist passerines experiencing secondary exposure to brodifacoum would be high for up two years after bait stations are installed.

Risks from disturbance under Alternative C – The installation and maintenance of a bait station grid across much of the island would lead to generally minor disturbances to passerine birds on the South Farallones. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit would have the potential to result in disturbance. Bait station maintenance would not lead to disturbance that would affect the fitness of any individual animals.

During aerial bait application of inaccessible areas, the helicopter would fly over terrestrial habitat approximately twice for each bait application session. With two bait application sessions, some bird habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of passerine birds to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, when aerial bait application would occur, leaving the roost is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals.

Overall, the level of disturbance to invertebrate-specialist passerines from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Passerines that feed on invertebrates share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. However, there is no evidence that mouse eradication would lead to effects in the invertebrate community on the South Farallones that would in turn affect passerines. Overall, mouse removal would not indirectly affect passerines on the South Farallones.

Significance of effects to invertebrate-specialist passerines under Alternative C – Implementation of mouse eradication activities as described in Alternative C would likely lead to individual mortalities of passerine birds on the South Farallones. There are nearly 50 invertebrate-specialist species that may may arrive on the South Farallones or fly by the islands over the course of the year. Many of these birds would not forage on the islands and the species that do land would not be at risk of experiencing mortality at a level that would cause noticeable changes in their populations that could be considered significant according to the criteria described in Section 4.3.1.7. The invertebrate-specialist passerine bird community on the South Farallones would return to normal patterns of diversity soon after bait stations are removed, with the arrival of other migrating individuals from the mainland.

4.4.4.3.7. Passerines – omnivores and herbivores

This section analyzes potential risks to passerine birds on the South Farallones that are either herbivorous (specializing in seeds and/or fruits) or omnivorous, and therefore may be at risk of both primary and secondary exposure to brodifacoum.

Brodifacoum exposure risk under Alternative C – In general, passerines would not have access to bait loaded into bait stations, but they may encounter small amounts of bait that has been removed from bait stations by mice or other animals throughout the course of operations. Birds that are foraging on land would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Birds that primarily eat plant matter would be at high risk for primary exposure for as long as brodifaccoum is present in the environment, up to two years. Birds that have a broad, omnivorous diet would be at high risk for both primary and secondary exposure for up to two years.

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to passerine birds is high. The likelihood of omnivorous or herbivorous passerines experiencing primary or secondary exposure to brodifacoum would be high for up two years after bait stations are installed.

Risks from disturbance under Alternative C – The installation and maintenance of a bait station grid across much of the island would lead to generally minor disturbances to passerine birds on the South Farallones. Once installed, bait stations would need to be visited as often as once daily for a period of two to three weeks, and then with decreasing frequency for up to two years. Each bait station visit would have the potential to result in disturbance. Bait station maintenance would not lead to disturbance that would affect the fitness of any individual animals.

During aerial bait application of inaccessible areas, the helicopter would fly over terrestrial habitat approximately twice for each bait application session. With two bait application sessions, some bird habitat would be exposed to peak helicopter noise approximately four times over the course of approximately three weeks. Each overflight would likely be of short duration. The response of passerine birds to visual and/or auditory disturbances varies, but the most common response is for birds to flush from a roost. Outside of the breeding season, when aerial bait application would occur, leaving the roost is part of these birds' normal behavior, and disturbance events that are short in duration and infrequent likely have little effect on individual animals.

Overall, the level of disturbance to omnivorous or herbivorous passerines from the operations described in Alternative C would be lower in intensity than in Alternative B, but would occur over a much longer period of time. Similar to Alternative B, the disturbance profile for Alternative C is not anticipated to have any effect on overall energy balance or fitness of any individual animals.

Indirect effects under Alternative C – Passerines that feed on invertebrates as part of their diet share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. However, there is no evidence that mouse eradication would lead to effects in the invertebrate community on the South Farallones that would in turn affect passerines. Overall, mouse removal would not indirectly affect passerines on the South Farallones.

Significance of effects to omnivorous or herbivorous passerines under Alternative C – Implementation of mouse eradication activities as described in Alternative C would likely lead to individual mortalities of passerine birds on the South Farallones. There are dozens of passerine species that may may arrive on the South Farallones or fly by the islands over the course of the year. Many of these birds would not forage on the islands and the species that do land would not be at risk of experiencing mortality at a level that would cause noticeable changes in their populations that could be considered significant according to the criteria described in Section 4.3.1.7. The omnivorous and herbivorous passerine bird community on the South Farallones would return to normal patterns of diversity soon after bait stations are removed, with the arrival of other migrating individuals from the mainland.

4.4.4.4. Other biological resources

4.4.4.4.1. Salamanders

Brodifacoum exposure risk under Alternative C – Salamanders may be able to access to bait loaded into bait stations throughout the course of operations, but they are carnivorous and would be unlikely to consume bait. Salamanders would also likely encounter bait pellets during and after aerial bait broadcast on areas that are not included in the bait station grid. Salamanders specialize at preying on invertebrates, and they may consume prey animals that have been exposed to brodifacoum. Salamanders would be at high risk for secondary exposure to brodifacoum as long as bait is available in the environment, for up to two years, because at least some invertebrates on the island would continue to consume bait pellets from bait stations.

Overall risks from brodifacoum use under Alternative C – The toxicity of brodifacoum to salamanders is unknown. The likelihood of salamanders experiencing secondary exposure to brodifacoum would be high for up to two years. Based on evidence from rodent eradications elsewhere in the world, brodifacoum use would not be likely to lead to negative population-level effects in salamanders. The risk of individual mortalities in salamanders is unknown.

Risks from disturbance under Alternative C – The installation of the bait station grid would likely lead to disturbance of salamander habitat, but ample alternative habitat would be available. Personnel activities would also expose some salamanders to low levels of disturbance, but no more than current monitoring activities on the islands. Overall, the level of disturbance to salamanders from the operations described in Alternative C is not anticipated to have an effect on the fitness of any individual animals.

Indirect effects under Alternative C – Salamanders, which feed exclusively on invertebrates, share this prey resource with mice, and if mice are eradicated, the invertebrate community would likely respond positively. While this may in turn positively affect the salamander population, as has occurred after mouse eradication from other islands in the world, there is currently no evidence to indicate this possibility on the South Farallones.

Significance of effects to salamanders under Alternative C – Based on evidence from elsewhere in the world, mouse eradication implementation of mouse eradication activities as described in Alternative C would not be likely to lead to noticeable changes in the population of salamanders on the South Farallones which could be considered significant according to the criteria described in Section 4.3.1.7.

4.4.4.4.2. Terrestrial Vegetation

Alternative C would result in moderate direct vegetation impacts from the installation of a bait station grid across up to 75 percent of the South Farallones' land area. The vegetation community would likely recover once the bait station grid is removed. However, project crews traveling across the islands could hasten the spread of non-native plant species to new areas on the island.

On the other hand, mouse eradication could result in positive impacts to the native vegetation of the South Farallones by removing mice as a seasonally major consumer of vegetation, especially maritime goldfields. However, there is currently no evidence to support this possibility on the South Farallones. Overall, Alternative C would not be likely to lead to long-term noticeable changes in the vegetation community which could be considered significant according to the criteria described in Section 4.3.1.7.

4.4.4.5. Irreversible and irretrievable impacts to biological resources under Alternative C

Seabirds often recover very slowly from negative impacts to their populations. However, the significant impacts likely under Alternative C to breeding seabirds on the South Farallones would not be likely to lead impacts that would be irreversible. After the bait station grid is removed, seabird populations that were significantly affected would be likely to recover in the long term.

4.5. CONSEQUENCES: SOCIAL AND ECONOMIC ENVIRONMENT

4.5.1. Alternative A: No Action

It is unlikely that the impacts that mice would continue to have on the South Farallones ecosystem would be perceptible to boaters near the islands. While the ashy storm-petrel population would likely continue to be threatened, these birds are cryptic and relatively rarely seen. Overall, taking no action with regard to non-native mice would be unlikely to have any direct or indirect impacts on the value of the South Farallones to Refuge visitors.

4.5.2. Alternative B (Proposed Action): Mouse Eradication with Aerial Bait Broadcast as Primary Technique

The area immediately surrounding the South Farallones would be closed to access by boaters during aerial bait application operations, which would be a minor short-term inconvenience to Refuge visitors. The expected recovery of the South Farallones ecosystem after mouse eradication would likely not be perceptible to boaters near the islands. However, interpretive materials on the islands' ecosystem recovery would be available in San Francisco Bay National Wildlife Refuge Complex visitor's center.

4.5.3. Alternative C: Mouse Eradication with Bait Station Delivery as Primary Technique

The area immediately surrounding the South Farallones would be closed to access by boaters during aerial bait application operations, which would be a minor short-term inconvenience to Refuge visitors. Additionally, the bait station grid would alter the appearance of the islands for up to two years. The negative impacts to seabird populations on the islands as a result of disturbance in Alternative C would likely not be perceptible to boaters near the islands. The subsequent expected recovery of aspects of the South Farallones ecosystem after mouse eradication would similarly likely not be perceptible to boaters near the islands. However, interpretive materials on the islands' ecosystem recovery would be available in San Francisco Bay National Wildlife Refuge Complex visitor's center.

4.6. CONSQUENCES: HUMAN ACTIVITIES AND VALUES: FISHING RESOURCES

4.6.1. Alternative A: No Action

Mice on the South Farallones do not currently affect the fisheries of the nearshore waters, nor would the Service expect any future impacts.

4.6.2. Alternative B (Proposed Action): Mouse Eradication with Aerial Bait Broadcast As Primary Technique

The area immediately surrounding the South Farallones would be closed to access by boats during aerial bait application operations, which would be a minor short-term inconvenience to fishing vessels. There would be no further impacts to fishing resources.

4.6.3. Alternative C: Mouse Eradication with Bait Station Delivery as Primary Technique

The area immediately surrounding the South Farallones would be closed to access by boats during aerial bait application operations, which would be a minor short-term inconvenience to fishing vessels. There would be no further impacts to fishing resources.

4.7. CONSEQUENCES: HISTORICAL AND CULTURAL RESOURCES

4.7.1. Alternative A: No Action

The Service has no evidence that mouse activities affect historical and cultural resources on the island. Mice are burrowing animals, a behavior that has the potential to damage buried artifacts, but there are numerous seabird species that burrow on the island as well, which makes the preservation of buried artifacts on the South Farallones difficult, whether or not mice are present. Mice may continue to cause damage to the historical buildings on Southeast Farallon, but this damage would likely be minor and would not likely be irreversible.

4.7.2. Alternative B (Proposed Action): Mouse Eradication with Aerial Bait Broadcast as Primary Technique

Alternative B would not affect the historical or cultural resources on the South Farallones.

4.7.3. Alternative C: Mouse Eradication with Bait Station Delivery as Primary Technique

The bait station grid required under Alternative C could have minor impacts on historical or cultural resources that are buried on the islands. To minimize impacts, the final grid placement would be determined in consultation with experts in the Farallones' historical and cultural resources including the State Historical Preservation Officer.

4.8. Consequences: Water Resources

4.8.1. Alternative A: No Action

Mice on the South Farallones do not currently affect the quality or quantity of island drinking water or marine water resources, nor would the Service expect any future impacts.

4.8.2. Alternative B (Proposed Action): Mouse Eradication with Aerial Bait Broadcast as Primary Technique

Some bait pellets are likely to drift into nearshore marine waters during bait application operations. However, the bait application techniques described will include mitigation measures to limit bait entry into water bodies to a level well under the target bait application rate.

Even if bait enters water bodies on or around the South Farallones at the full application rate, it would be very unlikely to contribute to detectable levels of brodifacoum in the water column. The low water solubility and strong chemical affinity of brodifacoum to the grain matrix of the bait pellets largely prevents the rodenticide from entering aquatic environments via run-off. Hypothetically, even if brodifacoum was highly water soluble, and bait was broadcast at the rate of 16 lb/ac (18 kg/ha) into water only 3.3 ft (1 m) deep, the resultant brodifacoum concentration in the water – about 0.04 parts per billion – would still be nearly 1000 times less than the measured LC50 value for trout (0.04 parts per million) (Syngenta 2003).

Environmental testing during rodent eradications and eradication trials in the California Current marine system and elsewhere have failed to detect brodifacoum in any water samples taken after bait application (Howald et al. 2005; Buckelew et al. 2008; Island Conservation, unpubl. data). Furthermore, post-application sampling in the Anacapa Island rat eradication did not detect any brodifacoum residue in any of the intertidal invertebrates tested (Howald et al. 2005).

Water supplies for personnel on the South Farallones can be protected during bait application activities to prevent the entry of pellets into water catchment areas.

In summary, there is a negligible risk that the marine water column or drinking waters supplies would register biologically harmful, or even detectable, levels of brodifacoum as a result of bait application to the island.

4.8.3. Alternative C: Mouse Eradication with Bait Station Delivery as Primary Technique

Bait from bait stations would not be likely to enter water bodies on or around the South Farallones. During aerial bait application of inaccessible areas, the risk profile under Alternative C would be similar to that of Alternative B described in Section 4.8.2 above.

4.9. Consequences: Wilderness Character

4.9.1. Alternative A: No Action

Since humans introduced mice to the South Farallones, they have influenced the islands' natural ecosystem. Their presence and impacts have thus degraded the wilderness character of the Designated Wilderness area of West End Island. Taking no action with regard to non-native mice on the South Farallones would allow this degradation to continue.

4.9.2. Alternative B (Proposed Action): Mouse Eradication with Aerial Bait Broadcast as Primary Technique

The aircraft, equipment, tools, personnel and installations required under Alternative B would produce short term negative impacts on the wilderness character of West End. The eradication effort would require manipulation of the existing ecological processes in an effort to restore natural systems that have been disrupted through the introduction of a non-native species. The personnel and equipment necessary for the operation have the potential to decrease a Refuge visitor's opportunity to experience solitude and unconfined recreation. However, the long term benefits of an enduring wilderness with restored ecological systems gained through a successful mouse eradication would be greater than the short term negative impacts the effort may have to the wilderness character of the South Farallones wilderness areas.

4.9.3. Alternative C: Mouse Eradication with Bait Station Delivery as Primary Technique

The installation and maintenance of a bait station grid in designated wilderness under Alternative C would produce short-term negative impacts on the wilderness character of West End. The operation of helicopters would contribute further to this short-term degradation. In addition, the mouse eradication effort would require manipulation of the existing ecological processes in an effort to restore natural systems that have been disrupted through the introduction of a non-native species. These impacts would have the potential to decrease a Refuge visitor's opportunity to experience solitude and unconfined recreation. However, the long term benefits of an enduring wilderness with restored ecological systems gained through a successful mouse eradication would be greater than the short term negative impacts the effort may have to the wilderness character of the South Farallones wilderness areas.

4.10. Consequences: Cumulative Impacts

4.10.1. Cumulative Impacts Under Alternative A (No Action)

The impacts that mice are having on the environment of the South Farallones, particularly on the islands' biological resources, would continue in perpetuity under the no action alternative. These impacts could be additive to other unrelated impacts on these resources in the future. For example, the ongoing indirect impact that mice currently have on ashy storm-petrels at the colony, in combination with a hypothetical major future change in the productivity of the marine waters of the California Current ecosystem on which ashy storm-petrel depend, could ultimately result in the disappearance of the South Farallones ashy storm-petrel colony. However, the likelihood of this kind of future cumulative impact on the South Farallones' biological resources is difficult to predict with certainty.

The continued presence of mice would not be likely to contribute to cumulative impacts on any other (non-biological) resources on the South Farallones.

4.10.2. Cumulative Impacts Under Alternative B (Proposed Action)

There would be no major negative impacts to the environment of the South Farallones under Alternative B. The minor negative impacts to biological resources on the islands as a result of Alternative B would not be likely to contribute additively to any ongoing unrelated impacts. Similarly, the expected positive impacts of Alternative B on the islands' biological resources would not be likely to contribute additively to cumulative impacts.

Alternative B would be limited in scope to the South Farallones, and in duration to the short period of time required for aerial bait application. It would be the first successful island mouse eradication in the United States, which could set a precedent for future actions, but the impacts of these future actions would be, at this point, purely speculative.

4.10.3. Cumulative Impacts Under Alternative C

Alternative C could result in major short-term negative impacts to breeding seabirds on the South Farallones. These impacts could be additive to other unrelated impacts on seabirds in the future. However, the likelihood of future impacts to these seabirds is difficult to predict. On the South Farallones, the islands' status as a National Wildlife Refuge would protect seabirds from further harm, assuming that the current restrictions on island access continued. Since seabirds have large ranges, further negative impacts to these birds elsewhere in their ranges are possible but the intensity of these impacts would be difficult to predict.

Alternative C would be limited in scope to the South Farallones, and in duration to the two years required for the bait station approach to ensure eradication success. It would be the first successful island mouse eradication in the United States, which could set a precedent for future actions, but the impacts of these future actions would be, at this point, purely speculative.

5. Consultation and Coordination

5.1. Introduction

TO BE COMPLETED

5.2. Regulatory Framework of the Alternatives

TO BE COMPLETED

5.2.1. Federal Laws

TO BE COMPLETED

5.2.2. California State Laws

TO BE COMPLETED

5.3. Inter-Agency Scoping and Review

TO BE COMPLETED

5.4. Public Scoping and Review

TO BE COMPLETED

5.5. Recipients of Requests for Comment

5.5.1. Government Recipients

TO BE COMPLETED

5.5.2. Public Recipients

TO BE COMPLETED

5.6. Comments Received

TO BE COMPLETED

5.6.1. Agency Comments

TO BE COMPLETED

5.6.2. Public Comments

TO BE COMPLETED

5.7. PREPARERS

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