House Mouse Eradication from the South Farallon Islands
Draft Environmental Assessment

January 2011

Lead agency:
U.S. Fish and Wildlife Service
San Francisco Bay National Wildlife Refuge Complex

Abstract
The United States Fish and Wildlife Service proposes to protect and restore the ecosystem of the South Farallon Islands, particularly seabirds and other native biological resources, by eradicating non-native house mice and preventing their future reintroduction. In accordance with the National Environmental Policy Act (NEPA) and its associated regulations, the Service has prepared this Environmental Assessment (EA) to determine whether mouse eradication on the South Farallones would have significant impacts on the quality of the human environment. The Service has considered three alternatives to address the problem of non-native mice on the South Farallones:

A. No Action, which would allow mice to remain on the South Farallone Islands maintaining the status quo;
B. Mouse eradication with an aerial brodifacoum broadcast as the primary technique; or
C. Mouse eradication with brodifacoum delivery through the use of bait stations as the primary technique.

The Service is soliciting comments from the interested public on this Draft EA. If no significant impacts to the human environment are identified, and public comments do not warrant major changes in the proposed action, the Service will then issue a Final EA with a Finding of No Significant Impact, and implement the action.

Public Comment Period:
April 4, 2011 through May 16, 2011

Please address comments to:
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Executive Summary

The Farallon Islands, or Farallones, are about 28 miles west of the Golden Gate and the city of San Francisco, California. This group of islands is managed by the U.S. Fish and Wildlife Service as the Farallon National Wildlife Refuge. The Farallones' isolated nature, varied and extensive habitats, and adjacent productive marine environment makes them an ideal breeding and resting location for wildlife, especially seabirds and marine mammals. The Refuge comprises the largest continental U.S. seabird breeding colony south of Alaska, and supports the world's largest breeding colonies of ashy storm-petrel, Brandt's cormorant, and western gull.

The South Farallon Islands, the island cluster within the larger Farallones group that contains the vast majority of the land area, have sustained ecological damage over many years from the presence of non-native house mice. Mice eat invertebrates, seeds and other plant matter, and possibly the eggs of nesting seabirds (mice have even been found to prey on seabird chicks in the nest on other islands). On the South Farallones, mice also artificially sustain burrowing owls that arrive from the mainland and prey heavily on small seabirds.

The purpose of the proposed action is to meet the Service's management goal of protecting and restoring the ecosystem of the Farallones, particularly seabirds and other native biological resources, by eradicating non-native house mice. Eradicating house mice would likely prevent burrowing owls from staying on the islands to prey on seabirds. Mouse eradication would also likely benefit native amphibians, invertebrates, and plants.

In accordance with the National Environmental Policy Act (NEPA) and its associated regulations, the Service has prepared this Environmental Assessment (EA) to determine whether mouse eradication on the South Farallones would have significant impacts on the quality of the human environment. Using the guidelines set by NEPA, the Service has considered three alternatives for addressing the problem of non-native mice on the South Farallones:

A. No Action, which would allow mice to remain on the South Farallone Islands maintaining the status quo;
B. Mouse eradication with an aerial brodifacoum broadcast as the primary technique; or
C. Mouse eradication with brodifacoum delivery through the use of bait stations as the primary technique.

Within this EA, the parameters of each of these alternatives are described and their potential impacts to the environment are considered. The environmental issues discussed include:

- Impacts to physical resources including water resources, geology and soils, and wilderness character;
- Impacts to biological resources including impacts from toxicant use and impacts from disturbance;
- Impacts to the social and economic environment, including Refuge visitors, fishing resources, and historical and cultural resources

The Service is soliciting comments from the interested public on this Draft EA. If no significant impacts to the human environment are identified, and public comments do not warrant major changes in the proposed action, the Service will then issue a Final EA and a Finding of No Significant Impact, and implement the action.

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Figure 2.1: Photograph courtesy of Island Conservation

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1. Purpose and Need

1.1. Introduction

The United States Fish and Wildlife Service (“USFWS” 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 impacts of actions – projects, programs, policies, or plans that are implemented, funded, permitted, or controlled by a federal agency or agencies – they propose to undertake. Specifically, Federal agencies must consider the environmental impacts of a reasonable range of alternatives for implementing an action, and make the public aware of the environmental impacts of each of the alternatives presented. If adverse environmental impacts are identified, NEPA requires an agency to show evidence of its efforts to reduce these adverse impacts through mitigation. An environmental analysis, such as this Environmental Assessment (EA), documents that an agency has considered and addressed these impacts.

This EA will be used by the Service to solicit public involvement and to determine whether the implementation of either of the action alternatives presented within 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 meet the Service’s management goal of protecting and restoring the ecosystem of the Farallones, particularly 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 mice. Prior to the introduction of non-native mammals, the South Farallones provided seabirds with breeding and roosting habitat and was nearly devoid of land-based predatory threats. Introduced European rabbits (*Oryctolagus cuniculus*) and cats (*Felis catus*), which were later removed, and mice, which remain on the South Farallones today, have had noticeable negative impacts on native species. Eradicating mice would improve the breeding conditions and may increase the local population size for at least two seabird species, the ashy storm-petrel (*Oceanodroma homochroa*) and Leach’s storm-petrel (*Oceanodroma leucorhoa*), and may also benefit other

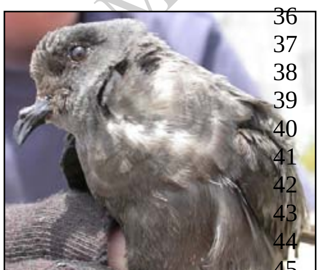


Figure 1.1. Ashy storm-petrel

seabirds, as well as native amphibians, invertebrates, and plants. The ashy storm-petrel is a rare species with a range limited almost entirely to California, with about half of the world's breeding population occurring at the South Farallones. The South Farallones colony declined roughly 40% between 1972-73 and 1992 (Sydeman et al. 1998). The Leach's storm-petrel is a much more widespread and numerous species with a global range; however, in recent years it has also declined in California (Carter et al. 1992). Data indicate the South Farallones colony has actually declined dramatically and may be close to extirpation (PRBO unpubl. data; G.J. McChesney pers. comm.).

1.3. Need for Action

1.3.1. Summary of House Mouse Impacts on the South Farallon Islands

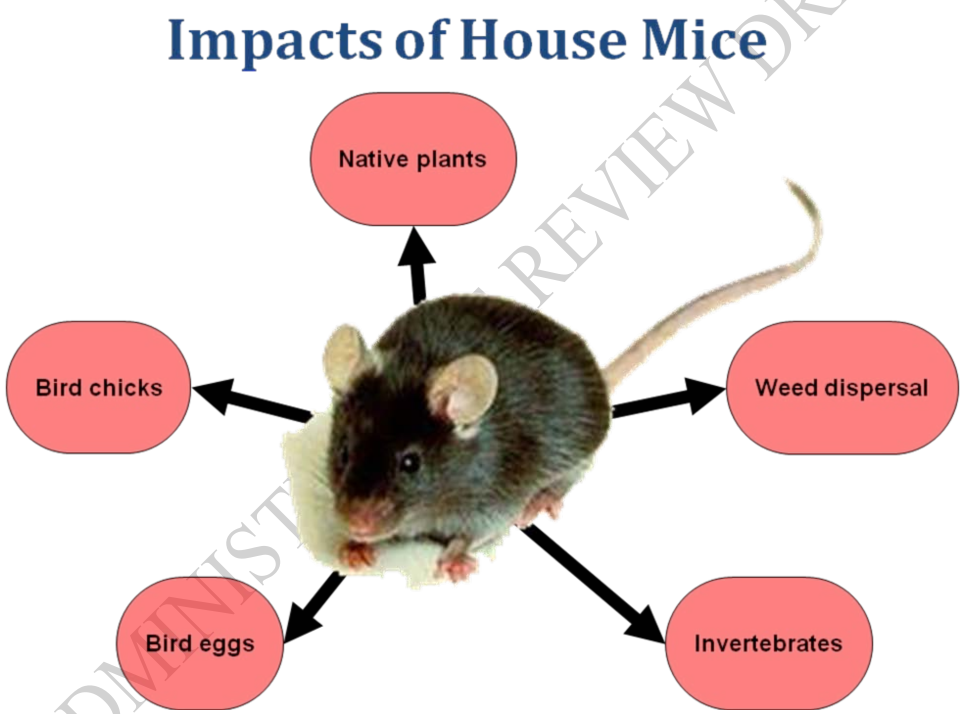
The Farallon National Wildlife Refuge, which originally encompassed the North and Middle Farallon Islands and Noonday Rock, but did not include the South Farallones, was established by President Theodore Roosevelt under Executive Order 1043 in 1909 as a preserve and breeding ground for marine birds. In 1969 the Refuge was expanded to include the South Farallones and is still managed with the same basic purpose today. Introduced non-native mice are directly and indirectly negatively impacting the populations of small burrow- and crevice-nesting seabirds on the South Farallones, particularly storm-petrels. In order to reduce this impact the Service has identified mouse eradication as an important step in fulfilling its main purpose to protect and restore the native ecosystems of the Farallone Islands.

Researchers have discovered that mice are indirectly responsible for extensive ashy storm-petrel predation by burrowing owls (*Athene cunicularia*) that winter on the islands (Mills 2006) (PRBO unpubl. data). The physical and behavioral similarities between ashy storm-petrels and Leach's storm-petrels have led researchers to suspect that Leach's storm-petrels are suffering similar predation. Burrowing owls are not considered island residents, but each year dispersing or migrating burrowing owls land on the South Farallones to rest before returning to the mainland (DeSante and Ainley 1980). The "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). Most landbirds that arrive on the Farallones return to the mainland within a few days (DeSante and Ainley 1980). However, some burrowing owls arriving to the South Farallones stay on the islands and subsist largely on mice during the fall, when the mouse population is at an annual peak. Between December and January, the mouse population begins to plummet (a cyclical counterpart to its fall peak) rendering mice essentially unavailable to burrowing owls as a food source by spring. As a result, the wintering burrowing owls must switch to alternative prey sources. Adult storm-petrels, which arrive on the islands starting in mid-winter to visit breeding sites and engage in courtship activity, are susceptible to depredation by burrowing owls


Figure 1.2. Ashy storm-petrel remains beneath burrowing owl roost.

Comment [g1]: Do we have a reference for this?

searching for alternative prey. Predation by owls is known to account for substantial annual mortality of the ashy storm-petrel population, which has recently undergone a precipitous decline at the South Farallones (Sydeman et al. 1998). In addition, owl predation is thought to threaten Leach's storm-petrels on the Farallones as well. Ultimately, the owls' switch in prey is often insufficient to sustain them through the winter. The majority of owls that are monitored on the island through the winter do not survive, which researchers believe is related at least in part to food scarcity, as well as fatal attacks by territorial western gulls (*Larus occidentalis*) that dominate the islands by spring.



In addition to their indirect contribution to owl predation on storm-petrels, mice also may directly impact storm-petrels through egg predation and disturbance to burrows. The inconspicuous nest sites of these small seabirds makes observation difficult and evidence of mouse predation and disturbance on the South Farallones scarce. However, on other islands similar to the Farallones throughout the world, mice have been documented preying on seabird eggs and chicks (Cuthbert and Hilton 2004, Wanless et al. 2007, Angel et al. 2009). A more detailed discussion of the impacts of mice to storm-petrels may be found in Section 4.4.3.3.1.

Evidence from other islands indicates that mice may have major impacts on invertebrates, plants, and the endemic, an organism that exists nowhere else on Earth, arboreal salamander subspecies (*Aneides lugubris farallonensis*) on the Farallon Islands. Mouse diet analysis on the South Farallones has shown that mice frequently consume native invertebrates and plants, including the ecologically important maritime goldfields (*Lasthenia maritima*), a California native daisy species (Jones and Golightly 2006). Furthermore, invertebrates and plants play a critical structural role on the ecosystems of the South Farallon Islands, and any major direct impacts from mice on these organisms have the potential to severely affect other aspects of the ecosystem and may severely affect the future diversity of these islands.

More detailed discussions of the potential impacts of mice to invertebrates, plants, and salamanders may be found in Sections 4.4.3.2.2-3 and 4.4.3.4.

1.3.2. Past Actions on the South Farallones

To reduce the rate of burrowing owl predation on storm-petrels, the Service has explored the option of 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 habitat improvement. Finally, burrowing owl translocation would not address the other likely impacts of mice on the island ecosystem. While burrowing owl translocation may temporarily reduce predation on storm-petrels in the short term, it cannot alone fulfill the ecosystem-wide restoration objective identified as the purpose of action.

Western gulls, which nest on the South Farallones in large numbers, are also responsible for substantial storm-petrel mortality due to both predation on storm-petrels and attacks on storm-petrels that encroach on gull nesting territories. In the early 1970s on Southeast Farallon Island, western gull breeding distribution was limited mainly to the island's broad marine terrace, which is outside the principal talus slope breeding habitat of storm-petrels (Ainley and Lewis 1974). Since that time, the South Farallones western gull colony has spread to nearly the entire island group, including important storm-petrel breeding areas. The Service has, with limited success, explored options for reducing the number of western gulls nesting in habitat critical to storm-petrels and other small seabirds. These options have included installing wire grids over breeding plots in an attempt to exclude predatory gulls. Additionally, the Service has considered the possibility of targeted lethal control of gulls that have been observed to specialize in preying on small seabirds including storm-petrels. While options for reducing the gull population on the Farallones may be appropriate as short-term actions that might provide mitigation for the high predation rates of storm-petrels by gulls; however, gull control without mouse eradication would not entirely fulfill the ecosystem-wide restoration objective identified as the purpose of action.

In addition, 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 and Leach's storm-petrels. For example, on Southeast Farallon Island a "habitat sculpture" for crevice-nesting seabirds was recently built, and crevices suitable for storm-petrel or auklet nesting were deliberately placed within recently rebuilt rock w(Ainley and Lewis 1974)alls. 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. Further enhancement of storm-petrel nesting habitat, without mouse eradication, would contribute partly towards the seabird restoration component of the South Farallon Islands' restoration needs, but benefits would be limited if the current levels of large scale adult storm-petrel mortality continues. In addition, these taxon-specific habitat enhancements would not fulfill the ecosystem-wide restoration objective identified as the purpose of action.

1.3.3. Benefits of House Mouse Eradication

The best scientific evidence available to the Service indicates that if mice are eradicated from the South Farallones migrant burrowing owls that arrive on the island in the fall would not remain over the winter and would be unlikely to survive if they attempt to stay. Studies conducted on seasonal fluctuations in owl diet have lent support to the hypothesis 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 unsuitability of the Farallones environment for resident burrowing owls.

While ashy storm-petrels are present in at least low numbers year-round, neither ashy nor Leach's storm-petrels are common on the South Farallones until their pre-breeding burrow visits begin around February (Ainley and Lewis 1974, Ainley et al. 1990a). On the other hand, two decades of data show that burrowing owls are much more likely to arrive on the South Farallones in the fall and early winter than in any other season (Richardson et al. 2003). Therefore, it is highly probable that if mice are removed from the South Farallones, then owls that arrive on the islands would behave similar to the thousands of other birds that are accidental to the islands each fall and stay no more than a few days. Thus, storm-petrels would no longer be at risk of predation by owls when they arrive later in the winter.

Mouse eradication may also lead to a noticeable increase in invertebrate populations (Newman 1994, Ruscoe 2001). This was the case on Mana Island, for example, 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).

The eradication of mice on the South Farallones will likely benefit the island's native salamander by removing the predation pressure on salamanders from mice and eliminating the competition between salamanders and mice for insects. Both of these benefits will likely have a positive impact on the salamander's island population. After a successful mouse eradication on Mana Island in New Zealand, the populations of McGregor's skinks (*Cyclodina macgregori*) and common geckos (*Hoplodactylus maculatus*) increased substantially; both of these species were under similar pressures from mice as the Farallones' salamanders are today (Newman 1994). More discussion of the benefits of mouse eradication may be found in Section 4.4.6.

1.3.4. Background: The Problem of Introduced Species on Islands

1.3.4.1. 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 of the 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 wordwide. While islands make up only about 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 makes them particularly vulnerable to aggressive introduced species (Diamond 1985, 1989, Olson 1989). Of the 484 recorded animal species extinctions since 1600, 75 percent were species endemic to islands (World Conservation Monitoring Centre 1992). Introduced species were at least partially responsible for a minimum of 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. 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), which could affect them anywhere along their travels (Wilcox and Donlan 2007).
3. Many islands are sparsely inhabited or uninhabited by humans, keeping the socioeconomic costs of protection low.

1.3.4.2. 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 (Efford et al. 1988, Triggs 1991, Atkinson and Atkinson 2000).

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

House mice are omnivorous species that eat a variety of seeds, fungi, insects, reptiles, other small animals, and the eggs of small birds. In addition, they are known to have dramatic negative impacts on endemic arthropods (Rowe-Rowe et al. 1989, Cole et al. 2000).

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 affecting the populations of a number of endemic invertebrates, especially the Marion flightless moth (*Pringleophaga marioni*), the single most important decomposer on the island. Furthermore, house mice may be affecting the amount of food available for the native insectivorous species, the lesser sheathbill (*Chionis minor*). 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 (Rowe-Rowe et al. 1989, Crafford 1990). Also on Marion Island, mice have significantly altered the vegetation community through seed predation, showing a preference for native plants over introduced ones (Angel et al. 2009).

House mice can also have a substantial negative impact to native reptiles and amphibians on islands. On Mana Island in New Zealand, for example, Newman (1994) found mice were a major contributing factor in the population collapse of the island's rare McGregor's skink (*Cyclodina macgragori*). After successful mouse eradication, the population of McGragor's skink, the gecko (*Hoplodactylus maculates*) and the endemic giant cricket (*Deinacrida rugosa*) increased significantly.

One of the more surprising effects of mice on islands is their negative impact to seabird and native landbird populations through direct predation on eggs and chicks, especially when mice are the only non-native mammal present (Angel et al. 2009). 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

Figure 1.3. A house mouse feeding on a seabird carcass on Gough Island.

habitat remaining on the island (Cuthbert and Hilton 2004). Similarly, on Marion Island, where the recent eradication of feral cats left mice as the only non-native mammal on the island, researchers recorded several wandering albatross (*Diomedea exulans*) killed by mice subsequent to cat removal (Wanless et al. 2007, Angel et al. 2009).

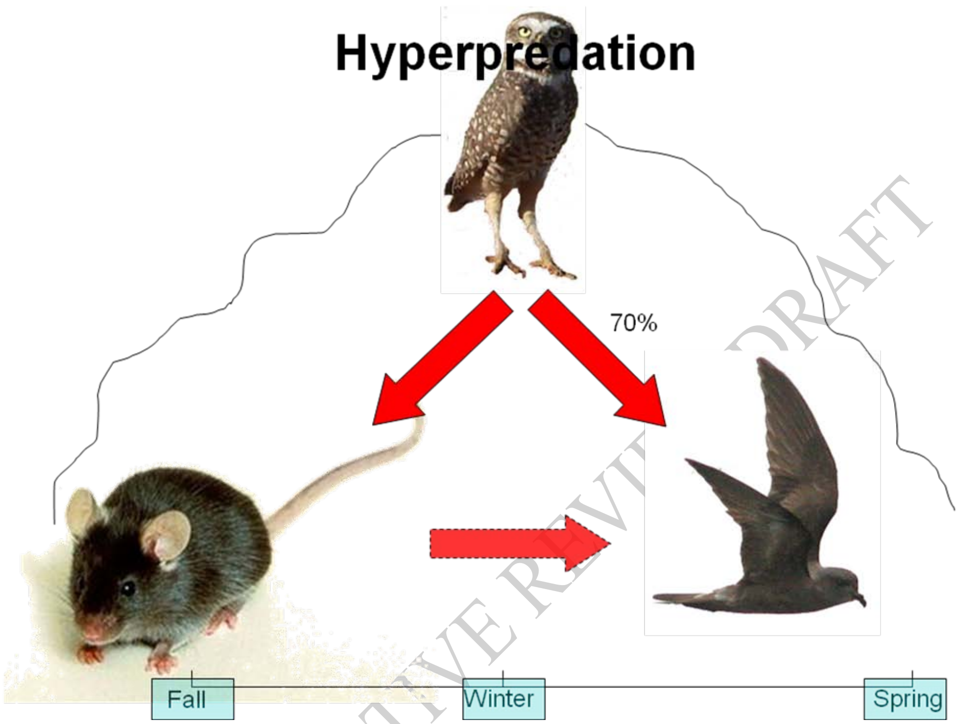
Comment [DG2]: Add calculation of kg/ha of island biomass consumed by mice per year

1.3.4.4. Hyperpredation on islands

Hyperpredation refers to an enhanced level of predation pressure on a secondary prey species due to an increase in the abundance of a predatory population or a sudden drop in the abundance of the main prey item; this mechanism has been documented in cases where an introduction of a non-native prey spcies causes the exploitation of native prey species (Holt 1977, Smith and Quin 1996, Moleón et al. 2008). The decline of ashy storm-petrels and likely Leach's storm-petrels on the South Farallones is partially driven by the interaction between burrowing owls and non-native mice (as described in Section 1.3.1 above) and is a good example of the impact that introduced species can have on an ecosystem through the mechanism of hyperpredation. A number of similar examples, involving one or more non-native species that contribute to declines in native island species, 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 island are attracting much larger numbers of barn owls (*Tyto alba*) than other ecologically similar sites in the region. Because owls also prey on the Audubon's shearwater (*Puffinus lherminieri*) that has breeding colonies on many of the cays in the region, the shearwater population on Allan's Cay is experiencing a mortality rate that is twice as high as on cays that are mouse-free. This high mortality will likely contribute to the colony's extirpation in the future if conditions do not change (W. Mackin pers. comm.).

Another example of hyperpredation 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 have had on the island's resources (Morrison et al. 2007). Biologists have seen a similar pattern on islands where feral cats maintain high population densities between seabird breeding seasons because they are subsidized by introduced rodents (Atkinson 1985) or rabbits (Apps 1983, Courchamp et al. 1999, 2000). In all of these examples, the presence of a non-native prey animal led to substantial declines in native prey species through opportunistic predation by a local predator that was sustained at artificially high population levels.

Hyperpredation on the Farallones consists of a transient burrowing owl population that is being subsidized by a non-native mouse population as a primary artificial food source in the fall and winter, but with the depletion of the mice numbers in the late winter, the owls shift to preying on petrels and other seabirds. If the mice were no longer present as a prey base, the owls would likely resume their normal patterns and move on back to the mainland after a couple of days on the island when they realize that very little prey occurs on the island. The figure below illustrates the shift in prey base and how the mice artificially subsidizes the owl population on the island.



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 includes mouse eradication from the South Farallon Islands as an objective for the Refuge's management direction.

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 focuses 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 South Farallon Islands, and to prevent the new introduction of any terrestrial vertebrates 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. During the scoping process, the Service identified the major environmental issues, or “impact topics,” that are described in Sections 1.6.2-1.6.4 below. These issues guided the development of the alternatives in chapter 2, and the scope and content of the environmental impacts analysis for each alternative found in Chapter 4.

1.6.2. Impact Topic: Physical Resources

1.6.2.1. Sub-topic: Impacts to water resources

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

1.6.2.2. Sub-topic: Impacts to geology and soils

Because the proposed action includes delivery of a toxicant into the Farallones environment, the potential for transfer and persistence of the toxicant in soils was identified as an important environmental issue.

1.6.2.3. Sub-topic: Impacts to wilderness character

All of the South Farallones except Southeast Farallon Island are 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.

1.6.3. Impact Topic: Biological Resources

1.6.3.1. Sub-topic: Non-target impacts from toxicant use

Mouse eradication would include the use of a toxicant that is lethal to mice. Toxicants should only be used in the environment if the behavior of that toxicant can be predicted with some accuracy. The impact of the toxicant to species other than mice and the persistence of the toxicant in the environment are important environmental issues related to the impacts of the action to biological resources, because animals other than mice, including birds, could ingest the toxicant.

1.6.3.2. Sub-topic: Disturbance to sensitive species

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

1.6.4. Impact Topic: Social and Economic Environment

1.6.4.1. Sub-topic: Impacts to 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. Finally, a small number of FWS and PRBO personnel, contractors, and visiting researchers utilize the island year-round.

1.6.4.2. Sub-topic: Impacts to fishing resources

The waters surrounding the Farallones are important recreational and commercial fishing grounds for species such as salmon, albacore tuna (*Thunnus alalunga),* Dungeness crab (*Metacarcinus magister),* halibut, and rockfish (Scholz and Steinback 2006). The State of California, as mandated by the State's Marine Life Protection Act, is in the process of

Comment [g3]: Identify the species

establishing the Southeast Farallon Island Marine Reserve surrounding the South Farallon Islands. Fishing will be prohibited within the Marine Reserve.

1.6.4.3. Sub-topic: Impacts to historical and cultural resources

The impact of the action to historical and cultural sites, structures, objects and artifacts on the South Farallones are important environmental issues.

Comment [g4]: Check the status marine reserve? What does that do to fishing?

Chapter 2 Alternatives

2.1 Introduction to the 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, 4 alternatives were identified: 3 action alternatives (Alternative B-D) and the no action alternative (Alternative A), 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 to the island ecosystem.

The action alternatives 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 alternatives are:

- *Alternative A: No Action*
- *Alternative B: Aerial broadcast*
- *Alternative C: Bait stations as primary method of bait delivery*
- *Alternative D: Phased aerial broadcast, with extensive use of gull-hazing measures*

Comment [DG5]: We should discuss whether This should be moved to Section 2.8 (Dismissed) due to lower likelihood of success

A number of action alternatives that were dismissed from detailed consideration are also described, and rationale for their dismissal is given (Section 2.8).

2.2 Alternative A: No Action

Analysis of the no action alternative is required under NEPA to provide a benchmark to compare the action alternatives to. Mice would not be eradicated under this alternative; however, other ongoing invasive species management programs on the South Farallones would continue based on previous agency decisions. Low-intensity mouse control – primarily snap-trapping – currently occurs within and around the residences and buildings on Southeast Farallon Island. These localized control efforts would continue under the no action alternative, but the mouse population on the rest of the South Farallones would not be subject to control efforts. The Service currently removes invasive plants through hand-pulling and herbicide applications. Additionally, native plant seeds are being spread to improve native populations and 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. These efforts would continue under the no action alternative. However, the continued presence and impacts of mice might compromise the effectiveness of future ecosystem restoration efforts.

The Service would also continue management activities focused on protecting storm-petrels and their habitat on the islands, including nest habitat construction and predator management. Prior to Fall 2008, the Service occasionally relocated burrowing owls that were overwintering on the island to protect storm-petrels from predation. The Service did not relocate any owls in 2008 to allow researchers to collect additional data on owl movement patterns. Under the no action alternative, the Service would continue to relocate burrowing owls whenever possible. Additionally, because western gulls are likely the most common resident predator of storm-petrels on the Farallones, there have been efforts in the past to deter gulls from nesting in prime storm-petrel habitat, but these efforts have been unsuccessful to date. The Service is considering the possibility for targeted control of gulls that specialize in preying on storm-petrels and would continue to consider this possibility under the no action alternative.

The current rodent introduction-prevention protocols for vessels that transport personnel and materials to Southeast Farallon Island would continue under the no action alternative. However, these protocols are not always enforced, leaving 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 effects of non-native mice would be contrary to the purpose of the refuge and other USFWS policies for conservation and restoration of natural biodiversity and management of designated wilderness.

2.3 Features Common to All Action Alternatives

All three action alternatives will necessarily involve the use of brodifacoum delivery by both bait stations as well as by aerial broadcast, and all three have many other features in common as well. These features are described below.

2.3.1 Use of Techniques with High Likelihood of Successful Eradication

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 objective of eradication is unique within the field of pest management because 100 percent of the target population must be made vulnerable. Eradication is a more complex objective than the much more common goal of “control,” in which managers aim primarily to reduce a target population to acceptably low numbers. The Service considered mouse “control” rather than eradication but dismissed it from detailed consideration (see Section 2.9.7).

The high cost and high complexity of non-native mouse eradication from the South Farallones make success especially critical. 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 carefully and correctly, the action alternative methods proposed would have a high likelihood of successfully eradicating mice (Witmer and Jojola 2006, Howald et al. 2007a).

Comment [DG6]: Need to discuss likelihood of success using Alternative C (bait stations)

2.3.2 Use of the Rodenticide Brodifacoum

Brodifacoum (3-[3-(4’–bromobiphenyl-4-yl)-1,2,3,4-tetrahydro-1-naphthyl]-4 hydroxycoumarin) is a coumarin-based anticoagulant rodenticide. Anticoagulant rodenticides are the most widely used toxicant for control of small mammals worldwide (Eason et al. 2002, Hoare and Hare 2006, Howald et al. 2007b). They act by inhibiting the synthesis of vitamin-K-dependent clotting agents in the liver, interfering with the blood’s ability to form clots and causing sites of even minor tissue damage to bleed continuously (Hadler and Shadbolt 1975, Eason and Ogilvie 2009). Mortality from anticoagulant rodenticides is caused by internal hemorrhaging, typically within 3-10 days of initial consumption (Buckle and Smith 1994, Howald et al. 2007b, Eason and Ogilvie 2009). 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 2004a). Its use is restricted to professional pest control operations (72 FR 10 pp. 1992-3, 2007). It would be used according to Environmental Protection Agency (EPA) approved pesticide label instructions, which define the legally allowable uses and restrictions of the specific pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). All bait application activities will be conducted under the supervision of a Pesticide Applicator certified by the EPA. 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. 2007a).

In order for the toxicant to have physical effects, brodifacoum levels in the liver must reach a toxic threshold; this level can vary widely between species and even between individuals. 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.

Pressed-grain bait pellets (1 g – 2 g) containing a rodenticide will be applied at a rate that is expected to successfully eradicate mice from the treatment area according to Environmental Protection Agency (EPA) approved pesticide label instructions, which define the legally allowable uses and restrictions of the specific pesticide. All bait application activities will be conducted under the supervision of a Pesticide Applicator certified by the U.S. EPA.

Anticoagulants are classified as first or second-generation according to when they were first developed as rodenticides and, consequently, their toxicity (Eason et al. 2002). First-generation anticoagulants, which include diphacinone, generally appear to be most effective at achieving mortality in rodents when consumed over several consecutive days, although a single high dose may be toxic to some animals (Eason and Ogilvie 2009). Second-generation anticoagulants are more toxic than first-generation, with lower LD_{50} values (median lethal dose, or the amount required to kill 50percent of a test population), and are typically 'single feed' poisons in high enough concentrations (Hone and Mulligan 1982) *in* (Eason and Ogilvie 2009). The generally lower toxicity of first-generation anticoagulants compared to second-generation products is attributed to their poorer binding affinity to sites in the liver. Second-generation anticoagulants have a greater binding affinity than first-generation anticoagulants, which increases the rate of metabolism, requiring only one feeding to be effective (Parmar et al. 1987). In order for either toxicant to have physiological effects, levels in the liver must reach a toxic threshold; this level can vary widely between species and even between individuals within a species. But any rodenticide can kill all of a rat population if the animals consume enough bait over an appropriate amount of time.

Brodifacoum-25D™ Conservation is manufactured by Bell Laboratories (Madison, WI, EPA Reg. No. 56228-37) specifically for use on island invasive situations in dry climates. The bait product is designed to be highly attractive to rodents, such that rodents on the island are more likely to choose the bait over natural food sources. The predominant inactive ingredients in these bait products are non-germinating grains, either sterile or crushed. It is a "restricted use pesticide" according to the EPA-approved pesticide label developed for each product:

- The product may only be used on islands or vessels [marine is implied]
- The product may only be used for the control or eradication of invasive rodents.
- The product is only available for sale to 3 federal government agencies: USDA/APHIS, Wildlife Services, U.S. Fish and Wildlife Service, and U.S. National Park Service, although these agencies can make the bait available to other agencies or private parties under their oversight.
- The product may only be applied by Certified Pesticide Applicators (a certification generally provided by the State or Territory in which the bait is to be applied) or persons under their direct supervision.

Comment [DG7]: Confirm #

Brodifacoum-25D™ bait product

Brodifacoum is the most frequently used rodenticide for rodent eradication from islands. Of the 278 successful island rodent eradication events worldwide (where the toxicant applied was known), 197 (71percent) used brodifacoum as the primary rodenticide (Howald et al. 2007b), Island Conservation unpubl. data). In 92 (47 percent) occasions bait stations were the primary technique used to deliver brodifacoum, 58 (29 percent) occasions used aerial broadcast as the primary technique, and 43 (21 percent) occasions used hand-broadcast as the primary technique. Of these, in 33 (17 percent) occasions, a combination of bait stations, hand-broadcast, aerial broadcast, and/or traps were used, the most common of which was aerial broadcast as the primary technique supplemented with hand-broadcast (14 or 7percent of occasions) (Howald et al. 2007b), Island Conservation unpub. data).

Brodifacoum is highly toxic to mice requiring the consumption of no more than a single bait pellet as a single feed or spread across multiple feeding events to result in mortality (Erickson and Urban 2004b, Eason and Ogilvie 2009). The LD_{50} dose has been achieved in Norway rats ingesting 1.5 g (0.052 oz) of brodifacoum bait product in a single feeding (0.3 mg/kg at 50 ppm brodifacoum) (Buckle and Smith 1994), The toxicity of brodifacoum to mice makes it desirable as a tool for rat eradication because it reduces the need to make bait consistently available to rats for an extended period of time.

Comment [DG8]: Review for mice LD50

Comment [DG9]: Add mouse LD50 citations

Brodifacoum-25D Conservation™ (hereafter referred to as Brodifacoum-25D™) is an unwaxed cereal bait product with 25 ppm brodifacoum, available in 1g-3g pellets with a sweet, grain flavor. The product is manufactured specifically for conservation purposes; Brodifacoum-25D™ is for use in dry climates and is designed to break down quickly after exposure to moisture, including both dew and rainfall.

Brodifacoum-25 ppm products (Bell Laboratories, Madison, WI) have been used to successfully eradicate rats from at least 5 islands using aerial broadcast as the primary technique (Samaniego-Herrera et al. 2009, Buckelew et al. 2010, Howald et al. 2010), and from one island using hand-broadcast (Hall et al. 2006). In addition, the bait product has been tested for efficacy and palatability under laboratory conditions, prior to their use in eradication operations. To successfully eradicate rodents from an island, every rodent must be exposed to sufficient quantities of rodenticide, by either consuming bait or eating other animals that have consumed bait, to acquire a lethal dose of brodifacoum. A bait trial must similarly demonstrate that 100percent of the rodents in the trial area were lethally exposed to bait. Brodifacoum-25 products (Bell Labs, Madison, WI) have also been tested with favorable results in at least 3 field sites: the Aleutian Islands in Alaska (Buckelew et al. 2008b), Palmyra Atoll in the equatorial Pacific (Buckelew et al. 2005b), and Pohnpei, Micronesia in the western Pacific (Wegmann et al. 2007).

During field trials, brodifacoum has been shown to be more palatable to rats in comparison to naturally-available food sources (Buckelew et al. 2005b, Buckelew et al. 2008b, Alifano and Wegmann 2010). The palatability of Brodifacoum-25 to rats makes it a desirable tool for mouse eradication because it increases the probability that every mouse on the island will consume bait.

While high toxicity and high palatability are desirable bait characteristics from the perspective of successfully eradicating rats, these same characteristics can be undesirable from the perspective of minimizing non-target impacts (Hoare and Hare 2006). Brodifacoum is highly toxic to many birds (Erickson and Urban 2004b), and can be toxic to secondary consumers that prey on primary bait consumers (Rammell et al. 1984, Dowding et al. 1999, Stone et al. 1999). Furthermore, because brodifacoum can persist in body tissues of vertebrate and invertebrate species, potential non-target impacts from brodifacoum through secondary exposure of predators, has been shown to be extended beyond the period of time that bait pellets themselves are available in the environment (Eason et al. 2002, Fisher et al. 2004). The pellets are manufactured with a grain base to be attractive as a food item to rodents, but the pellets are also likely attractive to other granivorous and opportunistic omnivorous animals. However, other species such as insectivores (some landbirds, shorebirds, reptiles), herbivores (e.g. fruit-eating pigeons), and carnivores (e.g. fish-eating seabirds) would be unlikely to identify the pellets as a food item, would not be as attracted to the pellets as food, and thus would be unlikely to intentionally consume them as food. Additionally, pellets would be dyed green which has been shown to make pellets less attractive to some birds and reptiles (Pank 1976a, Tershy et al. 1992a, Tershy and Breese 1994a). Despite this, mortality in individual non-target birds during several rat eradication operations have been attributed to brodifacoum bait products that were used for the eradications (Eason and Spurr 1995, Eason et al. 2002, Buckelew et al. 2005b, Buckelew et al. 2010).

Figure 2.2 Bait pellet after exposure to moisture.

In an effort to reduce risks to wildlife and people but allow rodenticide products to remain available, the EPA recently limited the use of brodifacoum and 9 other rodenticides; brodifacoum is currently restricted to agricultural applications, professional pest control operations, and ecosystem restoration efforts on islands (Environmental Protection Agency 2008). However, the EPA does not discourage the use of brodifacoum for rodent eradication from islands. On the contrary, the EPA's recent decision to restrict brodifacoum use explicitly exempted its use for island rodent eradication (Environmental Protection Agency 2008). In addition, the New Zealand Department of Conservation identifies brodifacoum as the preferred toxicant for island rodent eradication (Eason and Ogilvie 2009). These explicit exemptions are logical in light of the fact that island rodent eradication operations are fundamentally different from rodent control operations. The potential risks from using brodifacoum for eradication can be avoided or reduced more effectively on an isolated island, with a finite time period of bait availability, than for rodent control operations on mainland or larger-island sites where rodenticide is available in the environment chronically. Furthermore, the generally high cost and logistical complexity of conducting a whole-island rodent eradication necessitate techniques and tools that maximize the probability of successful eradication on the first attempt.

2.3.3 Bait Design and Application Requirements

The same bait would be used in all action alternatives, and it would be subject to a number of limitations. The grain base of the bait pellets would be between 1 to 2 grams, containing 25ppm brodifacoum. The bait would be a compressed grain pellet, approximately 1.1 g in weight, containing 25 parts per million (ppm) brodifacoum, which is a second-generation anticoagulant (see Section 2.5.2) for more information on brodifacoum). The bait used would be registered with the EPA and in compliance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The bait product would be designed to be highly attractive to mice. All other ingredients in bait pellets would be non-germinating grains (either sterile or crushed). Any bait not initially consumed would likely remain attractive to mice for several weeks, although the bait would likely disintegrate completely within one or two major rainfall events.

Comment [DG10]: Add Citation, support

The pellet would be attractive as a food item only to granivorous and opportunistic omnivorous animals. Insectivores such as some land birds, most shorebirds, and arboreal salamanders would not intentionally consume bait as food. Additionally, marine mammals and the majority of seabird species that use the Farallones would not likely consume bait due to their piscivorous diets. Pellets may be attractive to highly curious and omnivorous birds such as gulls, but this would occur regardless of the inert “matrix” of the bait. Additionally, pellets would be dyed green, which has been shown to make pellets less attractive to some birds, including western gulls (Pank 1976b, H. Gellerman unpubl. data, Tershy et al. 1992b, Tershy and Breese 1994b). The same pellets would be used in all aerial broadcast, bait station and hand baiting operations.

2.3.4 Aerial Broadcast Equipment

All three action alternatives would utilize some level of aerial bait broadcast and would be conducted using a single primary-rotor/single tail-rotor helicopter. Helicopter models considered for use in the operations would include the Bell 206B Jet Ranger, Bell 206L4 Long Ranger, MD500, or other small- to medium-sized aircraft.

Bait would be applied from a specialized bait bucket, known as a hopper, slung beneath the 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 (to broadcast bait over a wide swath) and off (to trickle bait at a low rate on a precise point below) remotely and independently of the outflow gate. The broadcast device would include a deflector and a skirt that can be easily installed when directional (120° rather than 360°) broadcast is necessary, such as on the coastline, so as to reduce the possibility of pellets reaching the ocean environment.

Figure 2.1 Bait hopper.

2.3.5 Aerial Bait Application Operations

The extent and timing of aerial broadcast operations is unique to each action alternative being considered, but many aspects of the aerial operations are identical for all three. For aerial broadcasts, helicopter operations would be staged on Southeast Farallon Island. Helicopters would fly to designated staging areas on existing concrete pads where personnel would re-fill the bait hopper, re-fuel the helicopter(s), and conduct other necessary maintenance. The staging area would be adequately stocked with bait, fuel, personal protective equipment (PPE) and other supplies and equipment to support the helicopters and project personnel during the bait application process. The housing areas and lighthouse would be excluded from aerial broadcast under all three alternatives and will instead be treated by hand-broadcast and placement of bait stations.

Bait broadcast by helicopter would consist of low-altitude overflights of varying portions of the land area of the South Farallones. 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, with the bait hopper long-lined 49-66 ft (15-20 m) below. The bait would be applied according to a flight plan that would take into account:

Comment [DG11]: Confirm flight specs

- The need to apply bait evenly and to prevent any gaps in coverage or excessive overlap;
- Island topography to minimize any localized pooling of bait at the bottom of slopes;
- Distribution of roosting seabirds, especially gulls and Common murres (*Uria aalge*);
- The need to avoid bait broadcast into the marine environment;
- The need to minimize disturbance any pinnipeds hauled out on land;
- The need to avoid bait broadcast into residential areas and water catchment pads;
- Weather conditions; and
- The need to minimize the substantial costs associated with helicopter flight time.

The baiting regime would follow common practice based on successful island rodent eradications elsewhere in the U.S. and globally (Howald et al. 2007a), 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. The width of a flight swath would be determined beforehand in calibration trials. It would likely range from 30m to 80m. 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 would likely be no more than three consecutive operating days.

In order to ensure eradication success, it may be necessary to conduct more than one aerial application. Two applications are standard procedure in mouse eradications using brodifacoum, with applications usually between 5 and 21 days apart, to minimize the likelihood of either competitively inferior adult mice or juvenile weanlings surviving the initial broadcast because they were not given an opportunity to feed on bait. Nevertheless, if project leaders determine that palatable bait would be likely to remain available for mouse consumption for longer than 10 days after an initial application, a second or third application may not be necessary. Bait pellets exposed to heavy moisture would degrade faster than pellets that fall in more protected locations.

Comment [DG12]: Add Citation

Comment [DG13]: Confirm application window, Citations, with weather contingencies

Comment [DG14]: Confirm date ranges and defensible thresholds for timing and bait rate for additional applications (second and third).

Bait would be applied strictly according to the limitations set by the EPA's pesticide regulations (FIFRA). The precise bait application rate after all applications would be up to but not in excess of 27kg/ha, the rate set by the EPA. The application rate is calculated so that an adequate amount of bait is available for consumption by mice for a period of at least four days.

Comment [DG15]: Add language reflecting how "nominal" rate is calculated for EPA label

Comment [DG16]: Add citation for 4 days

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

Comment [DG17]: Need to add discussion as to whether stratified baiting rates are appropriate or not, based on current info

To ensure complete and uniform application:

Figure 2.3 Helicopter broadcasting bait.

- The actual application path would be monitored onboard the helicopter using an onboard global positioning system (GPS), a navigation bar, and a computer to precisely guide the application in order to avoid gaps and unanticipated overlaps in application GIS grid lines would be mapped prior to broadcast and followed by the helicopter.
- 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 GPS tracking system.

Adjustments in bait flow rates, helicopter speed, and flight lines would be made as necessary to meet the optimal application rate, staying within the limits legally required by the EPA.

As a result of the need for caution near the marine environment, the coastlines of the main islands and offshore islets, which are potential mouse habitat, may not receive the optimal bait coverage with helicopter broadcast alone. In cases where it is evident or suspected that any land area did not receive full coverage, there would be supplemental systematic broadcast either by foot, boat, helicopter, or any combination of the above. Helicopters may hover for brief periods over land during bait application to bait offshore islets, either by hand or from the hopper with the broadcast motor off to trickle bait at a precise point directly underneath. 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. 2005a). In coastal areas with irregular shorelines, aerial broadcast may be replaced by hand baiting to minimize broadcast of pellets into the marine environment, and to minimize any pockets of coastal habitat that could otherwise be subject to bait densities over the targeted application rate.

All personnel that handle bait or monitor bait application in the field would meet or exceed all requirements for personal protective equipment (PPE) required by the EPA. 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.

Comment [DG18]: Add how these areas will be determined, and how additional rates will be calucated, as well as who will make the preliminary and final decision to apply more.

Comment [DG19]: Add additional description of how coastal circumference zone will be baited so as to avoid unintended overlap with parallel flight path baiting.

Comment [DG20]: Add other ways to do this based on recent success in the Galapagos

2.3.6 Bait Stations

All action alternatives would involve the use of bait stations as a delivery method to some extent. 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 (Figure 2.4). Bait stations reduce 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. The bait station design would effectively exclude birds while allowing easy access for mice. Bait stations would be deployed mostly on foot, but some might require rope, helicopter or boat transport in order to reach some areas.

Bait stations would be installed in and immediately surrounding all of the buildings and enclosed structures on the island in all three action alternatives. The bait used in bait stations would be identical to the bait pellets used for broadcast.

The bait station design for the Farallones would need to include the following characteristics:

- An entryway small enough to make entry by landbirds 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, as well as provide 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 would be assessed for the best choice prior to implementation. Alternatively, bait stations could be fabricated specifically for this project.

Figure 2.4 Example of a bait station. Note: The design of bait stations used for this project may differ considerably from this picture.

Since bait stations would need to be accessed frequently during bait dispersal, the Service would have to ensure that there is sufficient access would have to be ensured to each bait station. In some cases no landscape modifications would be necessary; however, depending on the local placement of each station, a number of landscape modifications and/or installations may be necessary to properly secure bait stations into place. Examples of these modifications could include:

- Paths cut through vegetation for stability;
- 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.
- Some bait stations may also require modification (i.e. additional covering) to prevent rain or moisture from entering the box and damaging the bait.

Some access pathways may need to be crossed especially in sensitive habitat such as areas with seabird nest burrows and rocky talus slopes that harbor seabird nest crevice habitat. Whenever possible, access paths would be routed around sensitive biological habitat, or temporary platforms, walkways, or other temporary infrastructures would be installed to avoid trampling.

Each bait station would be secured to the ground with anchors placed into the soil or drilled into the rock as appropriate. The infrastructure required for the bait station grid would be durable enough to withstand the corrosive marine environment of the Farallones for up to two years, but it would be removable and not a permanent fixture on the islands.

The use, placement and number of bait stations to be used would be unique to each alternative considered, but they would be used to treat buildings in all three alternatives, as discussed below.

2.3.7 Treatment of Buildings

The buildings on the Southeast Farallon Island, especially residences, provide high-quality habitat for mice, in that they provide food sources as well as shelter from the elements. Because two of the structures on island are residences, they would be excluded from any aerial bait application and the area within and around them would instead be baited with enclosed bait stations. The power house, outbuildings and concrete water catchment basin would also likely be within the aerial broadcast exclusion zone. The perimeter of these buildings and structures would be hand-baited and baited with enclosed bait stations. The water catchment area might be tarped to avoid the drift of any bait into this area, and bait apllied by hand and/or bait stations surrounding this area to avoid the entry of brodifacoum into the water collection system.

Ensuring that mice are removed completely from all buildings would be critical to the success of the proposed action. A preliminary rodent exclusion needs assessment of the houses and other man-made structures on Southeast Farallon was conducted in October 2010(Badzik, B. 2010). This assessment was conducted by the Integrated Pest Management Coordinator of the National Park Service that conducted and oversaw a similar successful rodent eradication effort on Anacapa Island in the Channel Islands National Park in 2001. This report identifies the preliminary actions that must be employed by the USFWS and PRBO prior to the eradication in order to ensure that no residual mice will be left within these structures afterwards to serve a recolonizing population (Appendix XX).

The Service and PRBO have already begun taking measures to begin sealing off access by mice to the interiors of the two residences. Additional work must be conducted to eliminate access by mice to any external or other portions of the houses, such as foundations, crawls spaces, attics and within the walls and pipes. Sealing other access points and holes to interior spaces will also need to be continued for the power house and other buildings on the island.

Comment [DG21]: Creat a list and timeline of tasks and operations to be conducted leading up to eradication.

Sources of food for mice in and around residences will also need to be eliminated in the months leading up to the eradication. The island's compost system, recycling system and treatment of food storage and waste will need to be modified so as to avoid providing mice with access to any items. Prior to the initiation of whole-island eradication, the Service and PRBO would take further steps to "mouse-proof" residences and other island buildings, cisterns and pipes by sealing possible entryways for mice, setting traps in and around buildings, and eliminating mouse access to any food or food scraps. Throughout the course of the operation, personnel on-island would be required to adhere to strict protocols to reduce the availability of food for mice within residences. During the operation, a high concentration of bait stations would be installed and maintained inside and outside all structures on the island.

During detailed operational planning, structures would be examined carefully in order to determine if mice can likely be eradicated from buildings using bait stations alone. If a pest control specialist determines that bait alone may not be sufficient to ensure complete removal of mice from structures, it may be necessary to use a fumigant in one or more buildings. If the

Service determines that a fumigant would be necessary to ensure a successful eradication, a building-treatment protocol would be developed and implemented.

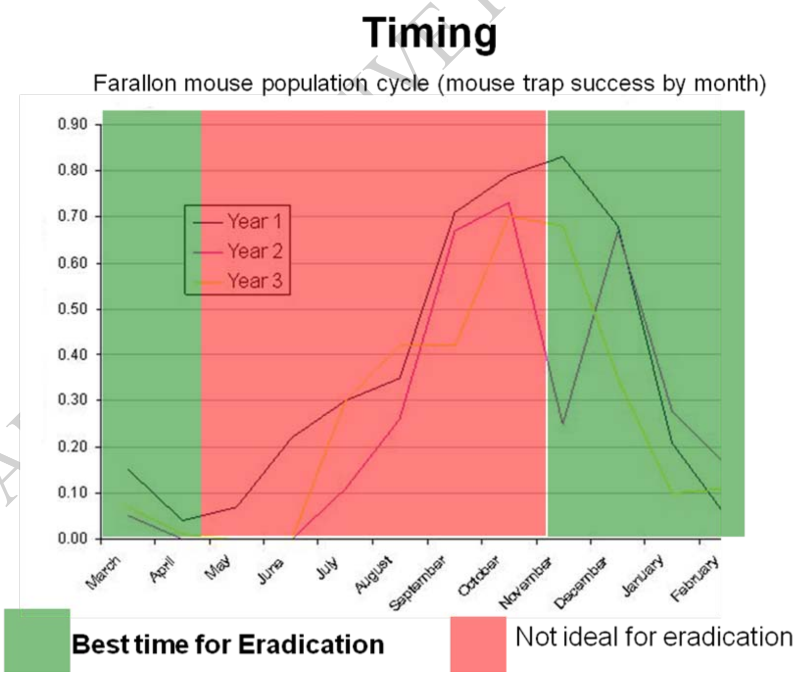
> **Comment [DG22]:** Would using a fumigant require additional Env. Compliance/Permits?

2.3.8 Timing Considerations

The seasonal timing for the action alternatives would be a critical factor for both the likelihood of successfully eradicating mice and reducing the risk of negatively impacting the biological resources of the South Farallones. The likelihood of success is influenced by three seasonally-dependent factors: 1) the local population biology of mice; 2) the availability of alternative food sources for mice; and 3) local weather conditions and seasonal patterns that would affect the feasibility of conducting operations. The risk of negatively impacting the biological resources depends on the local seasonal population biology of the vulnerable species, the breeding and migratory patterns of non-target species that may be vulnerable to rodenticide exposure, and the disturbance caused by the bait application process.

2.3.8.1 Biology of mice

Mouse eradication from an island is more likely to be successful if intensive baiting 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.

Mice in reproductive condition have been trapped on the South Farallones year-round, indicating that breeding may never completely cease; however, mouse trapping rates normally begin declining in November and fall dramatically between December and April, indicating that the number of mice on the island also declines (Irwin 2006). From the perspective of mouse population ecology, the ideal time period for mouse eradication would be between the months of November and April.

Comment [DG23]: We will revise this figure to include seabird breeding times, MM pupping, and rainfall and # of gulls

2.3.8.2 Seasonal sensitivity of native wildlife

The effects of the operational activities associated with mouse eradication (e.g., helicopter operations, bait station installation and maintenance) on the native wildlife of the South Farallones, particularly birds and marine mammals, would be reduced by avoiding seasons in which large wildlife populations are present, such as breeding and migration. Bait station maintenance would be required year-round, which would lead to wildlife disturbance in many cases; therefore, the initial installation of bait stations would be timed to avoid peak wildlife activity. Bait broadcast operations would occur during a season with minimal wildlife activity.

Specific timing considerations for birds include the following:

- Seabirds generally breed on the South Farallones between mid-March and October, with the peak breeding season for most species lasting from late April to mid-August. 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– particularly for gulls – or disturbed by aerial application procedures.
- Migrant seabirds, landbirds, and shorebirds stop frequently on the South Farallones during spring and fall. Between November and February, however, only a small number of overwintering and visiting birds are present on the island – a daily average of around 30 landbirds and around 60 shorebirds between mid-November and mid-December (PRBO unpubl. data).

Specific timing considerations for marine mammals include the following:

- The main pinniped breeding season on the South Farallones occurs between March and September. This encompasses the breeding seasons for California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina richardsii*), northern fur seals (*Callorhinus ursinus*), and Steller sea lions.
- Northern elephant seal pups are born on the South Farallones between late December and late February. Pups are weaned at about four weeks old, and pups 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 (Le Boeuf 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). Northern elephant seals molt according to a rough schedule stratified by gender and age class. Juveniles and

females molt starting in March, followed by sub-adult and then adult males, which molt through July (Le Boeuf and Laws 1994). During molt, pinnipeds undergo a short period of rapid hair loss during which time they may be reluctant to enter the water.

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

From the perspective of minimizing risks to native wildlife, the acceptable time period for the majority of the eradication operations would be between October, when the seabird breeding season has largely concluded, and the end of December, before the first northern elephant seal pups are born. The ideal time, particularly for aerial broadcast, would be from November to mid-December.

Comment [DG24]: We will create a graphic showing the timing of the major variables (breeding seabird timing, gull#s, marine mammal breeding, mice#s, rain, and a more expanded rationale for this window of time.

2.3.8.3 Weather considerations

Comment [g25]: We will add weather data for at least 10 years if available. Email Tom from NOAA?. Temp and Precipitation.

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 effectively broadcast bait by helicopter, with average wind speeds lower than 30 knots (35 mph). It is important to the success of the eradication that areas that are treated by bait broadcast be conducted within a time frame that is as short as possible, rather than in partial-island stages separated by multiple days or weeks. This consideration would prevent the potential reinvasion of mice back into areas previously treated with bait. Furthermore, the dry bait formulation used would not long withstand substantial rainfall events, 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 late fall and winter than during other seasons. However, the biological considerations of both sensitive native species and mice indicate that the late fall is the only reasonable effective time to conduct a bait application. While the late fall is not ideal from the perspective of helicopter operations and bait integrity, it is nevertheless likely that there would be ample opportunity to conduct two complete aerial broadcasts during the time period of November through December.

2.3.9 Preventing Bait Drift into the Marine Environment

Comment [g26]: We will discuss the CWA NPDES permitting once we know better how it will be dealt with!

Every reasonable effort would be made to minimize the risk of bait drift 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. Additional measures to reduce bait drift into the marine environment include reducing the aerial swath application width from 60m to 30m, which would allow for more precise placement of bait

Additionally, the hopper may be used with the broadcast motor off to trickle bait in precise points directly underneath, along the coastal perimeter of the island. Many areas along the shore and near intertidal zones that present the greatest risk of bait drift will be baited by hand from land or possibly by hand from a boat or helicopter to ensure that as little bait as possible drifts into the marine environment.

Comment [DG27]: Reiterate other methods to reduce bait drift, mentioned earlier

2.3.10 Reducing Wildlife 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. The requirements to reduce wildlife disturbance would include:

- Crouching or crawling when necessary to remain out of view of nearby animals, especially during the breeding season
- Moving slowly and deliberately to avoid frightening animals
- Traveling carefully by foot and avoiding sensitive areas when possible to reduce potential disturbance to seabird nest sites and marine mammal haul-out sites
- All staff would be shown maps detailing areas with sensitive wildlife and trained on how to avoid disturbing wildlife and avoiding impacts to sensitive habitats such as nesting burrows and crevices. These sensitive wildlife areas are fully described in Section 3.

2.3.11 Protecting Cultural Resources

Project personnel would exercise caution in general in order to not disturb the cultural or historical resources that have been identified on the South Farallones. Additionally, planning for the final layout of the bait station grid would be conducted in consultation with the State Historical Preservation Office so as to avoid inadvertently damaging buried resources during bait station installation. Personnel would be briefed on the known locations and identification of archaeological and historical resources that may be present on the islands. 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. Due to the presence of historic buildings and other features on the island, the Service would consult with an archeologist from the State Historic Preservation Office (SHPO) to ensure that planned activities would be compatible with protection of cultural resources o the island.

2.3.12 Minimizing Impacts to Wilderness

To address the special management regulations for the wilderness area on West End Island of the South Farallones, the Service would:

4. Avoid touching down in a helicopter anywhere other than the established helicopter landing zone on Southeast Farallon Island except in an emergency.
5. Minimize travel to West End and only for activities necessary for the eradication, such as bait delivery, bait station installation and maintenance, non-target mitigation actions including monitoring pinniped responses to helicopter operations, and efficacy monitoring such as setting traps.

Comment [DG28]: Can we be dropped off on West End to hand bait areas and to do mitigation/monitoring?

6. Choose aerial broadcast before bait station installation in wilderness areas where bait station installation would require greater-than-normal habitat modification such as frequent visits on foot, extra anchors or breaking rocks.

2.3.13 Minimizing Impacts to Birds

Some non-target bird species may be exposed to the bait either directly by consuming the bait pellets or indirectly by consuming mice or other organisms that have eaten the bait. A percentage of the resident raptors and gulls on the island at the time of the application may experience exposure to the bait without some form of specific efforts to avoid such exposure. Mortality reduction methods to be employed for all action alternatives would include:

- Systematic attempt to remove mouse carcasses, bird carcasses or that of any other animal found that is suspected of having succumbed to the toxicant, to reduce the likelihood of secondary exposure in scavengers;
- Attempting to capture and relocate all transient burrowing owls arriving on island to the mainland, as the Service has done in the past, to reduce the risk of toxicant exposure; and
- Efforts to capture, hold and release other resident and migrating raptors present, including the resident pair of Peregrine falcons and Common ravens(*Corvus corax*), until the Service determines the birds would no longer be at risk of exposure to toxicant;
- Attempt to reduce gull pellet consumption and non-target mortality by utilizing gull hazing techniques developed and tested during a January 2011 hazing trial.
- Installing bait stations rather than broadcasting bait in areas that are determined to have particularly high concentrations of birds that would be likely to feed on bait pellets after an aerial broadcast.

Comment [DG29]: Describe level of effort to be applied for this, areas, and timing of search

Comment [DG30]: Discuss if will capture/release other bird species (e.g. granivorous passerines migrating through) during the application?

Comment [DG31]: Are these areas just around the houses? Gull roost areas too?

2.3.14 Monitoring Eradication Efficacy and Ecosystem Response

Please refer to the Eradication Monitoring Plan presented in Appendix XX for a more detailed description of the monitoring activities that would surround the mouse eradication. The species and systems that would receive the most intensive monitoring are described below.

2.3.14.1 Mouse monitoring

During and after bait application activities, the mouse population on the South Farallones would be monitored for 2 years from the onset of the eradication operation to assess the effectiveness of eradication efforts.

For the action alternatives that employ aerial bait-broadcast as the primary rodenticide delivery method, rodent detection devices such as traps, flavored chew blocks, tracking tunnels, and motion-sensing cameras would be deployed in a post bait application efficacy monitoring program that would attempt to detect remnant mice where additional treatments or “mop up” response baiting is feasible. Also, radio collars would be deployed on a sample number of mice captured on Southeast Farallon Island prior to the bait application. The collared mice would be monitored just prior to the bait application, and then after bait application to confirm mortality, as well as time and location of mortality.

For the action alternatives that employ bait-stations as the primary rodenticide delivery method, eradication efficacy would be measured by the recording of station activity and by chew blocks and tracking tunnels associated with the stations. Passive observation by PRBO, and USFWS field station staff and visiting scientists would also be a very effective post-eradication efficacy monitoring measure. Due to the seasonal abundance of natural food resources and mice on the Farallones, a remnant mouse population should become readily detectible within one year of the eradication effort. Live or snap-traps set in and around the houses and buildings will be set and checked regularly.

Comment [DG32]: Decide whether to include the possibility of using trained dogs in visits to detect mice after eradication

For aerial broadcast alternatives, a team would return to the South Farallones four to six weeks after the second bait application to establish mouse detection stations throughout the islands. The detection station network would consist of corrugated plastic indicator blocks, tracking tunnels and/or a motion sensing camera traps. The stations would be checked and serviced every three days over a fifteen day period. If mice sign is detected on an isolated area that is small enough to effectively retreat by hand, the monitoring team would consult with the project management team about conducting a follow-up bait application on this area.

Comment [DG33]: Confirm timing specs

Detection stations that are placed on the islands would be monitored and serviced by trained PRBO and USFWS station staff according to this schedule: once per week for six months following the eradication, once per month after six months. At one year and two years after the eradication, a monitoring team would return to re-establish the mouse detection stations. During these monitoring efforts, live traps would be added to the detection station network, and stations would be monitored and serviced every three days.

Comment [DG34]: Confirm timing specs

2.3.14.2 Pinniped Monitoring

Pinniped including northern elephant seals *Mirounga angustirostris*, California sea lions *Zalophus californianus*, harbor seals *Phoca vitulina richardsii*, northern fur seals *Callorhinus ursinus*, and Steller sea lions *Eumetopias* jubatus will be monitored the Service and its contractors to see the response of pinnipeds to all activities, including helicopter operations, bait station installation and maintenance, and other project tasks to ensure compliance with the Marine Mammal Protection Act (MMPA) and the ESA. This observational monitoring is discussed in detail in Appendix J. Prior to conducting any aerial broadcasting or bait station installations, a visual survey of the island will be conducted by PRBO or USFWS personnel to determine the location and numbers of marine mammal haul-out sites, in order to determine what type of measures need to be employed to avoid unnecessary disturbances to the species present.

Comment [DG35]: Mention here the use of MM biologist in aerial survey/approach prior to baiting or other activities that could disturb pinnipeds..

2.3.14.3 Bird, Reptile, Plant Monitoring

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 40 years. The monitoring activities currently include a wide array of monitoring that includes ongoing weekly and daily studies and counts of marine mammals, birds, plants and arboreal salamanders. The Refuge's current monitoring activities fall outside the scope of this specific action, and would continue independent of the results of mouse eradication, so their environmental impacts are not analyzed here; however, they will be considered in the cumulative impacts analysis, in Chapter 4. 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. Ongoing acoustic monitoring studies as well as breeding bird counts would monitor the effect of the mouse eradication effort on affected seabird species.

Comment [DG36]: True? Or will additional breeding/non-breeding counts be needed?

Monitoring of abundance and distribution of native and invasive plant species would be conducted annually by the USFWS and PRBO as part of their ongoing habitat assessments and non-native plant control efforts.

Comment [DG37]: Would any additional vegetation mapping of natives and invasives like NZ spinach, be necessary/helpful?

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 negligible 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.

The timing of the eradication prior to the arrival, or after the departure of most nesting seabirds would be the most effective strategy to minimize the risk of short term rodenticide exposure in a bait broadcast scenario. The Service and its partners would continue to actively monitor the resident bird populations and continue their searches for dead or moribund individuals, especially gulls during and directly after the bait application period. The long term risk of rodenticide exposure to non-target shorebirds is low given the low rates of toxicant migration into the soil and the quick decline in toxicant residues, however, regular and opportunistic monitoring of the shorebird and seabird populations would continue as part of the Service's ongoing resource management plan for the Refuge.

Three additional monitoring activities would be conducted specifically to assess the effects of the eradication:

Comment [DG38]: Need to elaborate on exisiting databases/studies as well as monitoring studies that may need to be initiated prior to a broadcast (gulls, raptors, cricket surveys) and continued for 2 years afterwards.

2.3.14.4 *Invertebrate and Intertidal Monitoring*

- Monitoring of the near-shore fish and intertidal invertebrates in the marine environment would be coordinated and conducted by Dr. Jan Roletto, Research Coordinator for the Gulf of the Farallones National Marine Sanctuary (GFNMS). Pre-existing monitoring plots that have been monitored annually by NOAA for decades would be visited in the weeks following the bait applications in order to determine if the fate and concentrations of any rodenticide that may find its way into the intertidal marine environment during the operation. Similar studies have been conducted during and after other rodent eradications on the Channel Islands National Park off southern California in (Howald et al. 2001)-

Comment [DG39]: **Add citatation to references: 2001.** Progress in Rat Eradication, Anacapa Island, Channel Islands National Park, California Gregg R. Howald, Bernie R. Tershy, Bradford S. Keitt, Holly Gellerman and Donald A. Croll

- Monitoring of bait drift into the marine environment from aerial application would be conducted by placement of tarps over sample areas of inter-island channels, (such as Jordan Channel) so that the number of bait pellets (if any) landing on the tarp can be immediately counted and an island-wide marine bait drift amount can be calculated.

Comment [DG40]: This is a suggestion based on the Palmyra EIS plans using this technique.

- Surveys for endemic cave-dwelling camel crickets (*Farallonophilus cavernicola*) would be conducted before and one year after eradication, as standardized surveys for this rare endemic have not been conducted recently. It is expected that the eradication of predatory mice would generally result in increases in the numbers of invertebrates (as well as salamanders, native plants and some seabirds on the island, including the Ashy storm petrel and Cassin's auklet).

2.3.15 Public Information

All of the Farallon Islands are off-limits to the general public, and access can only be granted by permit issued by the USFWS. The waters surrounding the islands are productive fishing grounds, but most adjacent waters are within the recently-established Southeast Farallon Island Marine Reserve).Waters outside of the Reserve do provide recreational opportunities for fisherman, and whale watching boats from the nearby San Francisco Bay Area do visit the waters within the reserve. Informational posters describing the eradication actions taking place on the South Farallones would be distributed to tour boats that visit the islands as appropriate to ensure public safety and as an opportunity for interpretation, as well as, posted at nearby ports from which ships might embark for the vicinity of the islands.

Comment [g41]: Add Marine Reserve Map Update the status of the Marine Reserve.

Researchers that are permitted to conduct research on or near the island would be informed directly about eradication activities and timing, and all research activities would be adjusted to accommodate the eradication project. All approved island users such as research biologists, technicians, contractors, and volunteers would be given written materials stating that brodifacoum is present on the island, describing its appearance, and its intended purpose. In addition, approved pesticide warning and informational signs would be posted in the island's research housing and at all reasonable access points to the island. All island visitors would receive these materials, and signs would remain visible, until bait pellets are no longer found, which is estimated to be no more than three months after bait application has been completed, but subject to actual uptake rates and weather conditions.

2.3.16 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:

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

2.3.16.1 Re-introduction Prevention

The Service currently requires personnel, partners, and contractors traveling to the island to abide by a rodent and invasive plant exclusionary plan, but the requirements of this plan are not always enforced. These requirements include 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
- Implementing these measures would be thoroughly reviewed and enforced beginning before mouse eradication is complete. Full compliance among all island visitors would be essential.

To mitigate for post eradication rodent reinvasion risk, these biosecurity measures will need to be implemented and enforced more regularly and strictly. In addition, a combination of available rodent traps and bait stations would be maintained at the East and North Landing areas, the helicopter landing pad, and at any additional landing areas that may be utilized in the future.
A Farallon National Wildlife Refuge Biosecurity Plan would be written that includes specific rodent re-introduction prevention and response measures to be employed.

Comment [DG42]: Let's discuss this aspect.

2.3.16.2 Response

After the Service has 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 2.3.6.

Comment [DG43]: Develop application rates more fully in subsequent versions

2.4 Preliminary Bait Trial Results

As part of the development of potentially successful action alternatives, a field trial using non-toxic bait pellets was conducted in the fall of 2010 in order to better inform the efficacy and potential risks associated alternative operational plans that are being developed. A full account of the Biomarker Trial Plan (Grout, D. 2010) results can be found in the Farallon Biomarker Trial Report (Appendix #XX).

Comment [DG44]: Final analysis and report not yet completed.

2.4.1 Bait Trial Introduction

During November 2010, the Service conducted a non-toxic bait application trial on the South Farallones as part of the development and testing of operational alternatives. A placebo cereal bait without any rodenticide but instead infused with a non-toxic biomarker was hand broadcast in a study area on Southeast Farallon island. The non-toxic bait had a green food-quality dye that fluoresces under Ultaviolet (UV) light so that it could be detected in mice and throughout the greater environment. Bait was applied by hand in a portion of the island accessible on foot and in a manner that did not have any potential for impacts to natural resources on the island. The two main goals of the biomarker trials were to:

- Assess the palatability and efficacy of mouse eradication attempts utilizing the bait pellet at the registered EPA label application rate; and,

- To evaluate the potential risks to non-target species exposure to the bait, especially in gulls but also in other taxa, in order to assist the Service in developing measures to avoid, reduce and/or minimize these impacts.

Additional studies were also conducted during the trial to determine the following:

- Assess mouse abundance and current phase of the population cycle
- Determine if mice are still breeding at this time of year
- Bait pellet acceptability and preference by mice
- Biomarker detectability and persistence time in mice
- Bait pellet degradation and weathering rates
- Estimate rates of bait removal by mice and gulls
- Collect 50 DNA samples from mice on both Southeast Farallon and West End
- Locate and assess caves, coves and areas that may need special treatment
- Delineate which areas can/should be treated using bait stations
- Assess treatments that may be needed for buildings or other man-made features
- Determine access to various portions of the islands and surrounding islets
- Estimating the number of gulls and other non-target bird species on the islands

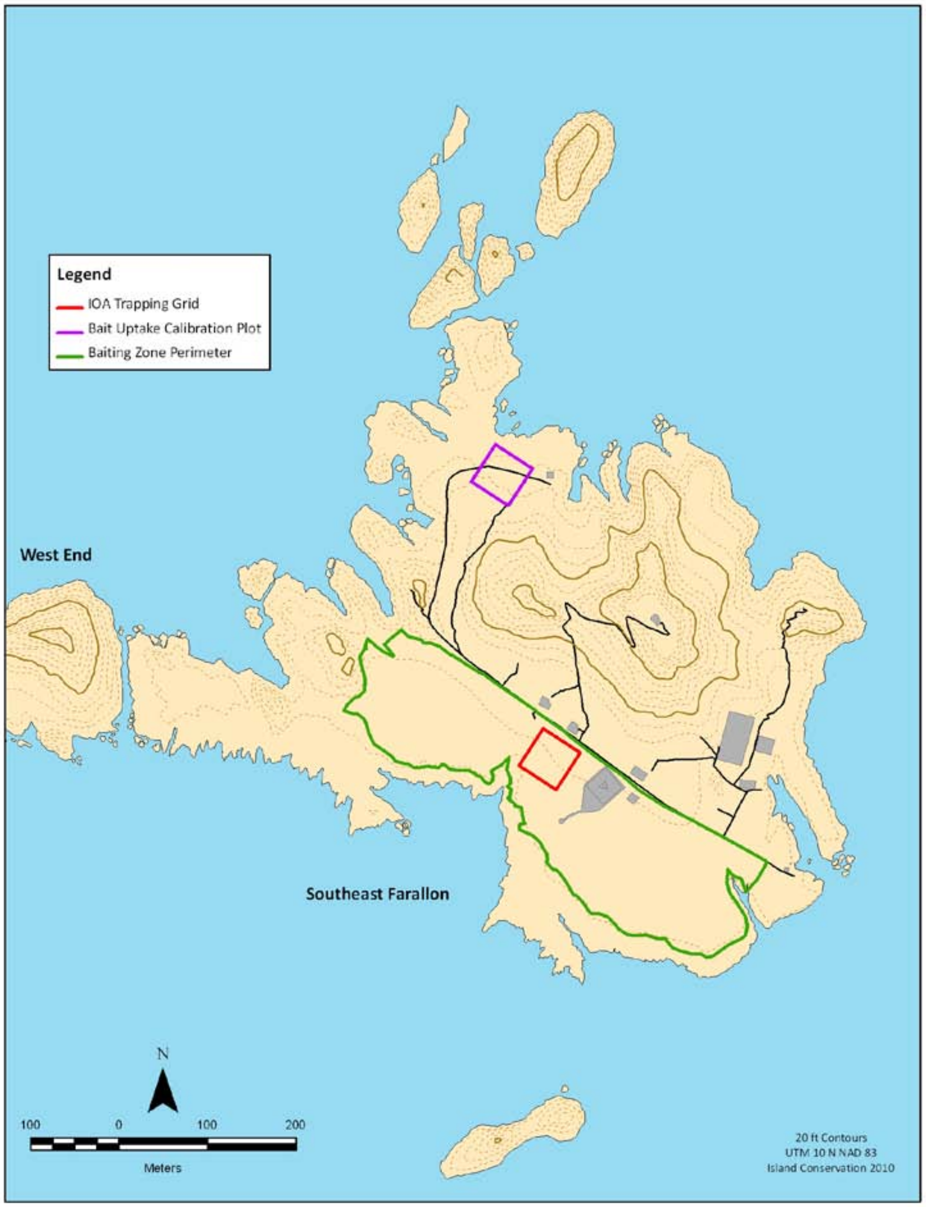
A full account of the study area, methods and results of the 2010 biomarker trial can be found in Appendix #XX?, but are summarized in the following Sections 2.4.2 through Section 2.4.4.

2.4.2 Study Area

The biomarker trials were conducted on Southeast Farallon Island, primarily on the marine terrace area on the southern portion of the island. Figure ## shows the primary bait trial study areas used in the fall of 2010. A 50m x 50m bait broadcast study plot was selected in the North Landing area to calibrate the expected bait uptake rates to be used during the subsequent field trial. A 6.4ha bait zone was selected for the actual biomarker baiting trial. A 0.25ha plot within this study area was chosen to determine an index of abundance for mice. To determine exposure to the biomarker, mice were live-trapped in and around the large baited area on two core trapping plots and along two trap transects to inspect mice for fluorescent marking indicative of bait consumption.

Comment [DG45]: Add #/Title to Trial Map

Ten 50m x 1m bait uptake plots were established within the bait zone to determine daily uptake rates of bait. Uptake transects 1-8 consisted of two transects place on either side of the two core trapping plots, and the other two transects were placed so as to assess bait uptake in the Index of


Legend
IOA Trapping Grid
Bait Uptake Calibration Plot
Baiting Zone Perimeter
West End
Southeast Farallon
N
100
0
100
200
Meters
20 ft Contours
UTM 10 N NAD 83
Island Conservation 2010

abundance plot (9) and within a known gull roost site (10). Additional studies were conducted in other portions of Southeast Farallon, West End and surrounding islets (See Appendix #XX for a full description.

2.4.3 Methods

2.4.3.1 Index of Abundance

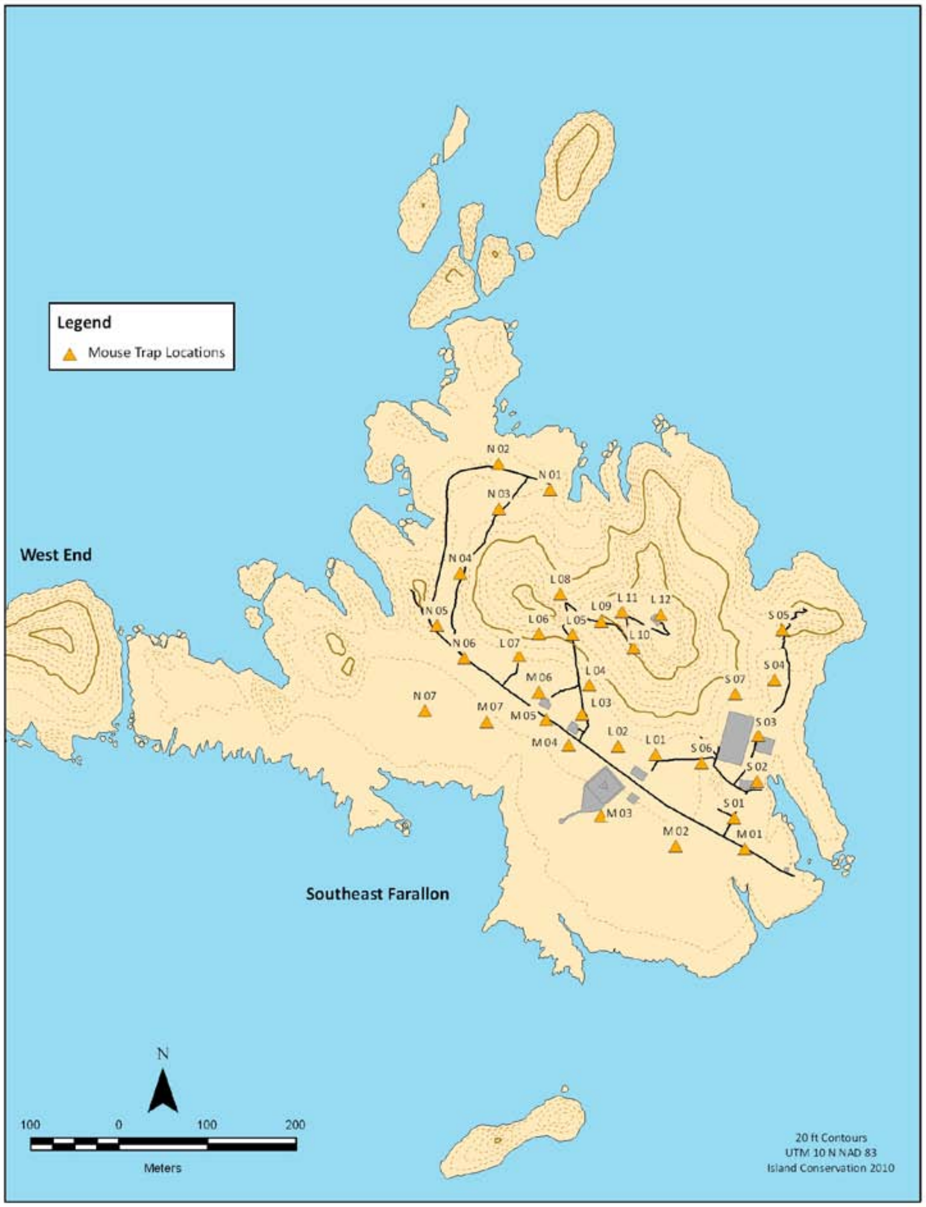
A mark-recapture live-trap grid was set up to obtain an index of mouse abundance (Figure ##). A total of 100 traps were set up in 10 by 10 grid pattern, with traps spaced 5m apart. Traps were set each evening and checked each morning for five consecutive nights during favorable weather conditions. The trap grid utilized Sherman live-traps baited with rolled oats. All captured mice were weighed, and inspected for sex, age and reproductive condition. All mice were marked with a unique Monel ear tag and released unharmed at the site of capture.

Additionally, a set of four transects trap lines comprised of 38 trap sites were established to be trapped monthly for the nest year to establish a monthly index of abundance of mice based on capture success rates. These transects and methods were largely based on re-initiating the previous index of abunadance mouse trap lines used by the USFWS in 2002-2004, although five additional trap locations were added to one of the transects in 2010 in order to better assess the Lighthouse Hill area (Figure ##).

2.4.3.2 Bait Application

A small 50m x 50m calibration area at North Landing was initially baited at 27kg/ha to assess if the EPA label bait application rate to be used during the subsequent bait trial would result in bait remaining on the ground for enough days to be effective. While bait uptake during this calibration was faster than expected, some of the increased uptake was likely due to edge effects and non-target uptake by gulls roosting in this area. Results of this calibration experiment informed the application rates and methods for the larger trial conducted in the following days.

In order to replicate a toxic bait operation as closely as possible, a large contiguous 6.4ha area of the island was hand-baited with non-toxic bait pellets. Baiting was conducted from a pre-determined baiting grid with bait broadcast locations spaced every 10 meters and located using hand-held GPS units and marked with biodegradable spray paint. Bait pellets were hand cast by four to eight people walking abreast along linear transect and distributed continuously over a 5m radius in all four directions. This simulated an aerial drop of equivalent densities of toxic bait. Baits were broadcast at 18kg/ha throughout the study area during the first application. A second bait application occurred five days later. On the second application, bait was broadcast on approximately western half of the study area (A) at 18kg/ha (west of the Helicopter pad), and on the eastern half (B) at 9kg/ha. Therefore study area B received a total of 27kg/ha, which is the registered bait application rate for the toxic form of the bait pellet, while study area B received 36kg/ha, which was tested to see if additional bait density might be needed to ensure that all mice in the core of the bait zone would receive the equivalent of a lethal exposure of bait.



We used a standard toxin-free cereal bait of the type used in rodent eradications: Conservation 25D produced by Bell Labs in a 1.1g dry formulation, infused with pyranine.

Mice appear unable to detect brodifacoum at concentrations used in rodent eradications, making the results of this trial directly comparable to toxic operation (O'Conner and Booth 2001). Pyranine fluoresces strongly under ultraviolet (UV) light and be detected visually on the feet, mouth anus and alimentary tract of mice several days after consumption. Baits were applied twice, five days apart. To ensure that all trapped mice were exposed to the bait, and were not animals that had ranged into the trapping area from a non-baited area, we applied baits at sufficient density to persist for at least 4 days and trapped mice only in the central portion of the baited area.

2.4.3.3 Trapping Protocol

A 10 by 10 core trapping grid was employed with trap locations spaced 2m apart, making for an 18m x 18m core grid. Two nine-inch Sherman live-traps were positioned at each trap location, consisting of a total of 200 traps per grid. Two trap grids were set up, one in the core of each bait density zone. Core grid A was at the center of the 36kg/ha bait zone, and core grid B was at the center of the 27kg/ha bait zone. Live-traps were baited with rolled oats. The distance from the edge of the core to the baited area was at least 50m, approximately double the apparent mean diameter of average mouse home range. We used trap transects to assess the affect of immigration, which is defined as movement into the core area of mice with home ranges outside the baited area. Each transect ran from the edge of the baited core grid through 50m of baited area, to up to 50m beyond the baited area (Figure #). Trap stations were placed in pairs at 10m intervals, totaling 14 traps along immigration transect A and 20 traps along immigration transect B.

Traps in both core grids and along immigration transects were set for the first time one day after each of the two bait broadcasting events and checked for two consecutive nights. Morphological measurements and reproductive condition were noted on all captured mice, and all mice were inspected externally with a UV light for exposure to the biomarker. Mice testing positive for bait consumption were euthanized using AVMA-approved methods to simulate a toxic removal from the population, while any mice not showing signs of exposure were released unharmed at the point of capture. Ten percent of the mice testing positive for exposure were set out on the grid and monitored in order to assess the rate of secondary uptake through scavenging of mouse carcasses.

2.4.3.4 Bait Consumption Rates

In order to conduct an effective eradication using brodifacoum, a sufficient amount of toxic bait must be delivered and available to all mice in all territories over at least 4 nights. For this reason it is necessary to measure the amount of bait still present in the environment each day for several days after each application. For the non-toxic trial, bait uptake was measured once per day on ten different uptake plots placed throughout the baited area. Transects were 50m x 1m, with four uptake plots within the 27kg/ha bait plot, and six within the 36kg/ha bait plot (Figure #). The bait in the ten uptake plots were flagged and monitored daily after each application until all bait was consumed. Bait pellet uptake rates were then calculated for each day.

Comment [DG46]: Add reference studies

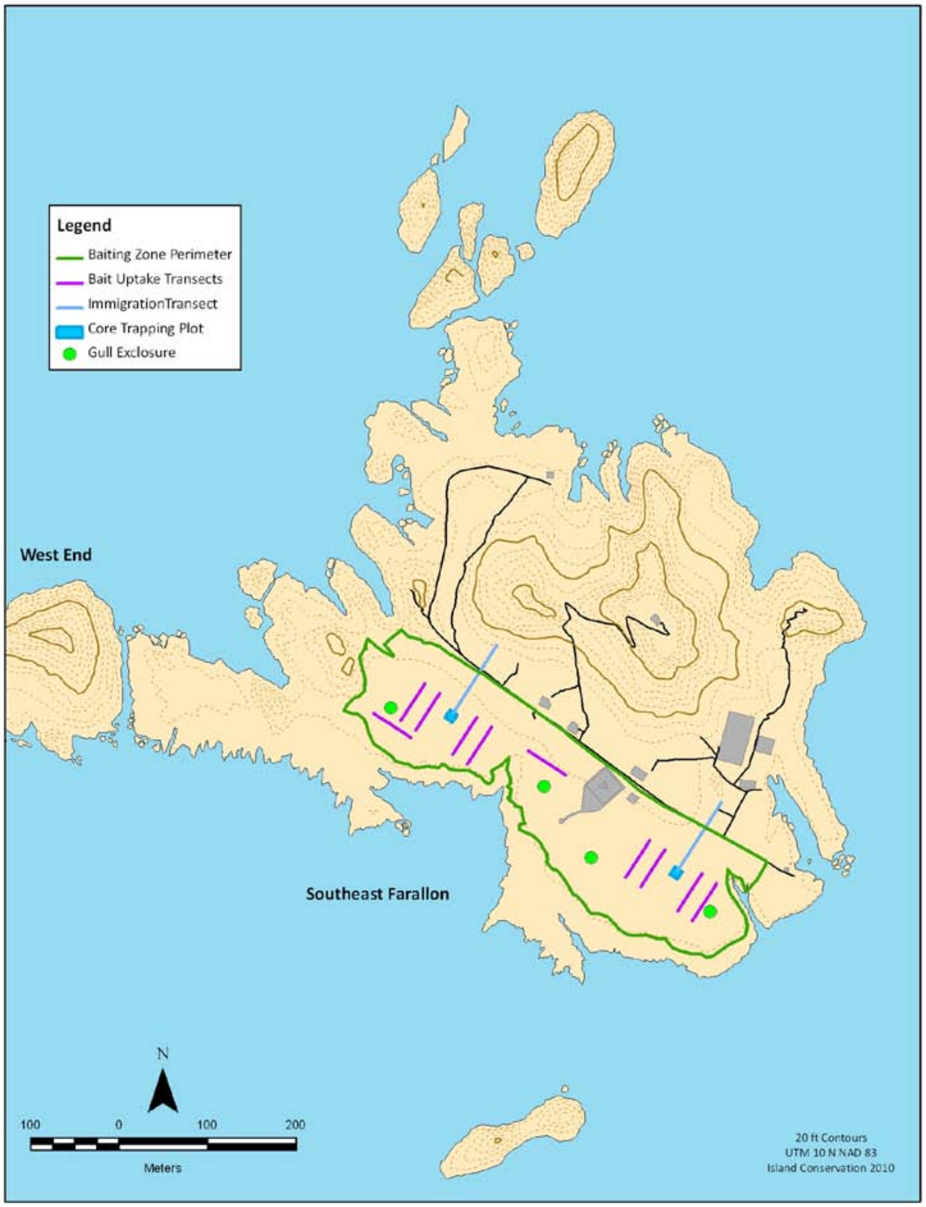


Figure ##. Biomarker detection trap areas, and location of bait uptake plots and gull exclusion zones

2.4.3.5 Non-target Bait Uptake Monitoring

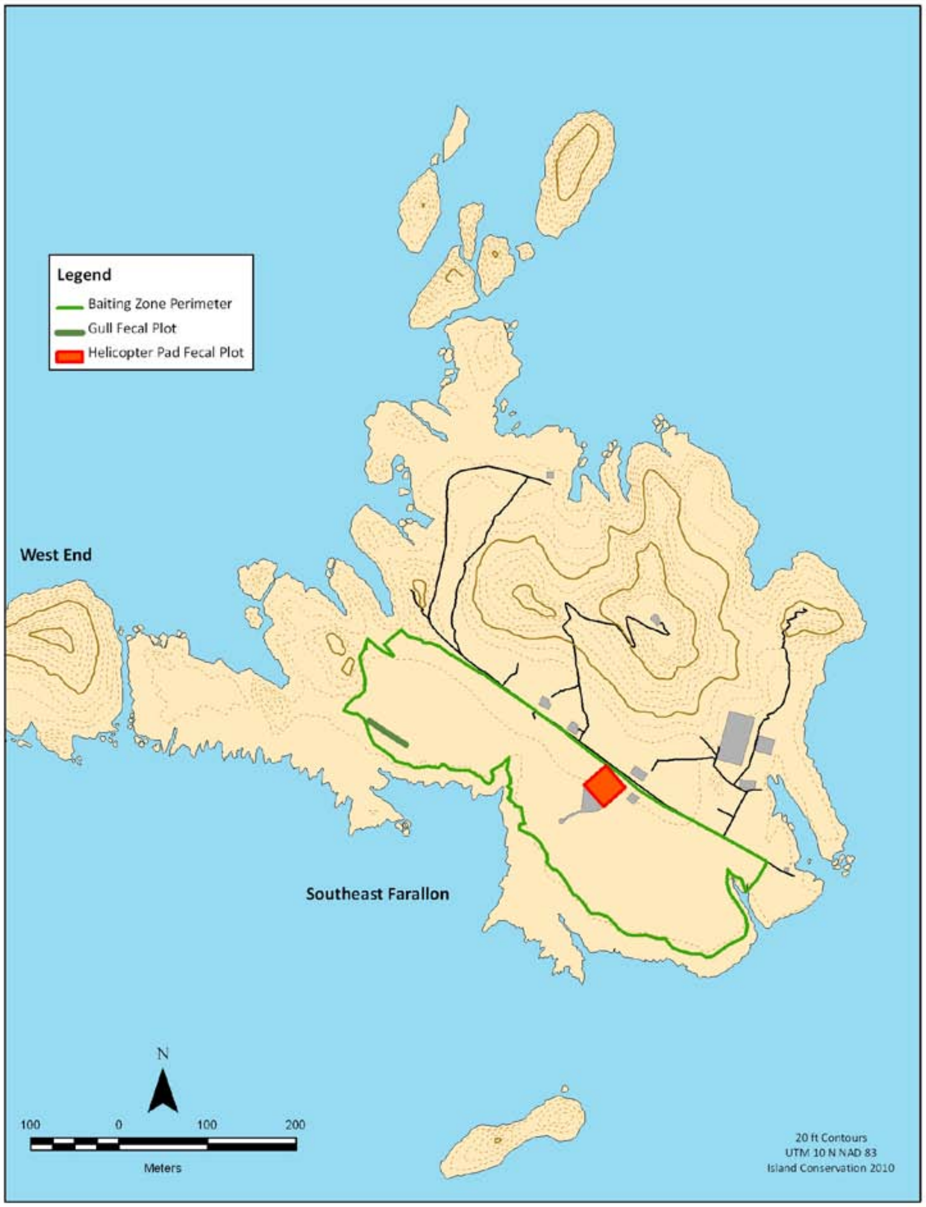
Because there was concern that bait could be taken up by gulls as well as by mice, four gull exclusion devices were set up within the bait zone and monitored daily for bait uptake to assist in determine the percentage of bait being taken by non-target gulls as opposed to mice. Gull exclusion devices were 2.4m x 2.4m x 0.5m constructed of wood and chicken wire that allowed mice to enter at ground level while eliminating any large birds such as gulls to enter and consume any bait. Two gull exclusion devices were in Study area A and two were in study area B (Figure #). Observations of gulls and other birds within and near the baited zone were also conducted throughout the day to determine approximate numbers on island and to assist in estimating the number of gulls and other non-target species actually foraging on the bait pellets. Two gull fecal plots, one in study area A and one in study area B were also established in two different known roosting areas and were monitored daily to determine the percentage of fecal deposits that tested positive for biomarker.

2.4.3.6 Additional Studies Conducted during the Biomarker Trial

A wide variety of other methods were also employed to assess additional variables listed below:

- Bait pellet acceptability and preference by mice
- Biomarker detectability and persistence in mice
- Bait pellet degradation (weathering) studies
- Determine if there is active reproduction ongoing at this time of year
- Rates of bait removal from the environment by mice and gulls
- Detection of biomarker in gulls and burrowing owls and salamanders
- Uptake rates of mouse carcasses euthanized and set to determine secondary uptake rates
- Conduct mice DNA sample collection from both Southeast Farallon and West End
- Detection of biomarker exposure in invertebrates
- Locate and assess caves, coves and areas that may need special bait treatments
- Assess and locate which areas can be treated using bait stations
- Identify and assess treatments that may be used for buildings or other man-made features
- Determine ability to access various portions of the islands and surrounding islets

(See Appendix #XX for a full report on the methods used for each aspect of the trial study).


Legend
Baiting Zone Perimeter
Gull Fecal Plot
Helicopter Pad Fecal Plot
West End
Southeast Farallon
N
100
0
100
200
Meters
20 ft Contours
UTM 10 N NAD 83
Island Conservation 2010

2.4.4 Summary of Biomarker Trial Results

2.4.4.1 Index of Abundance

Out of 500 possible trap nights (100 traps set for five nights) a total of 434 mice were captured. Trap success averaged 93% on days 2 through 5. The lower trap success the first night (62%) was likely due to less than optimal sensitivity setting of the trap triggers the first evening, rather than any neophobia, based on insepection of the trigger settings on the doors on the first morning. A total of 250 unique individual mice were captured and marked in the trapping period in the 0.25ha area. Recapture rates on nights 2 through 5 were: 35%, 40%, 56% and 66%. The mice were extremely abundant and easily trapped, likely to a combination of high population levels and a scarcity of food resources. Mice were commonly seen foraging throughout the daylight hours, as well as at night. A mouse density estimate is currently being developed using this data, but the raw data alone suggests an extremely high mouse density on the island, as these types of capture rates are rarely reported in the small mammal trapping literature.

2.4.4.2 Bait Efficacy Results

The trap results indicated a high likelihood of bait exposure in mice trapped in the sampled areas. On trap grid A 100% of the mice captured tested positive for biomarker bait consumption after each of the two bait applications. A total of 13 mice were captured in grid A, amounting to ~2% trap success. Area received On grid B mouse trap success rates were much higher, with 25 mice captured after the first application (6.5% trap success), and 129 mice captured after the second bait application (~32% trap success). All 25 mice captured on grid B after the first bait application were positive for biomarker (100% exposure), and on the second trapping 124 of the 129 mice were positive for biomarker, resulting in a 97% exposure rate for that grid on those trap dates.

The few mice not exposed to biomarker in plot B after the second application is likely due to two factors: 1) mice immigrated into the trap grid from outside the biomarker baited area, and/or 2) mice were not exposed to bait due to non-target bait uptake in this area being very high during the days leading up to and following the second bait application. The fact that all five unexposed mice were captured in the northern portion of the bait grid indicates that the mice may have moved in from the unbaited area to the north, which was the only non-baited area within 50m of the bait grid (Figure X). The fact that mouse captures increased by a factor of ten over time in this area indicates a wave of immigration may have occurred. This is supported by the rapid increase in the number of trapped mice on grid B over time, even though those mice testing positive were removed from the population each day. The total number of mice trapped on grid B each night 16 and 9 during the first two trap nights, and 32 and 97 on the next two trap nights, indicating that mice appeared to be moving into the trap zone over time.

Bait uptake by gulls in this area was also very high during this period, however, despite the fact that this area was baited at the higher density of 18kg/ha during the second application as described below in Section 2.4.4.2. It was also noted that non-target (gull) uptake in this area was quite high during the two days preceding the second trapping, leaving considerably less bait available for mice to consume, as described in Section 2.4.4.3.

Immigration transect trapping in both areas A and B revealed positive test results for biomarker in mice captured in traps placed within the bait zone, and a few negative trap results for those traps occurring outside the baited zone. Table #XX below summarizes the traps results for all biomarker trapping areas.

Table #XX Summary Statistics of House Mice Trapping for Presence of Biomarker

Trap Area	# Traps Set	Mice Trapped	Positive (%)	Negative (%)
Core Grid A	800	13	13 (100%)	0 (0%)
Core Grid B	800	154	149 (~97%)	5 (~3%)
Inner Immigration A	40	16	16 (100%)	0 (0)%
Inner Immigration B	40	17	16 (9#%)	1 (?%)
Outer Immigration A	16	11	1 (9.#%)	10 (#%)
Outer Immigration B	40	25	0 (0%)	25 (100%)

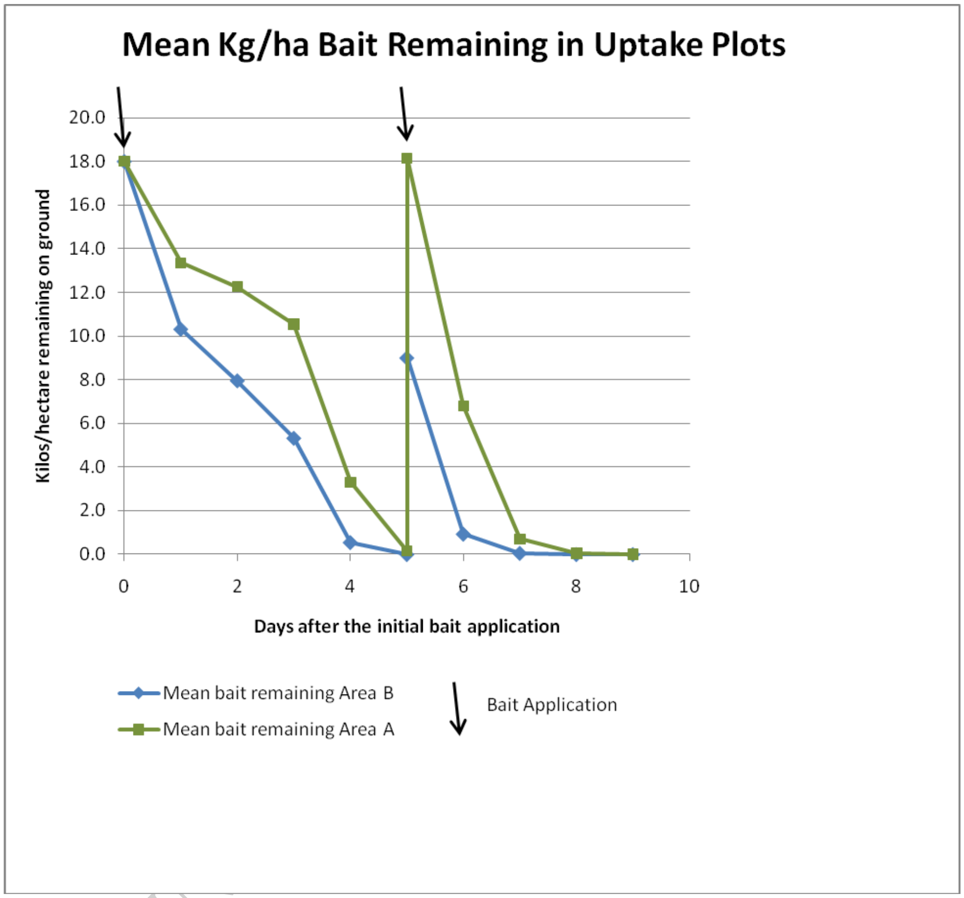
2.4.4.3 Bait Uptake Results

After the first bait application (at 18kg/ha), bait remained on the ground on most of the ten bait uptake plots for at least four nights, which is the target for eradication purposes. Most of the bait was gone by Day 5, when the second bait application occurred. Daily bait consumption rates after the first application were variable among the ten plots and between days, but ranged between 1.6 to 6.3 kg/ha/day over five days, with a daily average of 3.6kg/day (Figure #XX).

The average bait consumption rates per day after the second application was much higher than the first broadcast, with most bait disappearing from the four uptake plots in the eastern area (B) within one or two days. Much of this uptake was likely due to the higher abundance of mice in area B compared to the western study area (A), as mouse capture rates were as high as 49%/day in area B while area A had at most a 2% trap success rate.

On the second application, Area A received twice the amount of bait (18kg/ha) than Area B (9kg/ha), yet most of the bait on the six uptakes in area A were also consumed in two days as well. It is likely that some of this consumption was due to non-target uptake of the bait, as by this time some of the western gulls had learned to identify the pellets as a food item and been observed foraging for bait heavily in area A, and to a lesser extent in area B (See the following Section 2.4.4.4 for these results).

Comment [DG47]: Add conf. intervals to graph to inform application rates

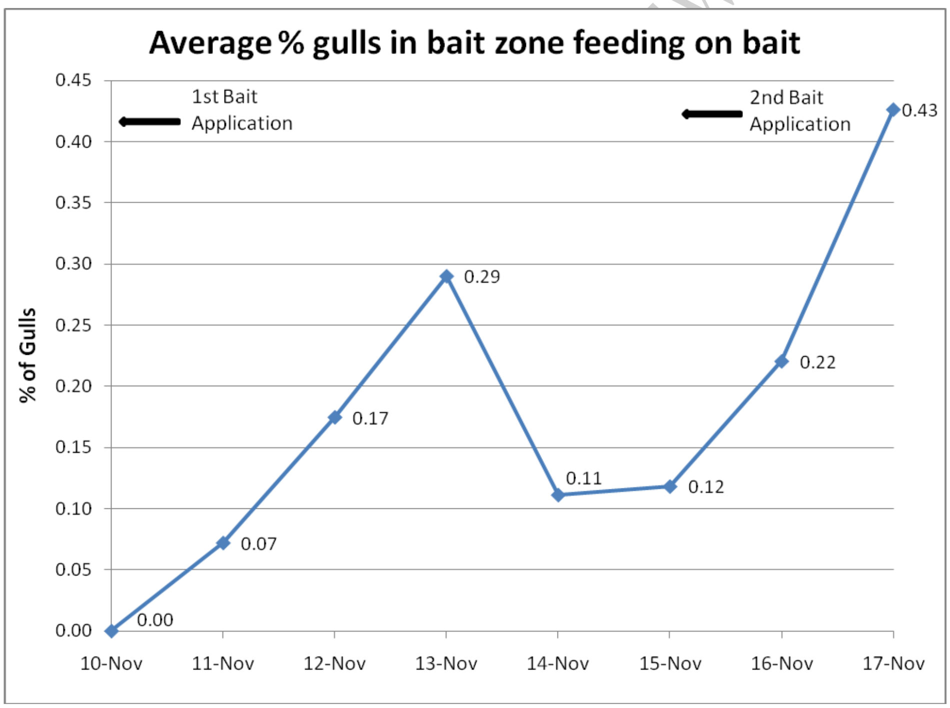


2.4.4.4 Trial Non-Target Bait Uptake

The daily uptake monitoring of bait in the four gull exclusion devices demonstrated that gulls were in fact a factor in consuming bait in the bait zone. Bait inside the two gull exclusion devices in Area B was consumed by mice within one to two days, while in the two exclusion devices in area A with relatively fewer mice, the bait lasted for three to four days longer than those immediately adjacent areas where bait was accessible to gulls which were roosting nearby and present in large numbers. Although the small size and number of the exclusion devices limits the ability to extrapolate the results to an island-wide scenario, it is possible that gulls could consume significant amounts of the bait if no avoidance measures are taken.

Comment [DG48]: We wil see if we can calculate this %, or present the data in a table or graph of results

In addition to these pellet counts, 324 ours of visual observations were made of the baited areas each day after baiting over 8 days to determine how many gulls were present in and near the baited zone and how many were observed actually or potentially foraging on the bait. Within a day of the first application less than a dozen western gulls were seen beginning to forage on the bait in a few small areas, but by the second and third days the maximum number of gulls consuming pellets were 118 and 233 total, amounting to 28% to 39% of the gulls in the bait zone. On days 4 and 5 the percentage dropped to 15%, but after the second application of bait on Day 5, the number of pellet-foraging gulls had grown to 153 and 321, representing 34% and 63% of the gulls present in the bait zone. On average, the percentage of gulls foraging onbait during the eight days it was available averaged 27%. The gull foraging behavior on the non-toxic pellets was a learned behavior that seemed to attract additional gulls as they witnessed the foraging motions of nearby gulls. The majority of the gull foraging occurred in the first two hours after sunrise and during the hours preceding sunset. This factor could be useful if applying any gull-avoidance measures during and eradication.



Preliminary trial results indicate that at least 25-50% of the gulls present on island could be at risk during a toxic pellet broadcast unless they were prevented from encountering the bait. Allowing gulls free access to bait would not only result in gull mortalities, but it could have the effect of removing bait that would be necessary to expose all mice on the island to the rodenticide for at least four nights. A successful eradication is one that ensures that every single

Comment [DG49]: Will need to re-analyze the data for a more accurate estimate mouse on the island is exposed to the toxin. The trial results indicate that some form of gull hazing may be necessary to achieving a successful eradication. A gull risk analysis has been contracted that will assess this risk in more detail.

2.4.4.5 Gull Counts

Island-wide gull counts conducted to estimate the number of gulls on the South Farallon Islands each day during November was highly variable from day to day, ranging from 525 to 3800, and increasing generally with time, as the population shifted from mostly non-breeding intertidal roosting gulls to a larger percentage of territorial breeding birds beginning to spend more time on potential breeding sites throughout the island.

Comment [DG50]: Add Avg/mean gull estimates for all SEFI and West End here, and include December as well. (Jan. add later)

Comment [DG51]: Add table/graph here

A focused gull risk analysis to determine the extent of the risk posed to gulls has been contracted to a team of professional risk analysts familiar with pesticide issues. The results will be discussed in Section 4 and will be provided as an Appendix for the Administrative Draft EA as it becomes available.

Comment [DG52]: First Draft Due ~Feb. 1

2.4.4.6 Additional Trial Results

The biomarker trial was very successful in confirming and assessing the trial's major goals. The following generalized results have informed the action alternatives that have been developed:

A. Mice were exceptionally abundant during the trial, with over 93% trap success, and over 250 uniquely marked individual mice captured in a 0.25ha study site over five nights.
B. While some mice may be able to breed year-round, most mice were not in reproductive condition in November, and most breeding activity appeared to be over at that time.
C. Mice are having a major impact on the island's resources, eating up to ## kg/year??
D. Mouse abundances on the island are highly variable from site to site.
E. The ~1g bait pellet size and composition was highly acceptable and palatable by the mice
F. The EPA registered application rate for brodifacoum of 27kg/ha (delivered at 18 and 9 kg/ha) would likely be effective at exposing all mice to bait under certain conditions.
G. Measures to limit non-target (gull) pellet consumption may be necessary to maintain bait on the ground for the time required for complete exposure to all the mice on the islands.
H. Some Western gulls would readily learn to eat the bait pellets within several days
I. That secondary exposure could occur to raptors, ravens and gulls from exposed mice unless mitigation measures were implemented to limit scavenging or predation on mice.
J. That unconsumed pellets of Conservation 25D would degrade after several rain events
K. That no exposure to the biomarker was observed in Farallon arboreal salamanders
L. That island invertebrates have been impacted by the presence and predation by mice
M. That mice occur on West End and are relatively abundant there as well as on SEFI
N. That the numerous caves, coves and steep slopes may require special bait treatments
O. That many areas of steep terrain, or with tidal influences, restricted entry and/or sensitive resources means that parts of the islands could not be treated using bait stations alone.
P. That the houses, buildings or other man-made features would require special treatment
Q. That access to various portions of the islands and surrounding islets will need to take into account logistics, wind, waves, tides, weather, and presence of marine mammals.

Comment [DG53]: Calculate based on density estimate to be determined.

Comment [DG54]: We should develop the relative abundance data analysis more

Comment [DG55]: Get Gregg Howald to confirm and qualify this conclusion

Comment [DG56]: Add supportive citations

R. That the number and location of roosting gulls and territorial western gulls on the island can be quite variable from month to month, day to day, and even hour to hour.

S. That effective gull hazing measures could reduce the number of gulls exposed to the bait

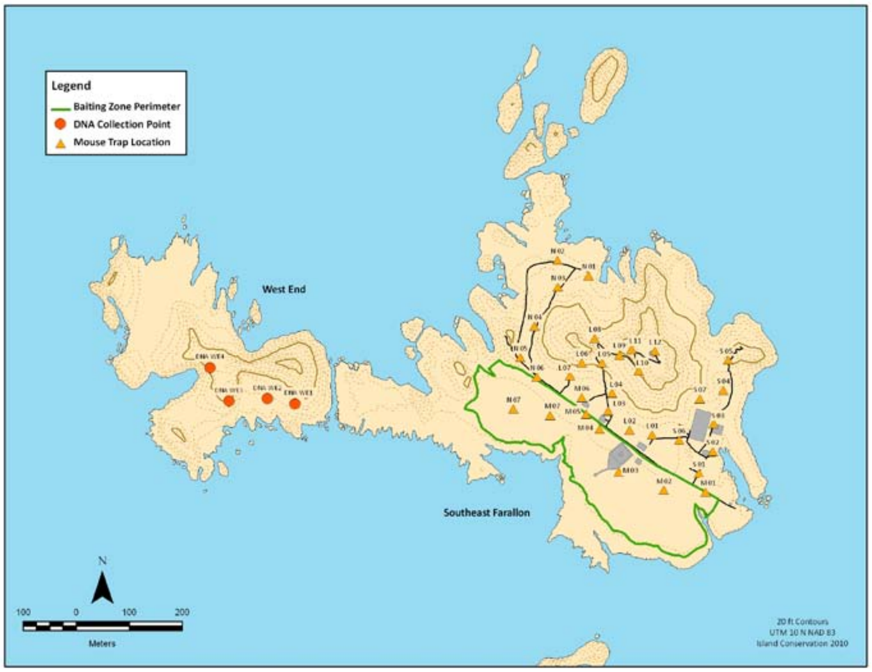


Figure XX. Sites of Mouse DNA collections - November 2010

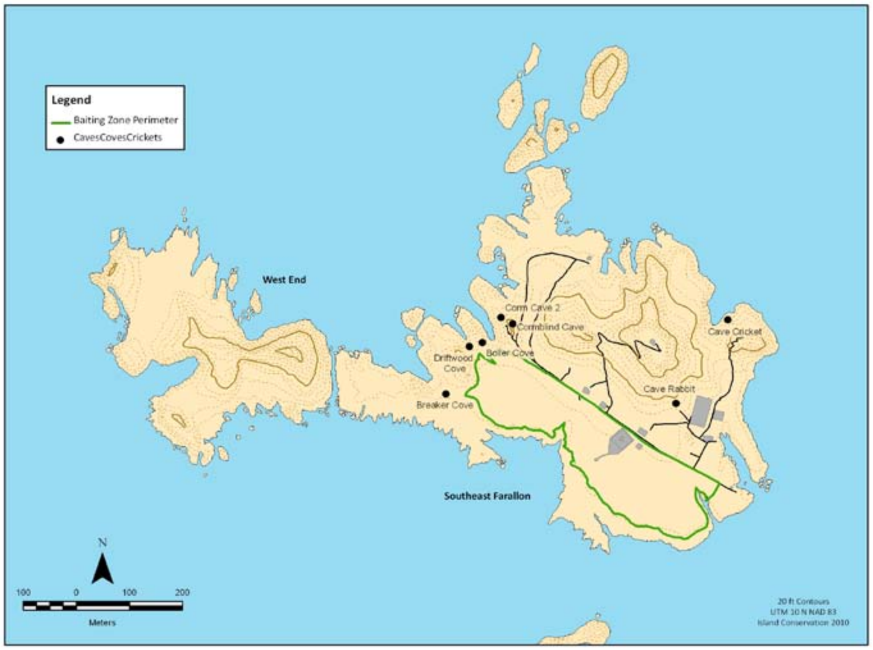
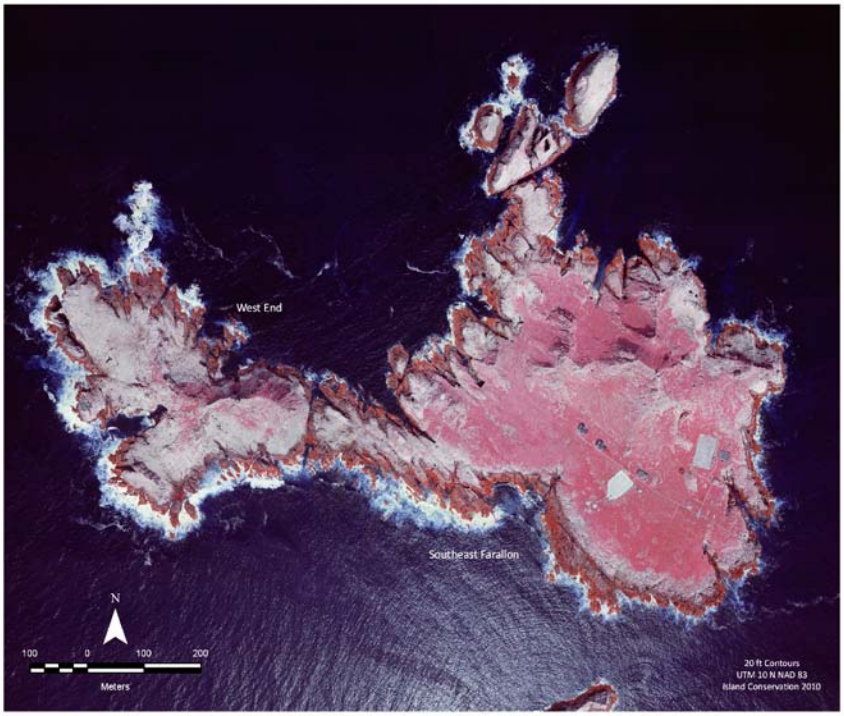


Figure XX. Caves and Coves which were GPSed and inspected during the 2010 Trial Study



2.4 Alternative B: Mouse Eradication with Aerial Bait Broadcast as Primary Technique

2.4.1 Rationale for Aerial Bait Broadcast

Employing aerial bait broadcast as the primary bait application method would minimize disturbance to the South Farallones' sensitive terrestrial habitat by allowing the Service to deliver bait to all potential mouse habitats on the island without setting foot on a majority of the landscape. Aerial bait broadcast could be conducted with less than two days of actual helicopter broadcasting, minimizing the length of disturbance to island wildlife. Aerial bait broadcast is also the only safe way to deliver bait to inaccessible terrain such as steep cliffs or within restricted use areas like the designated wilderness. Additionally, aerial bait broadcast by helicopter is the preferred bait delivery technique that is currently used most frequently worldwide for island rodent eradications (Howald et al. 2007a).

2.4.2 Summary of Bait Delivery Methods

This alternative would involve the use of several bait delivery methods. While the primary method employed would be aerial broadcast, it would also employ bait stations in and around the buildings, water catchment pad, and hand broadcast in selected areas. Figure XX shows which areas would receive which treatment under this alternative.

Comment [DG57]: add this Figure - Alternative B Bait Application Method Map

2.4.2.1 Aerial Application

Bait pellets containing rodenticide would be systematically applied by helicopter to most land areas above the mean high tide mark on the South Farallones. Bait would be applied in two to three applications, separated by 5 to 21days. Bait would be applied at up to 18kg/ha during the first application, and up to 9kg/ha during the second application. A third treatment would only be conducted if particular areas warranted it, based on bait uptake and the presence of or potential for any continued mouse activity. Helicopter swath width, and would be between 30m to 80m wide, and each swath would overlap the previous swath by 25-50%, depending on swath width, to avoid the risk of gaps in coverage. Bait application rates would be adjusted to account for this overlap. Two types of aerial application swaths would be mapped: a coastal swath up to 60m wide, and a set of parallel interior swaths. On the second application, the parallel flight lines would be run at right angles to the first to take into account variances in bait distribution based on terrain. Each of the two aerial applications could likely be conducted in less than one day.

Comment [DG58]: define these parameters for secondary bait rates and selection of additional bait rates and areas.

Comment [DG59]: Method to reduce superfluous bait drift into these zones where flight lines cross should be discussed more.

In those areas that cannot be baited by helicopter, such as near housing areas, along deeply invaginated coastlines, and over water catchment pads, project staff would distribute bait pellets manually, either by foot, by boat or by hand from the helicopter. The active water catchment pad would be tarped to reduce the possibility of drift into the water supply.

Comment [DG60]: Operational plan would delinate these areas in more detail.

Comment [DG61]: Confirm this method

2.4.2.2 Bait Stations

Project staff would install bait stations in limited circumstances, including within and near residences and outbuildings, in caves, and in more limited areas where bait might be exposed to water or to minimize non-target uptake in selected areas, such as along shorelines. Bait stations would be placed approximately every 5m to 12.5m, and used according to USDA EPA label requirements. Unbaited stations would be placed approximately six weeks prior to baiting, and they would be armed with bait 1-2days before the first aerial application, and checked every other day for three weeks, and then less frequently (weekly or as needed) to keep them armed. Bait stations would also likely be used in buffer zones around aerial exclusion zones to reduce any gaps in coverage.

Comment [DG62]: Confirm timing specs

2.4.3 Timing

Placement of the unarmed bait stations would occur in early fall, likely in September or October. Aerial broadcast operations would occur in the late fall or early winter, most likely in the months of November and/or December. The actual time period for bait application under the preferred alternative would be defined by the islands' biological patterns and acceptable weather conditions. The period available for bait broadcast would begin after the summer breeding season for seabirds, sea lions, and fur seals on the Farallones has ended, and end before female northern elephant seals (*Mirounga angustirostris*) have started giving birth in the early winter (more information on these species is in Chapter 3). Bait broadcast would be completed within this time period, allowing for anticipated weather contingencies. Furthermore, bait broadcast would only be initiated if local weather predictions indicate that precipitation would be unlikely for at least four days. If weather conditions interfere with the scheduled applications, some back-baiting might be required, where treated areas could be retreated.

Comment [DG63]: Build weather contingency into operational plan

Comment [DG64]: (Cite Anacapa EIS-Supplemental)

2.4.4 Equipment and Materials

Aerial broadcast operations would be conducted using a single primary-rotor/single tail-rotor helicopter equipped with a specialized bait bucket, known as a hopper, slung beneath, as described in (Section XX).

2.4.5 Bait Application Operations

Bait broadcast by helicopter would consist of low-altitude overflights of the majority of the land area of the South Farallones. Each aerial broadcast of bait would likely be completed in one day. Areas within the aerial broadcast exclusion zones would be hand baited or baited with bait stations. These areas include the houses, outbuildings, water catchment, and some highly invaginated shoreline areas and cliffs to minimize drift into the marine environment.

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 baited by hand or using bait stations. A limited number of bait stations would also be installed elsewhere on the island as necessary. The bait stations would have the design specifications listed in Section 2.4.4.

2.4.6 Project Support Operations

In addition to applying bait, helicopters would be used to transport equipment and personnel to the island for the purpose of this action. These additional helicopter operations would be localized to discrete flight paths that would be determined so as to minimize disturbance to native wildlife. Helicopters may hover for brief periods over land to drop off personnel and equipment.

Helicopters may be staged from the island or from a boat offshore of the island. Helicopters would only land at designated staging areas, where staff would re-fill the bait hopper, re-fuel, and conduct other necessary maintenance. These staging areas would be adequately stocked with fuel and other supplies and equipment to support the helicopter for the entire bait application process.

2.4.7 Mitigation Measures

Mitigation measures to be used in this and all other action alternatives are similar and have been described in Section 2.2, but there are differences in when, where and how the mitigation measures will be employed.

Some non-target bird species may be exposed to the bait either directly by consuming the bait pellets or indirectly by consuming mice or other organisms that have eaten the bait. A fraction of the resident raptors and gulls on the island at the time of the application may experience exposure to the bait without some form of specific efforts to avoid such exposure.

Mitigation Measures to be employed for this and all action alternatives would include:

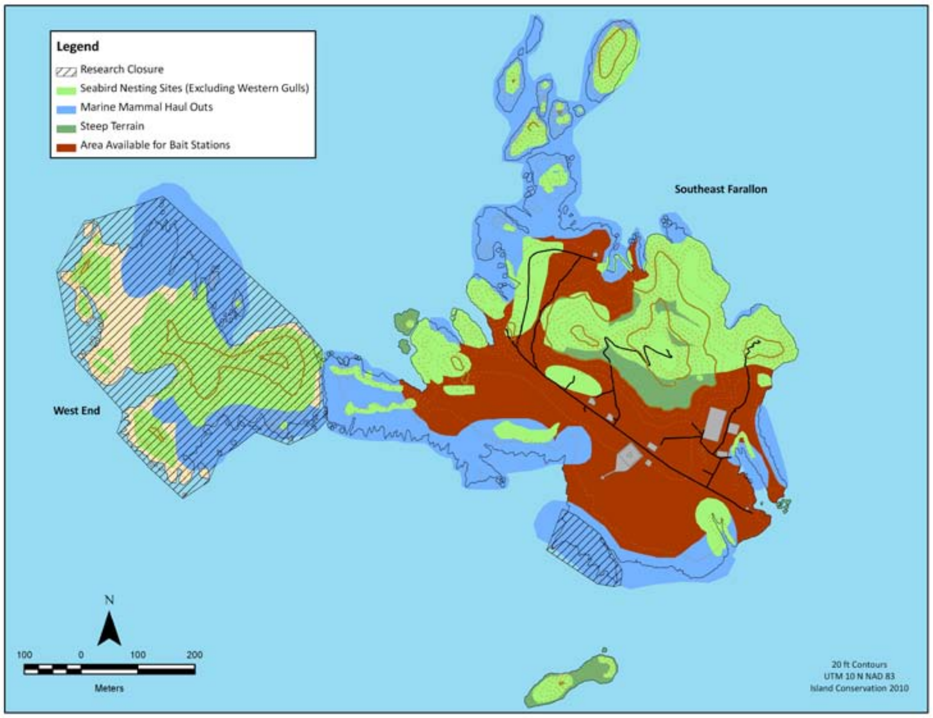
- **Timing:** Conducting the operation at a time of year when the resident seabird, shoerdird and land bird populations are at their lowest.
- **Carcass removal**: Dead mice, birds or any other animal found that is suspected of having succumbed to the toxicant, will be removed when found to reduce the likelihood of secondary exposure in scavengers;
- **Burrowing owl capture and relocation:** Efforts will be made to capture the transient burrowing owls arriving on island and to hold and release them on the mainland, as the Service has done in the past, to reduce the risk of toxicant exposure; and
- **Capture, hold and release efforts for other resident and migrating raptors**: The resident pair of Peregrine falcons and Common ravens (*Corvus corax*), and possibly other migrating raptors may be captured and removed until the Service determines the birds would no longer be at risk of exposure to toxicant;
- **Gull hazing:** Attempts will be made to reduce gull pellet consumption and non-target mortality by utilizing techniques developed and tested during a January 2011 hazing trial.
- **Use of bait stations:** In areas with particularly high concentrations of roosting gulls to reduce gull uptake of bait.

Pinniped disturbance reduction methods used for this alternative**:**

- **Timing**: Conducting the operation and before and after the pinniped pupping seasons;
- **Crouching** or crawling when necessary to remain out of view of nearby animals;
- **Moving slowly** and deliberately to avoid frightening animals while traveling by foot
- **Avoiding sensitive areas** when possible to reduce disturbance to haul-out sites
- **Education and Training**: All staff would be shown maps detailing areas with sensitive wildlife and trained on how to avoid disturbing wildlife and avoiding impacts to sensitive habitats such as nesting burrows and crevices. These sensitive wildlife areas are fully described in Section 3.

Addition mitigation: Alternative B will also employ the use of a controlled surveillance flight with a PRBO marine biologist prior to any aerial bait applications. Although none will likely be breeding during the aerial application window, pinnipeds will likely still be present in potentially large numbers during the late fall and early winter. In order to reduce the risk of unpredictable and potentially harmful disturbance to pinnipeds from helicopter operations, the helicopter pilot would conduct a controlled surveillance flight around the coastline before bait operations begin in which pinniped haulout locations are noted. During this surveillance flight, an experienced pilot would approach major haulout sites with the intention of exposing hauled out animals to a gradual auditory and visual disturbance similar to the bait application. This controlled "dry run" would likely enable the animals to become aware of the helicopter and then move off of major haulouts into the water, which would allow the helicopter to treat coastal areas immediately afterward while most pinnipeds are still in the water rather than hauled out again. This approach would reduce the risk of a stampede among hauled out animals, thus reducing their risk of injury. This technique was successfully employed in both the Anacapa Island treatment and the Rat Island treatment in the USFWS Alaska Maritime Wildlife Refuge (Citation).

Comment [DG65]: Add citation proper



2.5 Alternative C: Bait Station Delivery as Primary Technique

2.5.1 Rationale for Bait Stations

Using bait stations as the primary bait application method would reduce the risk that birds or other non-target species would be exposed to the rodenticide, and reduce the total amount of rodenticide introduced to the environment. Using bait stations would also reduce the extent of helicopter operations over the South Farallones. Bait station delivery was historically the first method of island rodent eradication, and it remains common today (Bell 2002, Burbidge and Morris 2002, Hayes et al. 2004, Clout and Russell 2006, Howald et al. 2007a).

It would be nearly impossible to conduct a successful mouse eradication operation using bait stations exclusively, and to date there has only been one successful mouse eradication only using a bait station technique (Citation) Therefore, under this alternative, the Service will treat inaccessible areas such as cliffs and unstable slopes by hand or by aerial broadcast. The primary rationale for using bait stations is to reduce the overall non-target risk for the majority of the islands biological resources. Unfortunately, a bait station operation would need to be installed and revisited every other day for several months, which could cause unacceptable impacts to

Comment [DG66]: Get citation

breeding birds and marine mammals in many areas, so that these sensitive resource areas would require aerial baiting as well to limit the human activity over large areas of habitat. Furthermore, a large percentage of the area (West End) is designated wilderness making much of the island almost entirely untreatable in this manner. Those areas that could conceivably be treated by bait station total 15-20? hectares and are shown in red in Figure XX.

2.5.2 Summary of Bait Delivery Methods

Enclosed bait stations would be installed every 5m - 12.5m in a grid pattern across the majority of the accessible land area on the South Farallones. In areas that cannot be included in the bait station grid, such as cliffs, unstable slopes, and critically sensitive habitat, bait pellets containing rodenticide would be spread by helicopter or by hand. In all areas where bait stations can be safely installed and major impacts to terrestrial habitat (such as seabird disturbance, dislodging of rocks, or erosion) can be avoided or minimized, bait stations would always be the preferred technique under this alternative. Bait stations would also be installed within and near residences and outbuildings.

2.5.3 Timing

Initially bait station installation would begin in the fall after the peak seabird fledging season in September or October. Bait stations would be set out six weeks prior to being armed, and armed one to two days before aerial operations. Areas that are not included in bait station coverage would be baited by hand and helicopter in the late fall or early winter according to the timing specifications described in Alternative B (Section 2.3.3). The use of bait stations in Alternative C would entail at least a year of maintaining the bait stations. This sequence of operations would be particularly important for Alternative C because bait would only be available in broadcast-treated areas for a limited period of time, thus it would be essential to eradicate mice from adjacent bait station-treated areas before broadcast treatment is initiated to eliminate the possibility that mice could migrate from station-treated areas into broadcast-treated areas after all the broadcast bait had disappeared.

Comment [DG67]: Confirm length of bait station operation.

Comment [DG68]: This is the main reason this Alternative method has a lower chance of success. It also requires many more people and hours on foot in breeding areas all year long.

2.5.4 Equipment and Materials

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 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.

Since bait stations would need to be accessed frequently during bait dispersal, the Service would have to ensure that there is sufficient access would have to be ensured to each bait station. In some cases no landscape modifications would be necessary; however, depending on the local placement of each station, a number of landscape modifications and/or installations may be necessary to properly secure bait stations into place. Examples of these modifications could include:

- Paths cut through vegetation for stability;
- 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.
- Some bait stations may also require modification (i.e. additional covering) to prevent rain or moisture from entering the box and damaging the bait.

Some access pathways may need to be crossed especially in sensitive habitat such as areas with seabird nest burrows and rocky talus slopes that harbor seabird nest crevice habitat. Whenever possible, access paths would be routed around sensitive biological habitat, or temporary platforms, walkways, or other temporary infrastructures would be installed to avoid trampling.

Each bait station would be secured to the ground with anchors placed into the soil or drilled into the rock as appropriate. The infrastructure required for the bait station grid would be durable enough to withstand the corrosive marine environment of the Farallones for up to two years, but it would be removable and not a permanent fixture on the islands.

Any areas in which bait station installation and maintenance would be extremely difficult (e.g. cliff areas) would be treated with a hand or aerial bait broadcast to ensure that all rodents on the island have access to the bait. The helicopter, hopper, bait and bait station that would be used are the same for all action alternatives, but the number of bait stations required for this alternative would be substantially larger than the other two alternatives.

Approximately 15-20 hectares of land would need to be baited with bait stations under this alternative, with potentially one bait station every 5m, amounting to up to 10,000 stations, with an additional xx stations required in and around the houses, outbuildings, caves, shorelines, and dense gull roost and/or haul-out areas.

Comment [DG69]: Revise figure based on calculated acreage.

Comment [DG70]: Need to discuss this strategy based on uptake, crushing of bait, and MM disturbances

2.5.5 Bait Delivery Operations

Bait stations would be placed on a grid that covers those portions of the islands potentially accessible on foot (Figure XX) To maximize the probability of delivering bait to each and every mouse, station spacing should be 5 to 12.5m apart. The total land area of the South Farallones is 120 acres (49 ha), but at least 70 percent? of that land area would be excluded from the bait station grid. Assuming, then, that a bait station grid would cover 20 ha, a 10 m spacing would require an estimated 2000 individual bait stations, and 5m spacing would require an estimated 8,000 stations. These stations would need to be visited every other day for XX days, requiring considerably more personnel than other alternatives and resultant repeated foot traffic on the island.

Comment [DG71]: Amend figure using planar or surface area figures?

Comment [DG72]: Get new #s based on %

The design and location of the bait station grids would be adaptive. The grid pattern would need to be carefully designed and installed taking the complex topography of the island into account – cliffs and highly unstable slopes would be identified during on-site surveys, mapped, and excluded from bait station grids. For all areas in which bait stations could be safely installed, the Service would choose bait stations over hand or aerially broadcasting bait, with two exceptions:

7. When the Service determines that bait stations in specific sites would likely cause major negative impacts to sensitive species such as seabirds and pinnipeds, bait may be broadcast instead, either by hand or by helicopter. When designing the bait station grid, however, the Service would need to prioritize the relative ecological importance of avoiding disturbance to seabirds nesting in different sections of the island, with the recognition that in order to cover greater than 50 percent of the island, thousands of seabirds would likely need to be disturbed.
8. In Designated Wilderness, the Service would choose hand or aerial broadcast before bait station operations in wilderness areas where bait station installation would require greater-than-normal habitat modification such as extra anchors or breaking rocks.

Each bait station would be armed with bait pellets as soon as possible once the program is initiated. 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. 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 another full mouse breeding cycle, documenting bait take and mouse sign in stations. Bait station visit rates would be modified based on uptake rates.

Comment [g73]: This will need to be modified to reflect the slowdown in bait taken. Look at Palmyra EIS for some insight.

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 or critically sensitive areas would require the use of a helicopter. Helicopter broadcast methods and considerations in Alternative C would be to the same as those described in Alternative B, (Section 2.3). 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. As described above in Section 2.4.3, the sequence of implementation would be important. In addition to the seasonal timing requirements of aerial broadcast described in (Section 2.3.3), bait broadcast operations would be further constrained because broadcasting would not start until the Service no longer detects mice within the core of the bait station grids. This will likely take at least four weeks from the time bait stations are first armed and possibly as long as three months after arming.

Comment [DG74]: Review Alternative C Map for accuracy of sensitive resource areas where no bait-stations will be allowable/possible.

Comment [DG75]: Confirm that bait overlap is allowed by label …ask Gregg Howald

Bait stations would also be installed in and immediately surrounding all of the buildings and enclosed structures on the island.

All personnel that handle bait or monitor bait application in the field would meet or exceed all requirements for personal protective equipment (PPE) required by the EPA. 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.

2.5.6. Project Support Operations

Helicopters would also be used to transport equipment and supplies, including the bait and bait stations that will be installed, to the island for the purpose of this action. These additional helicopter operations would be localized to discrete flight paths that would be determined so as to minimize disturbance to native wildlife. Helicopters may hover for brief periods over land to drop off personnel and equipment.

Helicopters may be staged from the island or from a boat offshore of the island. Helicopters would only land at designated staging areas, where staff would re-fill the bait hopper, re-fuel, and conduct other necessary maintenance. These staging areas would be adequately stocked with fuel and other supplies and equipment to support the helicopters for the entire bait application process.

The personnel required for bait station maintenance would join the PRBO researchers that live on-island year-round, using the residential facilities and infrastructure already in place, as well as limited additional storage and staging space on already-modified land.

2.5.7. Mitigation Measures

Mitigation measures to be used in this and all other action alternatives are similar and have been described in (Section 2.2), but there are differences as to when, where and how extensively the mitigation measures will be employed. Impacts are defined as either non-target consumption or disturbances.

Some non-target bird species may be exposed to the bait either directly by consuming the bait pellets or indirectly by consuming mice or other organisms that have eaten the bait. A fraction of the resident raptors and gulls on the island at the time of the application may experience exposure to the bait without some form of specific efforts to avoid such exposure.

<u>Bird mortality reduction methods to be employed for this and all action alternatives include</u>:

- **Timing:** Conducting the operation at a time of year when the resident seabird, shorebird and land bird populations are at their lowest levels.
- **Carcass removal**: Dead mice, birds or any other animal found that is suspected of having succumbed to the toxicant will be removed when found to reduce the likelihood of secondary exposure in scavengers;
- **Burrowing owl capture and relocation:** Efforts will be made to capture the transient burrowing owls arriving on island and to hold and release them on the mainland, as the Service has done in the past, to reduce the risk of toxicant exposure; and
- **Capture, hold and release efforts for other resident and migrating raptors**: The resident pair of Peregrine falcons and Common ravens (*Corvus corax*), and possibly other

migrating raptors may be captured and removed until the Service determines the birds would no longer be at risk of exposure to toxicant;

- **Gull hazing:** Attempts will be made to reduce gull pellet consumption and non-target mortality by utilizing techniques developed and tested during a January 2011 hazing trial.
- **Use of bait stations:** In areas with particularly high concentrations of roosting gulls to reduce gull uptake of bait.

Although supplemental bait broadcast under Alternative C would occur outside of any pinniped breeding activities, there are still many pinnipeds present during the late fall to early winter time period identified. The Service would follow the mitigation requirements described in Section 2.4.7 to reduce the risk of harmful disturbance to these pinnipeds.

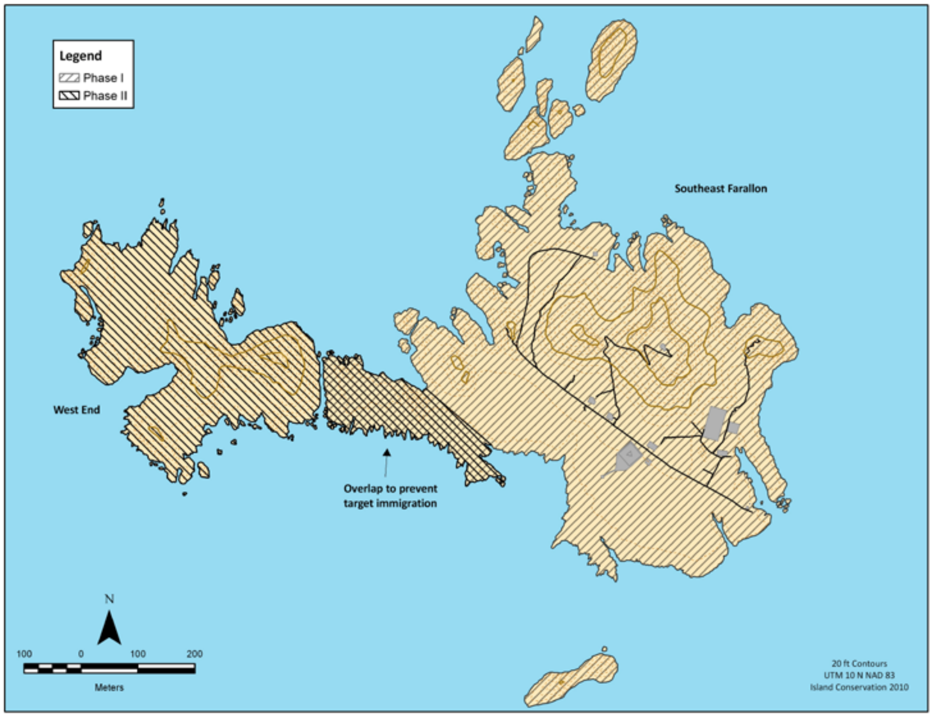
Pinniped disturbance reduction methods used for this alternative**:**

- **Timing**: Conducting the operation largely outside of any pinniped pupping seasons;
- **Crouching** or crawling when necessary to remain out of view of nearby animals;
- **Moving slowly** and deliberately to avoid frightening animals while traveling by foot
- **Avoiding sensitive areas** when possible to reduce disturbance to haul-out sites
- **Education and Training**: All staff would be shown maps detailing areas with sensitive wildlife and trained on how to avoid disturbing wildlife and avoiding impacts to sensitive habitats such as nesting burrows and crevices. These sensitive wildlife areas are fully described in Section 3.

Addition mitigation: Alternative C will also employ the use of a controlled surveillance flight with a PRBO marine biologist prior to any aerial bait applications. Although none will likely be breeding during the aerial application window, pinnipeds will likely still be present in potentially large numbers during the late fall and early winter. In order to reduce the risk of unpredictable and potentially harmful disturbance to pinnipeds from helicopter operations, the helicopter pilot would conduct a controlled surveillance flight around the coastline before bait operations begin in which pinniped haulout locations are noted. During this surveillance flight, an experienced pilot would approach major haulout sites with the intention of exposing hauled out animals to a gradual auditory and visual disturbance similar to the bait application. This controlled "dry run" would likely enable the animals to become aware of the helicopter and then move off of major haulouts into the water, which would allow the helicopter to treat coastal areas immediately afterward while most pinnipeds are still in the water rather than hauled out again. This approach would reduce the risk of a stampede among hauled out animals, thus reducing their risk of injury. This technique was successfully employed in both the Anacapa Island treatment and the Rat Island treatment in the USFWS Alaska Maritime Wildlife Refuge (Citation).

Comment [DG76]: Add citation

The Service would first aim to avoid negative impacts to pinnipeds by timing activities to occur outside of sensitive breeding and molting seasons. However, under Alternative C the maintenance of bait stations would need to continue over at least one year, which would overlap with the breeding seasons of all pinnipeds on the islands. In order to minimize disturbance to pinnipeds, the bait station grids would be designed to be out of sight of large concentrations of pinnipeds. In particular, the bait station grid would avoid known breeding sites for the threatened Steller sea lion (*Eumetopias jubatus*) to reduce disturbance.



2.6. Alternative D: Phased Aerial Bait Broadcast as Primary Technique

2.6.1. Rationale for Phased Aerial Bait Broadcast

This alternative is very similar to Alternative B (Section 2.4) except that the two main islands of the South Farallones (West End and Southeast Farallon) would be baited aerially approximately two to six weeks apart in order to provide the remaining birds and pinnipeds present in the fall with nearby undisturbed roost and haul-out sites on one island while the other is being aerially treated. This alternative would involve more intensive non-target hazing efforts than the other two action alternatives. In order to reduce non-target uptake of bait by roosting gulls, they would be intentionally hazed off of the treated island just prior to bait application, and allowing them to roost undisturbed on immediately adjacent nearby islands. After approximately two to six weeks, they would then be allowed to roost and haul out on the treated island, while the other island is hazed of gulls and then baited aerially. This alternative would also provide the marine mammals with at least one undisturbed island to haul out onto during the duration of the operation. This alternative also has the effect of both reducing impacts to non-target species as well as maximizing the ability to expose all of the mice on each island to the toxicant. Both gulls eating bait and pinnipeds rolling over bait could reduce the amount of bait available to mice in areas of dense roosts and ahul-outs. The only drawbacks to this method are: 1) the time-lag might

Comment [DG77]: Timing could be modified increase the chance that the first treated island could be re-colonized by mice before the second island is treated; and 2) a more intensive initial IHA will be required to allow for intentional disturbances to marine mammals so they can be slowly herded off the targeted island.

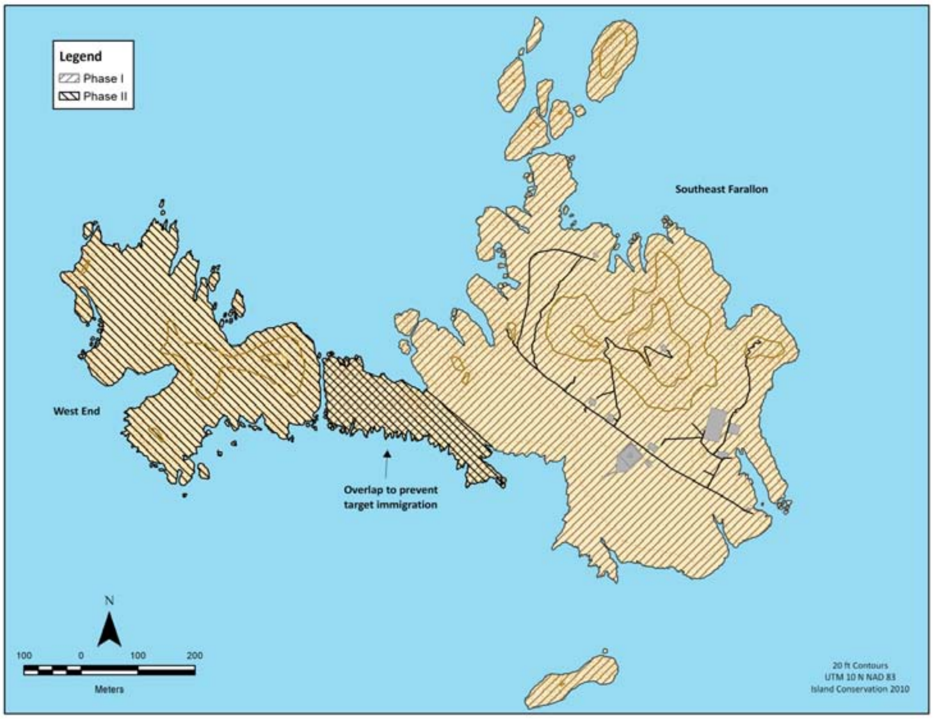
As with Alternative B, utilizing aerial bait broadcast as the primary bait application method would minimize disturbance to the South Farallones' sensitive terrestrial habitat by allowing the Service to deliver bait to all potential mouse habitats on the island without setting foot on a majority of the landscape. Aerial bait broadcast is also the only safe way to deliver bait to inaccessible terrain such as steep cliffs or within restricted use areas like the designated wilderness. Additionally, aerial bait broadcast by helicopter is the preferred bait delivery technique that is currently used most frequently worldwide for island rodent eradications (Howald et al. 2007a).

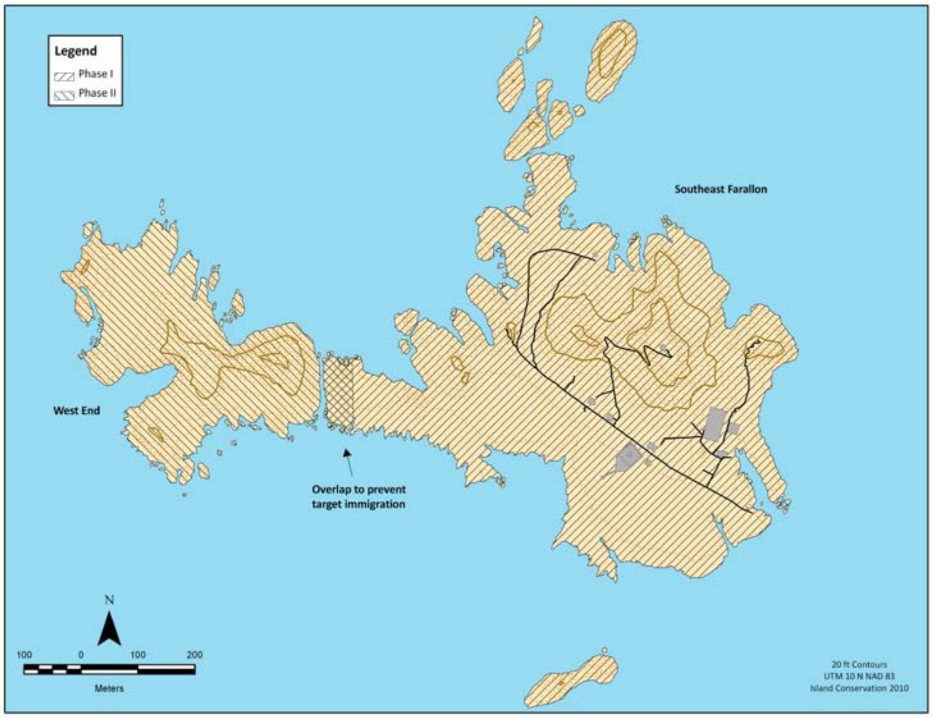
2.6.2. Summary of Bait Delivery Methods

This alternative would involve the use of several bait delivery methods. While the primary method employed would be aerial broadcast, it would also employ bait stations, as well as hand broadcast. Figure XX shows which areas would receive which treatment under this alternative.
The primary difference with alternative D involves the phasing of the application of bait on Southeast Farallone and West End Island, as shown in Figure XX.

Comment [DG78]: Add Figure XX Map here

Comment [DG79]: Add Map of Figure XX


Legend
Phase I
Phase II
Southeast Farallon
West End
Overlap to prevent
target immigration
N
100 0 100 200
Meters
20 ft Contours
UTM 10 N NAD 83
Island Conservation 2010



The Figures above represent two baiting configurations currently being considered for the phased option in Alternative D. The first represents a more conservative approach with more overlap to reduce the likelihood of recolonization by mice between baiting when the two phases of the operation are further apart in time;
The second with minimal overlap represents a strategy that could be employed if there were very little time between phases, although this poses a much greater risk of recolonization as mice may pass through the narrow baited zone without consuming a lethal dose of bait.
I included this second figure more out of concern for avoiding non-target gulls and pinnipeds in the larger peninsular area, and as a point for discussion of this topic.

2.6.2.1 Aerial Application

Bait pellets containing rodenticide would be systematically applied by helicopter to most land areas above the mean high tide mark on the South Farallones, first on Southeast Farallone, and then on West End. Bait pellets containing rodenticide would be systematically applied by helicopter to most land areas above the mean high tide mark on the South Farallones. Bait would be applied in two to three applications, separated by 5 to 21days. Bait would be applied at up to 18kg/ha during the first application, and up to 9kg/ha during the second application. A third treatment would only be conducted if particular areas warranted it, based on bait uptake and the potential for any continued mouse activity.

Helicopter swath width, and would be between 30m to 80m wide, and each swath would overlap the previous swath by 25-50%, depending on swath width, to avoid the risk of gaps in coverage. Bait application rates would be adjusted to account for this overlap. Two types of aerial application swaths would be mapped: a coastal swath up to 60m wide, and a set of parallel interior swaths. On the second application, the parallel flight lines would be run at right angles to the first to take into account variances in bait distribution based on terrain. Each of the two aerial applications could likely be conducted in less than one day.

2.6.2.2 Bait Stations

Project staff would install bait stations in limited circumstances, including within and near residences and outbuildings, in caves, and in more limited areas where bait might be exposed to water or to minimize non-target uptake in selected areas, such as along shorelines. Bait stations would be placed approximately every 5m to 12.5m, and used according to USDA EPA label requirements. Unbaited stations would be placed approximately six weeks prior to baiting, and they would be armed with bait 1-2 days before the first aerial application, and checked every other day for three weeks, and then less frequently (weekly or as needed) to keep them armed. Bait stations would also likely be used in buffer zones around aerial exclusion zones to reduce any gaps in coverage. In those areas near the water catchment pads, project staff would distribute bait pellets manually or use bait stations.

Comment [DG80]: Confirm timing specs

A strip of habitat on the southwestern portion of Southeast Farallon Island would be baited at the same time as West End, so as to reduce the likelihood of mice in this area crossing the Jordan Channel and recolonizing West End while SEFI is being treated**.** Bait stations may be used in this area as well as hand and aerial broadcast in order to ensure proper bait density applications. Use of supplemental bait stations in this area may be useful to reduce uptake by any nearby gulls and may reduce the crushing of bait by any pinnipeds attempting to haul out in this area. This strip has relatively high densities of roosting gulls and marine mammals hauling out.

Comment [DG81]: Need to discuss the area of overlap in more detail, and how to avoid going over EPA label restrictions

2.6.3. Timing

Although the baiting of the two main islands would be phased approximately two to six weeks apart, the aerial broadcast operations would still occur in the late fall or early winter, most likely in the months of November and/or December, just as in Alternative B. The actual time period for bait application would be defined by the islands' biological patterns and prevailing weather patterns. The period available for bait broadcast would begin after the summer breeding season for seabirds, sea lions, and fur seals on the Farallones has ended, and end before female northern elephant seals (*Mirounga angustirostris*) have started giving birth in the early winter (more information on these species is in Chapter 3). Bait broadcast would be completed within this time period, allowing for anticipated weather contingencies. Furthermore, bait broadcast would only be initiated if local weather predictions indicate that precipitation would be unlikely for at least four days. If weather conditions interfere with the scheduled applications, some back-baiting might be required, where treated areas could be retreated.

Comment [DG82]: (Cite Anacapa EIS.-Supplemental)

2.6.4. Equipment and Materials

As with alternative B and C, bait broadcast operations for alternative D would be conducted aerially using a single primary-rotor/single tail-rotor helicopter, by hand or using bait stations. The bait would be a compressed grain pellet, ~1.1 g in weight, containing 25 parts per million (ppm) brodifacoum, which is a second-generation anticoagulant The bait used would be registered with the EPA and in compliance with the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The bait product would be designed to be highly attractive to mice. All other ingredients in bait pellets would be non-germinating grains (either sterile or crushed). Any bait not initially consumed would likely remain attractive to mice. However, the bait would disintegrate completely within one or two major rainfall events.

2.6.5. Bait Application Operations

Bait broadcast by helicopter would consist of low-altitude overflights of the majority of the land area of the South Farallones. Bait broadcast would be very similar to that described in Alternative B (Section 2.2), using a helicopter with low-altitude overflights of most of the land area of the South Farallones. The only major difference would be that Southeast Farallone would be aerially treated first, and approximately two to six weeks later West End would be aerially treated**.** Each island would require two aerial applications, approximately **5 to 21 days apart**. Each aerial broadcast of bait would likely be completed in one day. A small area of the west side of Southeast Farallone would remain baited throughout the operation to reduce the likelihood of a reinvasion between islands in between the two operations.

Comment [DG83]: Confirm date ranges

Prior to aerial application, the gulls roosting on the targeted island would be selectively and carefully hazed off their roosts utilizing lasers and a variety of additional visual and auditory hazing techniques that have been shown effective for roosting gulls at airports and reservoirs in the U.S. and around the world. Specific gull hazing techniques for this alternative are being developed and tested in a January 2011 hazing trial, in association with the USDA bird hazing program and the Oiled Wildlife Care Network with CDFG and UC-Davis.

Comment [DG84]: Cite OSPR and manual and the draft gull hazing study plan

In addition to providing a refuge for the gulls, this alternative would also marine mammals a place to remain hauled out in the area while baiting and gull-hazing operations are ongoing on the other island. Alternative D would also employ slowly approaching helicopters for the pinnipeds, so as to ensure a slow and cautious but thorough emptying of the targeted area. Slow herding by land-based personnel may be required as well to ensure no marine mammals are stranded.

After the haulouts are emptied, temporary (plywood and 2”x4”) fencing may be installed at the haul-out access points to inhibit them from returning to that site for the duration of the application (~2-6 weeks) so as to ensure no unnecessary additional disturbances to them during the duration of the baiting procedures.

Comment [DG85]: We need to discuss whether to use this access-reducing measure, and how much to employ careful but intentional hazing on the pinnipeds themselves, versus purely incidental harassment.

After most of the non-target species that can be hazed have left the bait zone, and then the aerial application can begin in that area. The aerial bait application would consist of a helicopter flying 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, with the bait hopper long-lined 49-66 ft (15-20 m), as in Alternative B. 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 to reduce pooling at the base of steep slopes;
- The distribution of roosting seabirds on the adjacent islands, especially western gull and common murre (*Uria aalge*);
- The need to avoid bait broadcast into the marine environment;
- The need to minimize disturbance to native wildlife, especially any pinnipeds hauled out on the adjacent island(s).
- The need to avoid bait broadcast into residential areas;
- Weather conditions; and
- The need to minimize the substantial costs associated with helicopter flight time.

The baiting regime would follow common practice based on successful island rodent eradications elsewhere in the U.S. and globally (Howald et al. 2007a), 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. The width of a flight swath would be determined beforehand in calibration trials. It would likely range from 164-246 ft (30-80 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 targeted island would likely be subject to two helicopter passes. Within each bait application, there would likely be no more than three consecutive operating days.

In order to ensure eradication success, it will likely be necessary to conduct more than one application, each between **5 and 21 days apart,** to minimize the likelihood of either competitively inferior adult 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 would be likely to remain available for mouse consumption for longer than 10 days after an initial application, a second or third application may not be necessary.

Comment [DG86]: Cite standards

Bait would be applied strictly according to the limitations set by the EPA's pesticide regulations (FIFRA). The precise bait application rate would not exceed the rate set by the EPA (27kg/ha), with applications occurring at up to 18 kg/ha during the first application and up to 9kg/ha during the second application.

Bait uptake (including both consumption and breakdown) on the South Farallones in this alternative will be similar to that described in Alternative B. Soon after application, bait pellets would be consumed or cached by mice. Some bait may be consumed by other animals as well, including gulls, but far less mortality would be expected due to the more extensive use of hazing during this alternative. Bait pellets would soon degrade over time and exposure to rain. Pellets exposed to heavy moisture would degrade faster than pellets that fall in more protected locations. The application rate will be calculated so that an adequate amount of bait is available for consumption by mice for a period of at least four days.

As a result of the need for caution near the marine environment, the coastlines of the main islands and offshore islets, which are potential mouse habitat, may not receive the optimal bait coverage with helicopter broadcast alone. In cases where it is evident or suspected that any land area did not receive full coverage, there would be supplemental systematic broadcast either by foot, boat, helicopter, or any combination of the above. Helicopters may hover for brief periods over land during bait application to bait offshore islets, either by hand or from the hopper with the broadcast motor off to trickle bait at a precise point directly underneath.

Comment [DG87]: Cite standards for deciding where and when and how much to apply

Areas within the aerial broadcast exclusion zones would be hand baited or baited with bait stations. These areas include the houses, outbuildings, water catchment, and some highly invaginated shoreline areas and cliffs to minimize drift into the marine environment.

Bait stations would be installed in and immediately surrounding all of the buildings and enclosed structures on the island, as well as in the southwestern portion of Southeast Farallone. 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 2.4.4. A limited number of bait stations could also be installed elsewhere on the island as necessary.

All personnel that handle bait or monitor bait application in the field would meet or exceed all requirements for personal protective equipment (PPE) required by the EPA 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. 2005a). 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.

2.6.6. Project Support Operations

In addition to applying bait, helicopters would be used to transport equipment and personnel to the island for the purpose of this action. These additional helicopter operations would be localized to discrete flight paths that would be determined so as to minimize disturbance to native wildlife. Helicopters may hover for brief periods over land to drop off personnel and equipment.

Helicopters may be staged from the island, mailand or from a boat offshore of the island. Helicopters would only land at designated staging areas, where staff would re-fill the bait hopper, re-fuel, and conduct other necessary maintenance. These staging areas would be adequately stocked with fuel and other supplies and equipment to support the helicopter for the entire bait application process.

2.6.7. Mitigation Measures

All of the mitigation measures proposed to be used in the other action alternatives will be employed in this alternative as well, and have been described in Section 2.2, Features Common to All Alternatives. The mitigation features unique to this alternative include the extensive and intensive hazing of the gulls and the phasing of the baiting operation to allow both the gulls and the pinnipeds an undisturbed site to roost and haul out while the other island is being baited.

Mortality reduction methods to be employed for this and all action alternatives would include:

- **Timing:** Conducting the operation at a time of year when the resident seabird, shoerdird and land bird populations are at their lowest.
- **Carcass removal**: Dead mice, birds or any other animal found that is suspected of having succumbed to the toxicant, will be removed when found to reduce the likelihood of secondary exposure in scavengers;
- **Burrowing owl capture and relocation:** Efforts will be made to capture the transient burrowing owls arriving on island and to hold and release them on the mainland, as the Service has done in the past, to reduce the risk of toxicant exposure; and
- **Capture, hold and release efforts for other resident and migrating raptors**: The resident pair of Peregrine falcons and Common ravens (*Corvus corax*), and possibly other migrating raptors may be captured and removed until the Service determines the birds would no longer be at risk of exposure to toxicant;
- **Use of bait stations:** In areas with particularly high concentrations of roosting gulls to reduce gull uptake of bait.
- **Unique to this alternative: Intensive gull hazing efforts** will be employed to reduce gull pellet and mouse consumption and other non-target mortalities by utilizing extensive bird techniques developed and tested during a January 2011 hazing trial. Techniques tested may include lasers, air canons, poppers, screamers, trained dogs, kites, distress calls, flares, and remotely operated aerial toys.

Comment [DG88]: Add and refer to hazing plan

Pinniped disturbance reduction methods used for this alternative**:**

- **Timing**: Conducting the operation and before and after the pinniped pupping seasons;
- **Crouching** or crawling when necessary to remain out of view of nearby animals;
- **Moving slowly** and deliberately to avoid frightening animals while traveling by foot
- **Avoiding sensitive areas** when possible to reduce disturbance to haul-out sites
- **Education and Training**: All staff would be shown maps detailing areas with sensitive wildlife and trained on how to avoid disturbing wildlife and avoiding impacts to sensitive habitats such as nesting burrows and crevices.
- **Unique Element: Phasing of baiting/hazing** to allow pinnipeds a safe haul out refuge

Addition mitigation: Alternative D will also employ the use of a controlled surveillance flight with a PRBO marine biologist prior to any aerial bait applications. Although none will likely be breeding during the aerial application window, pinnipeds will likely still be present in potentially large numbers during the late fall and early winter. In order to reduce the risk of unpredictable and potentially harmful disturbance to pinnipeds from helicopter operations, the helicopter pilot would conduct a controlled surveillance flight around the coastline before bait operations begin in which pinniped haulout locations are noted. During this surveillance flight, an experienced pilot would approach major haulout sites with the intention of exposing hauled out animals to a gradual auditory and visual disturbance similar to the bait application. This controlled "dry run" would likely enable the animals to become aware of the helicopter and then move off of major haulouts into the water, which would allow the helicopter to treat coastal areas immediately afterward while most pinnipeds are still in the water rather than hauled out again. This approach would reduce the risk of a stampede among hauled out animals, thus reducing their risk of injury. This technique was successfully employed in both the Anacapa Island treatment and the Rat Island treatment in the USFWS Alaska Maritime Wildlife Refuge (Citation).

Comment [DG89]: Add citation proper

2.8. Comparative Summary of Actions by Alternative

Table 2.1. Comparison of important attributes of actions under each action alternative.

Action attribute	Alternative B	Alternative C	Alternative D
Primary bait delivery method	Aerial broadcast	Bait stations	Phased aerial broadcast
Secondary bait delivery methods	Hand broadcast Bait stations	Aerial broadcast Hand broadcast	Hand broadcast Bait stations
% of land area with aerially broadcast bait	~95%	65-70%?	~95%?
Start season	Late fall	Early fall	Late fall
Duration	~1 month	Up to 2 years	~ 1.5 months
Chance of success	Good	Moderate-low	Moderate-good
Risk to non-targets	Moderate (gulls)	Lower	Lowest
Amount of disturbance to sensitive breeding birds and mammals	Low	High	Low

2.9 Alternatives Dismissed from Detailed Analysis

2.9.1 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. 2007a). 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 (VanderWerf 2001, Nelson et al. 2002). However, diphacinone has been used only rarely on islands to eradicate rats (Wingate 1985, Donlan et al. 2003, Witmer 2007). Land managers in Hawai`i recently completed two aerial broadcasts of diphacinone to eradicate rats from small offshore islands; Mokapu was a success and Lehua was a failure. Other diphacinone-based island rodent eradications have been conducted with bait stations. Additionally, diphacinone has never been successfully used to eradicate mice (Howald et al. 2007a).

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 2004a). Furthermore, due to the weaker physiological binding properties of diphacinone, rodents have to feed on diphacinone bait in a very large quantity and often 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 can result in high mortality rates after only a single dose. While there are differences in toxicity among 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 LD_{50} dose. According to scientific evidence, house mice would need to eat at least 60 percent of their body weight for up to five days in order to achieve an LD_{50} dose of 50 ppm diphacinone. In comparison, house mice would need to eat only between one 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 baits were tested) after three days of exposure.

The risk of failing to eradicate mice using diphacinone is very high for the following reasons; 1) the low toxic threshold of diphacinone to mice, 2) the large amount of bait that mice would need to eat to achieve that threshold, and 3) the typically sporadic feeding habits of mice (Rowe 1973), which would reduce the probability that mice would feed consistently on the bait. For these reason, the use of diphacinone as an alternative bait has been dismissed in this evaluation.

2.9.2 Use of Other Toxicants

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. 2007a). Nine additional eradications have used non-anticoagulant toxicants 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 of zinc phosphide have demonstrated that rodents associate toxic symptoms with bait they had consumed earlier if the onset of symptoms occurs within 6 to 7 hours after consumption (see Lund 1988). Thus, any individual that consumes 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 rats from very small islands (Donlan et al. 2003). While these characteristics show potential as a candidate toxicant 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 3 days of exposure in a captive laboratory situation (Witmer 2007). After 7 days of exposure, cholecalciferol was still only 20 percent lethal. Cholecalciferol's dubious efficacy for mice disqualifies it from detailed consideration.

Diphacinone was also considered but rejected due to the comparative likelihood of completing a successful eradication using this bait product. It is critical to recognize that the differences in toxicity and palatability between these brodifacoum and diphacinone products that results in different likelihoods of successful rat eradication.

At a basic level, from the perspective of operational efficacy, brodifacoum is a better choice for rat eradication than diphacinone because the higher toxicity and efficacy of brodifacoum means there is a greater probability of eradication success. In addition, a greater efficacy is more important for bait broadcast delivery than for bait station delivery where bait can be made available for long periods of time. A rat eradication using brodifacoum has been proven to be successful using either one or 2 aerial bait applications. For diphacinone, the few successful eradications using aerial application means that a strategy for aerial application has not been extensively tested. Given the knowledge that diphacinone is physiologically more effective at low repeated doses, and that successful eradications using bait stations have required diphacinone bait to be consistently available for long periods, aerial application of diphacinone would require multiple applications.

As such, a brodifacoum eradication using aerial techniques would be more cost-efficient and more effort-efficient than a diphacinone broadcast, which might demand at least 4 broadcast applications over a period of 30 days or more in order to make bait consistently available for the required period. The higher toxicity of brodifacoum also renders the eradication at less risk of failure. Diphacinone, delivered by aerial broadcast, has successfully eradicated rats from 3 islands and failed on one (see Table 2). The multiple-feed requirement of diphacinone as a contributor to operational failure for aerial applications cannot be ruled out. On Lehua Island, Hawai`i, where aerial broadcast of diphacinone in 2009 was unsuccessful at eradicating rats, island managers believed that the success of the operation was compromised by unanticipated regulatory actions that prevented implementers from conducting more than 2 broadcast applications, as well as, limited bait broadcast around the coastline. In comparison, brodifacoum, delivered by aerial-broadcast, hand-broadcast, or a combination of both, has been used successfully for rodent eradication on at least 75 occasions (Howald et al. 2007b).

In comparison to broadcast delivery, bait station delivery allows implementers to deliver bait into every potential rat territory, over a longer period of time, and with more opportunity to adapt to the changing dynamics of a decreasing rat population. However, effective bait station delivery requires the majority of the rat population on the island to enter a bait station to consume bait, a behavioral requirement that leaves the operation potentially vulnerable to failure if some rats are hesitant to enter stations. While this behavioral requirement can compromise the success of rat eradication regardless of the toxicant used, it is a greater risk when using diphacinone because of the multiple-feeding requirement; rats would need to enter bait stations repeatedly on multiple consecutive days. However, diphacinone delivered in bait stations has been used to successfully eradicate rats from at least 10 islands (Table 2). In comparison, brodifacoum delivered in bait stations has been used successfully to eradicate rats from islands on at least 92 occasions (Howald et al. 2007b) (Island Conservation unpubl. data).

Bait palatability is another important aspect of the likelihood of successful rat eradication. The products Brodifacoum-25D™ and Ramik® Green (comparable to Diphacinone-50™) have both been shown to be preferred by most rats over locally available natural food sources. Brodifacoum-25 bait products (Bell Laboratories, Madison, WI) have been used to successfully eradicate rats on at least 5 islands, and have shown favorable results in at least 3 other eradication trials. The bait product Diphacinone-50™ has not yet been proven to successfully eradicate rats, but a comparable product (Ramik® Green) was successfully used on Mokapu Island, Hawaii. Ramik® Green has also shown at least partially favorable results in trials the Aleutian Islands. Both of these products appear to provide adequate palatability for the purpose of rat eradication.

While bait product choice is an important component of eradication efficacy, the most important component is the methodology used for bait delivery. Bait delivery methodology can vary significantly due to the specific bait product used, the equipment and supplies available for implementation and, most importantly, characteristics of the local environment. There is no single “recipe” for successful rat eradication beyond the basic principle of ensuring that every rat on the island is exposed to a lethal dose, which varies by species and toxicant. Implementers must approach each new project with a strategy that is customized for the parameters of the project. This being said, implementers can and should adopt and adapt strategies from other successful eradications. For Palmyra Atoll, the proven record of successful eradications using aerially-broadcast brodifacoum – at least 58 operations – provides a comprehensive set of tested methodologies from which to design a strategy.

From an operational perspective, the essential difference between application of diphacinone-50™ and brodifacoum-25D™ to eradicate mice from the Farallones would be that quantities of diphacinone need to remain relatively consistent across a period of up to 12 days. With a brodifacoum operation, a mouse that ingests bait on day one will likely not need to ingest bait again because brodifacoum has a high binding affinity and is metabolized slowly. However, with a diphacinone operation, bait needs to be available to all mice for 10-12 days; this requires that (a) the bait is highly attractive to rats to ensure that rodents prefer it above natural food items, (b) that sufficient bait is available daily to ensure mice frequently encounter bait within their environment, (c) that the consistent bait uptake in the environment through ingestion by mice,

Comment [DG90]: Citation? Get from GH and other animals, and degradation by invertebrate, microbial, and other environmental action does not diminish the amount of bait available to the level at which sufficient bait is no longer daily available for ingestion by mice.

Conservation practitioners seek to avoid causing harm to biological resources. However, affect to individual animals or plants that are incidental to a conservation action can arise. FWS policy, and other government regulations, acknowledge that circumstances exist in which the responsible management of Refuge lands may necessitate actions that might incidentally harm individual animals or plants. For example, a recent clarification of the Migratory Bird Treaty Act (MBTA) (FWS 2010) has allowed for the issuance of a special-purpose permit during invasive species eradication actions where *take* of listed migratory birds is possible when the overall effects to migratory birds is positive. Therefore, potential incidental harm to individual animals during mouse eradication operations on the Farallones may be acceptable as long as any individual impacts are outweighed by the expected beneficial effects of mouse eradication to the ecosystem.

In conclusion, from the perspective of the likelihood of eradication success, Brodifacoum-25D™ is a better choice than Diphacinone-50™, due to its higher toxicity and extensive proven record. While use of diphacinone imparts a considerably lower risk to non-target species than brodifacoum, the difference in the predicted likelihood of success of Brodifacoum-25D™ in comparison to Diphacinone-50™ is an important consideration when deciding between the alternatives rodenticides available. The concern for potential non-target impacts, especially non-target impacts that would not affect species at a population level are important, but the need to ensure eradication success is critical. A failed eradication attempt would provide no conservation returns in the long term, since mice would quickly re-establish throughout the island (Buckelew et al. 2005b). The most cost-effective conservation returns on rat eradication investment is through a successful eradication on the first attempt.

Comment [DG91]: Add additional info from RI

2.9.3 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 efficacy at eradicating rodents (Howald et al. 2007a). Even a highly lethal mouse-specific pathogen would be ineffective at eradicating mice from the South Farallones, because the mouse population would most likely rapidly declined, causing the introduced disease to disappear before fully infecting the entire mouse population. Furthermore, the introduction of novel diseases into the environment carries tremendous unknown risks to non-target species.

2.9.4 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 toxicants. 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.

2.9.5 Biological Control

The alternative to introduce predators on mice, such as snakes and cats, was dismissed because biological control most often only reduces, rather than fully eliminates the target species failing 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 (Atkinson 1985), consuming fewer rodents during these times. When seabirds migrate off of the islands following the breeding season, cats switch prey to rodents, which allows the island cat population to remain stable at higher levels than if no rodents were present on the island (Atkinson 1985, Courchamp et al. 1999, 2000). Thus, birds are impacted not only by rodents but the larger number of cats that are sustained by rodent presence on the island. Introducing another species onto an island can have severe and permanent consequences to the ecosystem (see Quammen 1996). Therefore, this alternative was eliminated from further consideration.

2.9.6 Fertility Control

Fertility control has been used with limited success as a method of pest management for a few invasive 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 to 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 (Tobin and Fall 2005).

2.9.7 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 doubled from the combined impacts from mice and control operations. 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, and was therefore eliminated from consideration.

Chapter 3: Affected Environment

3.1. Introduction

The 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 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, varied and extensive habitats, and adjacent productive marine environment makes them an ideal breeding and resting location for wildlife, especially seabirds and marine mammals. The Refuge comprises the largest continental U.S. 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 1800s when marine mammals were harvested for fur and food, as an egg gathering venture in the mid to late 1800s, a military outpost during two world wars, and until 1972 as a manned U.S. Coast Guard light station. Wildlife populations were heavily exploited from the late 18th to late 19th centuries for meat, hides, and eggs. Over-fishing of Pacific sardines (*Sardinops sagax*) in the mid-20th century may have reduced seabird and marine mammal food supplies. Some species were extirpated or declined drastically. The active U.S. Coast Guard station further impacted island wildlife and habitat until the full automation of the light station in 1972. Under FWS stewardship, some extirpated species have re-colonized the islands, and wildlife populations as a whole are slowly recovering. Still, certain Refuge species remain at reduced population levels or are even declining, and wildlife remains vulnerable to the impacts of introduced animals and plants, oil spills, other pollution, fisheries interactions, and global climate change.

3.2. General Description of the South Farallon Islands

3.2.1. Geographical Setting

The South Farallon Islands are situated just inshore of the continental shelf edge, 28 miles west of the Golden Gate and the city of San Francisco, California, at 37°42'N latitude and 123°00'W longitude. The South Farallones are made up of two main islands that are separated by a narrow channel: Southeast Farallon Island and West End (or "Maintop Island"). Several offshore islets immediately surround the main islands, including Saddle (or “Seal”) Rock, Sugarloaf, Arch Rock, Aulon Islet, Sea Lion Rock and Chocolate Chip.

The Farallon Island group and the Farallon National Wildlife Refuge also includes a number of islets that extend to the northwest, including the North Farallon Islands, Middle Farallon, and Noonday Rock, which becomes completely submerged at times. These islets to the northwest are isolated, relatively small, barren, extremely difficult to access, and are not known to harbor house mice or any other non-native mammals. Thus, they would not be included in the mouse eradication actions described and analyzed in this document.

Comment [g92]: We need to confirm this!

Comment [g93]: Is this still true?

3.2.2. Size and Topography

The South Farallones have a planar land area of approximately 120 acres (49 ha). The highest peak, at the top of Lighthouse Hill, is 370 ft (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 steep, rocky, wave-washed, and difficult to access. The south side of Southeast Farallon has an extensive marine terrace that terminates into an large intertidal zone. West End is dominated by the steep-sided, dome-shaped peak called Maintop, and several other smaller peaks and ridges. An extensive north-south valley, called Shell Beach, is situated on the western side. See Appendix A for a topographic map of the South Farallon Islands.

3.2.3. Climate

Comment [g94]: Input weather table for at least the last five years! Contact Tom at NOAA

The climate of the Farallones is characterized by moderate temperatures, wet winters and dry summers. The average temperature is 55.2 ºF (12.9 ºC) with little seasonal variation. September is the hottest month (average temperature 59 ºF (15.0 ºC)), and January the coldest (average temperature 52.3 ºF (11.3 ºC)). The region's hottest days are typically during the fall when high pressure builds into the Pacific Northwest and Great Basin, and dry offshore winds replace the Pacific seabreeze. The three hottest days on record in the city of San Francisco occurred in September and October (Null 1995). The lowest and highest temperatures recorded for Southeast Farallon Island from 1971 through 2007 were 34 ºF (1.1 ºC) in December 1990, and 90 ºF (27.2 ºC) in September 2000.

Summertime is characterized by cool marine air with persistent coastal stratus and fog. Rainfall from May through October is relatively rare. Considerable moisture, although rarely measurable as precipitation, is due to drizzle when the marine layer deepens sufficiently. Spring and fall are transition periods. Spring and early summer are characterized by strong northwesterly winds. The occurrence of rainfall during the early spring and fall is infrequent. While most storms during these periods produce light precipitation, there are occasional heavy rainfall events. In winter, the islands experience periods of storminess and moderate to strong winds, as well as periods of stagnation with very light winds. Annual rainfall averages 20 in (with a standard deviation of 7.25 in). Winter rains (November through April) account for about 89 percent of the average annual rainfall.

Climate data summarized here are from PRBO unpublished data 1971-2007 except where noted otherwise.

3.3. Physical Resources

3.3.1. 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 coliforms and nitrates. Results have largely been below levels of concern, and any water quality issues have been quickly resolved.

Marine water quality within the surrounding Gulf of the Farallones National Marine Sanctuary (NMS) is somewhat unaffected by threats to water quality due to the distance from sources of pollutants and land-based runoff, as well as the continuous circulation of the offshore waters at many scales. However, discharges from sunken vessels and illegal discharges from oil tankers and cargo vessels have been a periodic source of negative impacts to marine organisms within the sanctuary. The threat of an offshore spill is a constant presence in areas near well-used shipping lanes. In the event of an oil spill, the impact to the open coast would mainly be determined by the wind and sea conditions, which could easily overcome protection efforts. Also, persistent organic pollutants such as DDT and PCBs were widely used nationwide before the mid-1970s, and residuals of these chemicals still remain in sediments and organisms within the Sanctuary. Elevated levels of pollutants have been reported for fish, seabirds, and marine mammals found within the Sanctuary (NOAA 2008).

The waters surrounding the South Farallones have also been designated as an Area of Special Biological Significance (ASBS). California regulations prohibit any waste discharge into ASBSs. A recently-installed 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.

Comment [g95]: Check on this status!

Between 1946 and 1970, nearly 50,000 drums of hazardous and radioactive wastes were dumped over a 350 square nautical mile area overlaping the boundaries of the Gulf of the Farallones NMS. Unfortunately, the precise locations of these drums are unknown, and only 15 percent of the potentially contaminated area has been mapped. The extent of contamination to the waters surrounding the islands is unknown (Karl et al. 2001).

3.3.2. Geology and Soils

The Farallones are composed primarily of granitic rock, which is evidence of the ancient marine terraces that they are a part of. 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, much of the marine terrace and certain other portions of Southeast Island are covered with dark brown soil up to eight 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 feathers, bone fragments, vegetation, possible fish teeth and human-made detritus (Vennum et al. 1994).

3.3.3. Wilderness Character

West End Island is Designated Wilderness as regulated by the Wilderness Act (PL 88-577). See Appendix B for a map illustrating the Farallon Wilderness. 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 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 in achieving a management objective. Under this principle, the use of vehicles, motorized tools, and other mechanized devices are generally discouraged, but in some instances the use of mechanized tools or equipment are necessary for the action agency to effectively manage designated wilderness areas. The Wilderness Act and other related agency-specific guidance provides a general framework for determining the minimum tool necessary to complete a restoration action in a wilderness area. See Appendix K for a detailed "Minimum Requirements Analysis" for non-native house mouse eradication on the South Farallones.

3.4. Biological Resources

3.4.1. 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 to biological resources: impacts from the use of rodenticide, impacts from disturbance caused by the personnel activities and machinery operation necessary for bait application, and the 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 an effect on these resources.

3.4.2. Birds on the South Farallones

Appendix C contains a full list of birds that regularly breed on the South Farallones. Appendix D contains lists of birds that are likely to visit or reside at the South Farallones at some point during the year, categorized according to their risk profiles (detailed in Chapter 4). Appendix F illustrates common seabird roosting and nesting areas.

3.4.2.1. Breeding birds

The South Farallones is the largest seabird breeding colony in the lower 48 U.S. states. Thirteen bird species are known to breed regularly on the islands, including 12 seabirds and one shorebird (black oystercatcher, *Haematopus bachmani*). A number of other birds have occasionally or historically bred on the islands as well. 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, but some species continue breeding activities through September, and ashy storm-petrels breed until November. Cormorants and common murres inhabit rocky slopes and cliffs. The marine terrace and slopes of Southeast Farallon are dense with nesting gulls, with lower gull densities in other areas. Even below the surface, rock crevices and burrows house nesting storm-petrels, auklets, guillemots, and puffins.

The Farallones are the breeding site for about half of the world's population of the ashy storm-petrel, which breed only along the coast of California and northern Baja California, Mexico. The Farallones also host the world's largest colonies of Brandt's cormorant and western gull, as well as one of the southernmost colonies of rhinoceros auklet (*Cerorhinca monocerata*) and tufted puffin (*Fratercula cirrhata*) on the west coast of North America. Common murre, which nest in extremely dense colonies, are the most abundant breeding species and the Farallones and likely house the largest common murre colony outside of Alaska (G. McChesney pers. comm.).

The onset of breeding activity varies considerably between seabird species. The earliest egg-laying occurs in March with Cassin's auklet (*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 differs, there is a clear seasonal pattern among nearly all seabirds in which chicks fledge by no later than September. The only major exception to this are ashy storm-petrels, which primarily fledge in September and October with some chicks fledging as late as December (Ainley 1990, PRBO unpubl. data, Ainley and Boekelheide 1990).

Many 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 may knock their eggs from their precarious perches or leave them exposed to be eaten by avian predators. Some seabirds will abandon their nest sites for the season if they are disturbed. 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. All but one species (Cassin's auklet) raise only one brood annually, and some species lay only 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 population recovery. As a result, factors that increase mortality in adults can seriously jeopardize seabird populations, especially if population levels are already low (USFWS 2005b).

A plethora of factors affect each of the seabird species that are present on and around the South Farallones, both at the island and elsewhere in their ranges. The Service's 2005 Seabird Conservation Plan for the Pacific Region describes current threats, management goals and detailed information for 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 occurs over different spatial and temporal scales. Researchers are often able to find a correlation between years of particularly high or low marine productivity and breeding productivity in the Farallones' seabird species (Ainley and Boekelheide 1990).

3.4.2.2. Visiting birds

The productive waters surrounding the Farallones provide foraging grounds for a number of additional species such as grebes, shearwaters, scooters, phalaropes, and several species of gulls, most of which remain in the water or in flight but a few also use the island for roosting. Additionally, the island's intertidal habitat supports a number of shorebird species such as plovers, turnstones, whimbrels, and willets. Finally, many other species of freshwater and estuarine waterbirds have been sighted on the Farallones during migration, and some occasionally overwintered. The community makeup of these additional waterbirds varies substantially, both seasonally and inter-annually.

There are no permanent resident landbirds on the Farallones, but the island is 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) concluded 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 for a few species (mainly rock wren *Salpinctes obsoletus*) (DeSante and Ainley 1980).

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

Breeding Seabirds:

Seabirds that breed on the Farallones also reside on the island during other parts of the year. Western gulls are nearly year-round residents and have peak numbers at the start of the breeding season by mid-March. Adults leave the island at the end of the breeding season in late July and juveniles also leave by mid-September (Pierotti and Annett 1995). However, birds begin returning to the Farallones by early fall to reoccupy territories and numbers increase until they peak again in March (Penniman et al. 1990). Common murres begin breeding in early May and chicks fledge at only three weeks old in July and August; chicks depart with their fathers to forage in the surrounding waters (Ainley et al. 2002). Most of the breeding population likely remains within a one to two day flight to the breeding grounds, and periodic visits occur in late October or early November . Pigeon guillemot (*Cepphus columba*) begin arriving to the Farallones by March, breed beginning in May, and depart from the island soon after chicks fledge; colonies are vacated by early September (Ainley et al. 1990c, Ewins 1993). Cassin's Auklet is the most common seabird present on the Farallones and visits their burrows on the island year round. Depending on the timing of egg laying, Cassin's auklets generally visit their burrows daily between January and June. Visitation decreases substantially in July and continues to decline through December (Ainley et al. 1990b). Rhinocerous auklet and tufted puffin breed on the Farallones, yet this island is the southernmost edge of their ranges in the eastern Pacific. The Farallones consist of 41 and 40% of the California population, respectively. Both species begin arriving to the island for breeding in April and depart by September (Ainley et al. 1990e). Leach's storm-petrels begin arriving at the Farallones at the end of February for breeding and depart by the end of September or mid-October. Ashy storm-petrels are present on the island longer than Leach's and begin visiting in late December. They reach peak numbers in February, and largely depart by mid-November; however, some individuals remain year-round (Ainley et al. 1990d). The most abundant cormorant on the Farallones is Brandt's cormorant; the Farallones house the largest breeding colony of this species world-wide. They arrive for breeding in mid- to late-March, populations peak in late May, and most of the colony departs by August (Boekelheide et al. 1990b). Other cormorant species nesting on the Farallones are Pelagic and double-crested cormorants, although this represents a small portion of their breeding population. Pelagic cormorant arrival ranges from December to April, depending on the weather, although numbers during the winter remain very low. The population peaks in May and June, and most birds depart the island by September (Boekelheide et al. 1990a). Double-crested cormorants generally arrive by April and depart the island by September. Black oystercatchers are present and breeding on the island, although in small numbers (Ainley and Lewis 1974).

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

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

Pelagic seabirds (living out in the open sea) occurring offshore of the island reach maximum diversity during September although maximum numbers of sooty shearwater (*Puffinus griseus*) often occur during the summer, and phalaropes are often most abundant in August. With the exception of pelicans and gulls, none of these 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 reach maximum visitation rates in September or early October when the major arrival of landbirds wintering in coastal California occurs. The maximum diversity usually occurs from mid-September to early October. Landbird visitants decline during late October and dwindle to very low numbers by late November.

Neritic seabirds (deriving nutrients from the region of water lying directly above the sublittoral zone of the sea bottom) 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. The fall migrant California 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, including estuarine and freshwater species, while pelagic seabirds are generally very rare. Only a few landbirds winter on the island, including the white-crowned sparrow (*Zonotrichia leucophrys*), the golden-crowned sparrow (*Zonotrichia atricapilla*), the fox sparrow (*Passerella iliaca*), the yellow-rumped warbler (*Dendroica coronata*), the western meadowlark (*Sturnella neglecta*), and the black phoebe (*Sayornis nigricans*). Most overwintering landbirds arrive during the fall migration period, primarily October and November, and depart in March and April. Researchers on Southeast Farallon have recorded a daily average of around 30 landbirds and around 60 shorebirds between mid-November and mid-December (PRBO unpubl. data).

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 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 rare during the spring migration. However, large numbers of small gulls and phalaropes often 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; these include a majority of eastern North American species.

3.4.2.4. Special legal protection for birds on the South Farallones

The native birds that visit or reside on the South Farallones are protected from harm by the Migratory Bird Treaty Act (MBTA). Additionally, American Peregrine Falcon (*F.p. anatum*). are federally delisted but still state listed as endangered, and are a "candidate" for state delisting. Peregrines are a migrant, and several (usually between 3 and 5 or so) individuals winter on SEFI.

No bird species found on the South Farallones are currently listed and either threatened or endangered under the Endangered Species Act.

3.4.3. Terrestrial Wildlife of the South Farallon Islands

3.4.3.1. Seabirds and the South Farallon Islands ecosystem

Breeding seabirds are a major component 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's soil prevent some species from thriving, they simultaneously provide ideal habitat for many other species. The island's ubiquitous maritime goldfields, a small herbaceous composite, exists only on seabird breeding colonies and roosts (Vasey 1985). In turn, western gull and cormorants rely heavily on maritime goldfields for nesting material at the South Farallones (Coulter 1971, Ainley and Boekelheide 1990). 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 and numerous invertebrate species. Finally, the abundance of seabird carcasses that occur on seabird colonies provides a reliable food resource for a host of decomposer invertebrates.

3.4.3.2. Salamanders


Figure 3.1. Arboreal salamander.

The arboreal salamander subspecies *Aneides lugubris farallonensis* is endemic to the South Farallones. In the most habitat-rich areas of the island, salamander densities can reach nearly 300 animals per acre (700/ha) (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 breed and lay eggs during the summer (Boekelheide 1975) with young appearing in the fall (Lee 2008). Salamanders are a major predator of the endemic camel cricket (*Farallonophilus cavernicola*) (Steiner 1989).

PRBO Conservation Science recently began collecting baseline data to monitor the seasonal abundance and distribution of salamanders on the South Farallones and thereby measure the impacts of mouse eradication over time (Lee 2008).

Comment [g96]: Do we have any results from these studies yet???

3.4.3.3. Bats

There are no breeding or resident bats on the South Farallones. However, a number of bat species are known to visit and roost on the island primarily during fall migration. Most visitors are hoary bats (*Lasiurus cinereus*), but others include western red bat (*Lasiurus blossevillii*), Mexican free-tailed bat (*Tadarida brasiliensis*), little brown bat (*Myotis lucifugus*), and Eurasian pipistrellus (*Pipistrellus* sp.) (PRBO unpubl. data) (Cryan and Brown 2007).

3.4.3.4. 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.

Comment [g97]: ***Look up invertebrates; this is very awkward and confusing!!!

Few insect studies have been conducted on the Farallones. The most well-described invertebrate endemic to the island is the endemic cave-dwelling camel crickets (*Farallonophilus cavernicola*), which is found in caves around the island (Steiner 1989). Surveys for camel crickets would be conducted before and one year after eradication, as standardized surveys for this rare endemic have not been conducted recently. It is expected that the eradication of predatory mice would generally result in increases in the numbers of invertebrates. Additionally, a unique island form of the flightless intertidal beetle (*Endeodes collaris*) has also been described (Giuliani 1982).

3.4.3.5. Non-native animals

When the Service incorporated the South Farallon Islands into the Refuge in 1969, there were non-native rabbits, feral cats, and house mice present on the islands. Although island managers do not know when mice were first introduced to the South Farallones, anecdotal evidence suggests that they arrived early in the sequence of human activities, which began in the early 1800s. American and Russian sealers, egg collectors, lighthouse keepers, the U.S. Navy and the U.S. 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 of the island they implemented a management program to remove rabbits and cats, which ended successfully in 1975 leaving house mice as the only resident non-native mammal on the Farallones.

House mice are small rodents, around 0.5-0.7 oz (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 3 weeks and are reproductively active soon after (Witmer and Jojola 2006). Individual house mice most frequently travel no further than 49-66 ft (15-20 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 eggs or 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 early 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 storm-petrels each spring when mouse numbers are low. The islands' ashy storm-petrel breeding population was reported to have declined more than 40 percent between 1972-73 and 1992 (Sydeman et al. 1998). This decline likely resulted, in part, from the presence of mice on the South Farallones.

While mice are the only non-native mammallian residents on the South Farallones, non-native landbirds such as European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), and rock pigeon (*Columba livia*, commonly known simply as "pigeon") may be present during migration and winter. Starling and house sparrow have also bred on the South Farallones in the past, but have not been reported in the past decade. Non-native birds are unlikely to have any impact on the small avian landbird community of the islands.

3.4.4. Intertidal and Nearshore Ecosystems

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

Gulf of the Farallones National Marine Sanctuary is contiguous with the Farallon National Wildlife Refuge at the mean-high tide line. The Sanctuary has conducted long-term monitoring of plants and invertebrates in 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 oceanl 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; 5 are rare and 7 were extended ranges. See Appendix H 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 white acorn 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 California mussel *Mytilus californianus* can dominate the available attachment substratum in the mid-intertidal zone. Intertidal predators generally include whelks (sea snails), sea stars, sea urchins, octopus, fishes, and shore crabs. Overall on the South Farallones, the most common invertebrates include intertidal sea amemonea *Anthopleura* and molluscs *Mytilus*.

Black oystercatcher and black turnstone (*Arenaria melanocephala*) are the most common birds along the rocky shoreline. The oystercatchers are resident. The turnstones are most abundant during fall and winter, and during this period, are accompanied by small numbers of ruddy turnstone (*Arenaria interpres*), surfbird (*Aphriza virgata*), and wandering tattler (*Tringa incana*). A variety of species commonly considered landbirds also feed along rocky shores during fall and winter, including black phoebe, Brewer's blackbird (*Euphagus cyanocephalus*) and European starling.

The heads of coves on Southeast Farallon and West End include small sandy beaches. These areas are prime haulout locations for northern elephant seals and California and Steller sea lions. Over the past two decades a combination of elephant seal activity and large storm events have caused erosion of the sand from these coves, thus reducing their use as haulouts. 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, including 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.

Marine Sanctuary staff may establish a baseline collection of intertidal survey data (particularly surveys of intertidal fish taxa, which are comparatively poorly known) prior to project implementation and would monitor response, either positive or negative, in the intertidal community after mouse eradication.

3.4.5. Marine Mammals

3.4.5.1. California sea lion

California sea lions are the most abundant pinniped to haul out on the South Farallones. There are probably roughly between 1,000 and 3,300 animals present on the island and in surrounding waters year-round, with peak numbers from May through August (Ainley and Allen 1992, PRBO unpubl. data). California sea lions breed during the summer months of May through July with the majority of pups being born in June (Wilson and Ruff 1999).However, the South Farallones are not a major breeding site and only a few pups have been born in recent decades. Most California sea lions that are found on the Farallones breed either on the California Channel Islands or on islands off the coast of Mexico (Sydeman and Allen 1997).California sea lion abundance has increased substantially at the South Farallones over the last quarter century. Based on pup counts, southern California populations had an estimated 5.2% annually growth rate between 1975 and 1994 (NOAA 1997). West coast population estimates of California sea lions in 1994 range from 161,066 and 181,355 (Barlow et al. 1995).

3.4.5.2. Northern elephant seal

Northern elephant seals has been recovering from their near extinction in the 19th century, which was caused primarily from overharvesting for their blubber. The current elephant seal colony at the Farallones began in 1959 with one individual and grew to 100 individuals by 1971 .The colony grew rapidly during the 1970s, 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; however, the population currently appears stable (Sydeman and Allen 1999). In 2007, a total of 179 cows were counted on the South Farallones, and 132 pups were weaned (Lee 2007). Annual counts from 2000-2009 range from 10-1,000 individuals on the islands per month (PRBO unpubl. data). The current International Union for Conservation of Nature (IUCN) status of the species is of the lowest level, Least Concern (LC) (Vié et al. 2009).

Northern elephant seals are present on and in the waters surrounding the South Farallones year-round, but they are more abundant during breeding and molting seasons (Le Boeuf and Laws 1994, Sydeman and Allen 1997). In mid-December, adult males begin arriving on the South Farallones closely followed by pregnant females on the verge of giving birth. Females give birth to a single pup, generally in late December or January (Le Boeuf and Laws 1994), nurse their pups for approximately 4 weeks (Reiter et al. 1978), and copulate until March (conceiving pups that will not be born until the following winter), when they leave the islands to forage in deep offshore waters. The spring peak of elephants seals on the rookery occurs in April, when females and immatures (animals one to four years old) arrive again at the colony to molt (a one month process). The year's new pups remain on the island through both of these peaks, generally leaving by the end of April. In May, the majority of animals leave the island to forage during the summer and fall. The lowest numbers of elephant seals present on the rookery occurs during June, July, and August, when adult males molt. By early September, most adult males have left to forage at sea in preparation for the upcoming breeding season. Juveniles (one to 4 years of age) return to the rookery for a haulout period in October, some of which undergo partial molt(Le Boeuf and Laws 1994). See figure 3.X from Le Boeuf 1994.

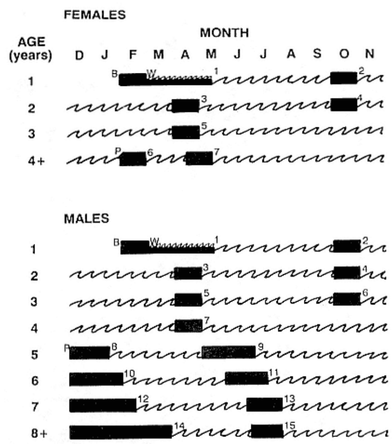


Fig. 3.X. Annual distribution of time spent on land and at sea for male and female northern elephant seals from birth to adulthood. Solid bars represent time on land, waves represent time at sea, bars and waves represent initial water experience prior to departure from the rookery. B = birth, W = weaning, P (for females) = parturition, P (for males) = puberty. Primiparity in females occurs at 3, 4, or 5 years of age. The numbers in the figure denote the consecutive trips to sea by each sex. From Le Boeuf 1994.

3.4.5.3. Pacific harbor seal

Pacific harbor seals are one of the most common pinnipeds in California and are present on or around the South Farallones year-round (NOAA 1997). Their populations have increased significantly since the MMPA was established in 1972 (NOAA 1997), and the mid-90's population was estimated at 30,000 in California alone (Wilson and Ruff 1999).. 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). Female harbor seals give birth to one pup per year, whichoccurs between April and May in

California (Wilson and Ruff 1999);between 1 and 3 pups are born on the South Farallones each year (PRBO unpubl. data). Pups are weaned at three-six weeks and breeding generally takes place two weeks later (Wilson and Ruff 1999). Harbor seal abundance has increased at the South Farallones during the last quarter century, averaging a growth rate of 15.9% per year from 1973-1985, yet leveling off to 9.0% from 1985-1997 (Sydeman and Allen 1999). This increase in abundance is thought to be largely the result of immigration from coastal waters (Sydeman and Allen 1997). Average numbers of harbor seals on the Farallones each month ranged from 0 to almost 200 individuals in 2000-2009 (PRBO unpubl. data). .

3.4.5.4. Northern fur seal

Northern fur seals are also present year-round in the waters surrounding the South Farallones. They are most commonly seen during the fall season, although the monthly average number of northern fur seals sighted is generally less than 40 (Pyle et al. 2001, PRBO unpubl. data). During 2000-2009, fur seal numbers ranged from 0 to almost 200 individuals, peaking during the breeding season (Wilson and Ruff 1999). Although the Farallones were 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 the second half of that 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 during the summer. These numbers have increased dramatically in recent years, with nearly 200 animals observed in 2006 (PRBO unpubl. data). Male fur seals generally come ashore in late May or June to prepare for the breeding season. Females come ashore in late June or July and give birth to one pup per year, and soon thereafter breeding occurs (Wilson and Ruff 1999).

3.4.5.5. Steller sea lion

Steller sea lions are primarily a species of the far north Pacific, and their colony on the South 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). Steller sea lion began recolonizing the Farallones in the mid 1970's, which was once part of their historic range (Sydeman and Allen 1999).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 from a few individuals to nearly 400 (PRBO unpubl. data). Steller sea lion breeding on the South Farallones primarily occurs on West End Island, although breeding sites have shifted over the years. The South Farallones breeding colony has become less productive over the past quarter century; generally only between 5 and 10 pups are born annually compared with 20 to 30 pups annually during the 1970s (Sydeman and Allen 1997). In general, the Steller sea lion population using 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. See Appendix E for a map of Steller sea lion distribution on the South Farallones.

The eastern Distinct Population Segment (DPS) of Steller sea lions, which includes individuals occurring in California (including the South Farallones), Oregon, Washington, Canada and southeast Alaska, is listed as Threatened under the ESA. The South Farallon rookery and waters around the island are designated Critical Habitat under the ESA (50 CFR 226.202). In addition to the island, the Critical Habitat designation includes the waters and air space within a radius of 3,000 feet of the rookery. 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.

Over the past 20 years, the eastern DPS overall population 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 (NMFS 2008). The reasons for ongoing population declines in California are unclear; however, the growing population of California sea lions in this region may be out-competing Steller sea lions. This in combination with changing oceanic conditions that are negatively affecting food availability for Steller sea lions but not for California sea lions may be contributing to the overall decline (NMFS 2008).

3.4.5.6. 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*) have on rare occasions been spotted on the islands or 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 including grey, blue and humpback whales, 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.

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

All of the regularly-occurring marine mammals at the South Farallones are protected from harm under the Marine Mammal Protection Act (MMPA). The Steller sea lion is listed as depleted throughout its range and is also listed as threatened under the ESA.

3.4.6. Terrestrial Vegetation

The vegetation diversity on the Farallon Islands is low compared to the nearby mainland due to the harsh marine environment. Sparse soil coverage, guano, and continuous trampling by seabirds and pinnipeds 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 Southeast Farallon Island. Maritime goldfields are specialized for life on offshore seabird colonies, occurring on islands, sea stacks and coastal cliffs along the Pacific coast of North America from San Luis Obispo County, 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, Vasey 1985).

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 (great brome *Bromus diandrus* and hare barely *Hordeum murinum leporinum*), New Zealand spinach (*Tetragonia tetragonioides*), least mallow (*Malva parviflora*), and buck's horn plantain (*Plantago coronopus*). Most non-native plants are found on the marine terrace in the south and southeast portions of Southeast Farallon and up the south-facing 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 and habitats. 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 2005b).

Comment [g98]: List some of the management efforts to control NZ spinach!

Several 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 two Monterey cypress individuals that were planted in 1982 (Pyle and Henderson 1991) near the houses. There are also three "cultivated patches" of bush mallow (*Lavatera arborea*), a non-native species, near the housing units and near the east end of the Marine Terrace (Pyle and Henderson 1991). The islands' few landbirds largely congregate in the immediate vicinity of these larger plants.

Much of the native vegetation on the Farallones senesces or dies by the summer and rebounds in the early winter and spring when seasonal rainfall begins. Several non-native species, such as New Zealand spinach, grow year-round.

3.5. Social and Economic Environment

3.5.1. 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 about twice 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 the National Oceanic and Atmospheric Administration (NOAA) as the Gulf of the Farallones National Marine Sanctuary. The waters surrounding the islands out to a distance of one mile are designated as the Farallon Islands State Marine Conservation Area by the California Department of Fish and Game. Between March 15 and August 15 boat traffic is also prohibited within 300 ft. of designated sections of the shoreline. The Department of Fish and Game is in the process of establishing a no-take Marine Reserve surrounding the South Farallones, which will also include a year-round Special Closure area encircling the island except in limited areas during the fall.

Comment [g99]: Check on the status!!!

Due to the sensitive nature of the wildlife and the difficulty of landing on the islands, access to the South Farallones is strictly monitored and currently limited to FNWR and PRBO Conservation Science staff, their approved contractors and collaborators, special-use-permit holders, and the US Coast Guard. Except as prohibited above, vessels use the East Landing and less often the North Landing, as calm-weather anchorages.

The South Farallones are within San Francisco County limits, but the islands do not provide any employment opportunities for the general public. The waters surrounding the island are harvested by commercial fishing operations. Wildlife-viewing and sport-fishing charter boats, none of them operated by the Service, also generate income for the region. Fishing will no longer be permitted within the soon-to-be-established Southeast Farallon Island Marine Reserve.

Comment [g100]: Is is allowed now?

3.5.2. Recreational and Aesthetic Uses

There are currently no recreation opportunities available to the public on land due to the presence of sensitive wildlife and habitat. However, the immediate surrounding waters provide an estimated 3,500 “wildlife viewing visitor days” annually (USFWS 2005a). 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, to some of the seabird species that breed on the Farallones and forage near the mainland.

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.

3.5.3. Commercial Fisheries

The waters surrounding the South Farallon Islands are currently productive grounds for commercial fishing. 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.

The waters immediately surrounding the South Farallones will soon be designated a no-take Marine Reserve by the State of California. Fishing will not be permitted within the Reserve.

Comment [JS101]: More info needed: Effective date? Marine Reserve boundaries?

3.5.4. Historical & Cultural Resources

The South Farallones have had extensive human activity beginning as a marine mammal hunting ground, a coveted egg gathering site, a manned Coast Guard light station, and a military outpost. 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 2 residences, a carpenter’s shop, the lighthouse trail, and the rail cart system. The oldest structural remains on the South Farallones are thought to be the Russian House foundation, which was used by seal hunters. The area surrounding the Russian House foundation also has the highest concentration of historic marine mammal bones on the island.

There are numerous artifacts from the islands’ 19th century history as an important source of eggs for the rapidly growing San Francisco region. The infamous Farallon Egg Wars were fought here in 1863 (White 1995, 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 and Garbage Gulch served as dump sites in the later part of the 19th century. Many archaeological deposits are still present in these areas that help to provide insight into early human occupation on the island.

Figure 3.2. Southeast Farallon residences as seen from Lighthouse Hill.

The 2 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 PRBO biologists, Refuge staff, and other visiting researchers and contractors 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. The portion of the rail system that remains running from East Landing to the housing units, 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 been maintained only modestly.

The building now called the Carpenter Shop was constructed by the U.S. Navy in 1905 as barracks and was occupied 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 Farallon 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 including bones from elk, deer, and pig indicates that occupants relied on meat from the mainland.

4 Chapter 4: Environmental Consequences

4.1 Purpose and Structure of this Chapter

Chapter 4 analyzes the environmental consequences of the alternatives 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 resources of the South Farallones. The purpose of the impacts 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:

5. Impacts may be both *beneficial* and *adverse*. A significant effect may exist even if on balance the effect will be beneficial.
6. The degree to which an action affects *public health or safety*.
7. *Unique characteristics of the geographic area* (e.g. historical or cultural significance, specially protected lands, ecologically critical areas).
8. 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 of "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]).
9. The degree to which the possible impacts of an action are *highly uncertain, or involve unique or unknown risks*.
10. 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.
11. 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.
12. 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*.
13. The degree to which an action may *adversely affect an endangered or threatened species or critical habitat as listed under the ESA.*
14. 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 Section 5.3-6).

In the analysis below, the potential significance of effects 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
  - Impacts to water resources
  - Impacts to geology and soil
  - Impacts to wilderness character
- Impacts to biological resources
  - Impacts to Birds
  - Impacts to Mammals
  - Impacts to Amphibians
  - Impacts to Fish
  - Impacts to Invertebrates
  - Impacts to Vegetation
- Impacts to the social and economic environment
  - Impacts to refuge visitors and recreation
  - Impacts to fishing resources
  - Impacts to historical and cultural resources
- Cumulative impacts
- Irreversible or irretrievable commitment of resources
- Relationship of short-term uses to long-term productivity

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

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

Air quality

Impacts of the action alternatives on air quality at the South Farallones will not be analyzed in detail because there are no activities proposed that would represent a measurable change from the background levels of air pollution caused by nearby water- and aircraft. The brief, localized helicopter operations that would occur as part of each action alternative would have no more than a negligible contribution to local or regional changes in air quality.

Cetaceans (e.g. whales and dolphins)

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. The likelihood of cetacean exposure to brodifacoum would be negligible. 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 aerial or terrestrial. Additionally, the likelihood of these activities having measurable impacts on cetaceans would be negligible because they would have to consume extremely large quantities of bait to experience lethal or sublethal affects.

Environmental justice

The impacts of the action alternatives on environmental justice (the agency mandate set in Executive Order 12898 to identify and address the potential for disproportionate placement of adverse environmental, economic, social, or health impacts on minority and low-income populations) will not be analyzed in detail because there are no minority or low-income populations that would be affected by either of the action alternatives.

4.3 Consequences: Physical Resources

4.3.1 Water Resources

Analysis framework for water resources

Significant water quality impacts were analyzed for the identified action alternatives with respect to potentially adverse physical and biological impacts from bait application on the South Farallones.

Mice on the South Farallones are frequently found on and around the shoreline. For this reason, it is essential that managers apply the rodenticide all the way down to the high tide mark to ensure the exposure of all rats on the entire atoll. Even though maximum effort will be taken to prevent bait drift into the marine environment, permitting for aerial pesticide use around the littoral zone will be sought to comply with EPA's new CWA guidelines for aerial pesticide applications over waters of the United States.

Water quality in the State of California is regulated by the State Water Resources Control Board, which requires all state waters to meet minimum criteria for a number of designated uses. While the federal Clean Water Act (CWA) prohibits the discharge of "pollutants" into waters of the United States, in 2007 the EPA clarified its interpretation of the term "pollutant" to exclude pesticides that may unavoidably enter the water through bait drift while being applied to control pests that occur "over, including near" water bodies (71 CFR 227 pp. 68483-68492). This ruling was vacated by the 6th Circuit Court of Appeals in 2009, requiring all projects that use aerial pesticide broadcast techniques over or near waters of the U.S. to comply with the CWA National

Pollution Discharge Elimination System (NPDES) permitting process. Subsequently EPA was granted a stay until April 9, 2011 to allow the agency time to determine the appropriate permitting process. We will fully comply with all Clean Water Act NPDES permitting required by the EPA pending the 2011 announcement.

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.

Alternative B: Aerial Broadcast of Brodifacoum

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

Even if bait does drift into the 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 LC_{50} value for trout (0.04 parts per million) (Syngenta Crop Protection 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 (Buckelew et al. 2005a, Buckelew et al. 2008a, 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 (Buckelew et al. 2005a).

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

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

Alternative C: Brodifacoum Deliver Primarily Through Bait Stations

Bait from bait stations would not be likely to drift into 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 4.3.1.3.

Alternative D: Phased Aerial Broadcast of Brodifacoum

During aerial bait application of inaccessible areas, the risk profile under Alternative D would be similar to that of Alternative B described in Section 4.3.1.3.

4.3.2 Geology and Soils

Analysis framework for geology and soils

The major issues of concern for the geology and soil resources of the Farallones are 1) permanent damage to granitic rock formations, 2) increases in soil erosion, and 3) contamination of soils.

Alternative A: No action

Under the no action alternative, mice would remain on the island and would continue to burrow in areas with a substantial soil layer. However, there are numerous seabird species that burrow on the island as well, and mouse burrowing activity would not be likely to contribute to noticeably more erosion than seabird burrowing. Mice would not measurably impact rock formations or contamination in soils.

Alternative B: Aerial Broadcast of Brodifacoum

The activities in Alternative B would not have a noticeable impact on soil erosion, rock formations, or soil contamination. The installation and maintenance of bait stations in limited circumstances may have highly localized impacts to soil and rock but these impacts would not be significant. The extremely low concentration of brodifacoum in bait pellets would not lead to measurable soil contamination. In environmental monitoring after rat eradication on Anacapa Island using brodifacoum pellets, all soil samples collected tested negative for brodifacoum residue (Buckelew et al. 2005a).

Alternative C: Brodifacoum Deliver Primarily Through Bait Stations

The bait station grid required under Alternative C would have minor to moderate, localized impacts on soil erosion and rock formations, but these impacts would not be significant to the general soil conditions of the islands. Concurrent with soil erosion, seabird burrows would likely be damaged. This impact is discussed in Section 4.4 (impacts to biological resources). Limited aerial broadcast of brodifacoum pellets would not lead to measurable soil contamination.

Alternative D: Phased Aerial Broadcast of Brodifacoum

The activities in Alternative D would not have a noticeable impact on soil erosion, rock formations, or soil contamination. The installation and maintenance of bait stations in limited circumstances may have highly localized impacts to soil and rock but these impacts would not be significant. The extremely low concentration of brodifacoum in bait pellets would not lead to measurable soil contamination. In environmental monitoring after rat eradication on Anacapa Island using brodifacoum pellets, all soil samples collected tested negative for brodifacoum residue (Buckelew et al. 2005a).

4.3.3 Wilderness Character

Analysis framework for wilderness character

Areas of the South Farallones are designated Wilderness as regulated by the Wilderness Act of 1964 (PL 88-577). Preservation of wilderness character is not a category of analysis required under NEPA regulations, but the special designation of several 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:

15. Untrammeled by human impacts;
16. Undeveloped, without permanent structures or habitations;
17. Influenced primarily by natural forces; and
18. Has outstanding opportunities for solitude or a primitive and unconfined type of recreation.

The impacts of each alternative that relate to the Wilderness Act will be discussed according to their benefit or harm to each of the above four qualities that characterize wilderness. Additionally, the Service is preparing a Minimum Requirements Analysis as required for projects which require the use of tools normally prohibited in Designated Wilderness.

Comment [g102]: Has FWS started working on this? Does IC need to prepare anything for this requirement?

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 Farallon Wilderness Area. Taking no action with regard to non-native mice on the South Farallones would allow this degradation to continue.

Alternative B: Aerial Broadcast of Brodifacoum

The aircraft and personnel activity required in the Farallon Wilderness Area 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. 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 Farallon Wilderness Area.

Alternative C: Brodifacoum Deliver Primarily Through Bait Stations

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. Alternative C would require a major increase in human activities within the Wilderness Area, unprecedented since the Service assumed responsibility for the South Farallones. While personnel would make an effort to minimize the spread of non-native plants to the Wilderness Area, the risk of new introductions would be increased from current use patterns. 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. 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.

Alternative D: Phased Aerial Broadcast of Brodifacoum

The aircraft and personnel activity required in the Farallon Wilderness Area under Alternative D 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. 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 Farallon Wilderness Area.

4.4 Consequences: Biological Resources

4.4.1 Introduction

In order for the project to be considered a restoration success, the long-term benefits of mouse eradication must outweigh any potential 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 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 benefits (positive effects) and the costs (negative effects) of mouse eradication.

While the impacts of each alternative to the biological resources of the South Farallon Islands will be examined with respect to individual animals, the primary focus will be to 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 they should not be considered interchangeable with the significance determination for each impact topic.

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 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.

4.4.2 Assessing Significance of Impacts to Biological Resources

As described in Section 4.1, the concept of significance is shaped by both the context of an action and the intensity of the action's 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 appropriate context within which to consider impacts to biological resources is at the population level 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 and MMPA listings) 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 as "more intense" than similar impacts would be to unlisted species.

For all biological resources analyzed, 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 an organism will experience noticeable changes that will be measurable throughout their range?
- Is there a high likelihood that impacts on organisms at the South Farallones will be measurable elsewhere in the region?

4.4.2.1 Special significance considerations for ESA-listed species

There is one species that is likely to occur on the South Farallones that is on the Federal Endangered Species list, the eastern DPS of the Steller sea lion is listed as Threatened. Listing under ESA provides a context for impacts analysis which lowers the threshold of significance. This analysis will identify any ESA-listed species and any ESA-designated critical habitat that may be affected by the preferred alternative. 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.

Comment [g103]: Are there any other ESA listed species?

Endangered Species Act regulations also 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 initiate a formal process of consultation with the National Marine Fisheries Service (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 the ESA are likely to be “taken” by the agency’s action, the Service must apply for an Incidental Take Permit, which allows managers to implement a project that may incidentally affect listed species that are not the target of the management action.

4.4.2.2 Special significance considerations for marine mammals under the Marine Mammal Protection Act (MMPA)

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 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.

- For California sea lion (*Zalophus californianus*), the significance threshold will be set according to the MMPA’s definition of Level A Harassment: “any act which injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild” (MMPA 515.18(A)).

- For Stellar sea lion (*Eumetopias jubatus*), the significance threshold will be set according to the MMPA’s definition of Level A Harassment: “any act which injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild” (MMPA 515.18(A)).

- For harbor seal (*Phoca vitulina*), the significance threshold will be set according to the MMPA’s definition of Level A Harassment: “any act which injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild” (MMPA 515.18(A)).

- For northern elephant seal (*Mirounga angustirostris*), the significance threshold will be set according to the MMPA’s definition of Level A Harassment: “any act which injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild" (MMPA 515.18(A)).

- For northern fur seal (*Callorhinus ursinus*), the significance threshold will be set according to the MMPA's definition of Level A Harassment: "any act which injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild" (MMPA 515.18(A)).

4.4.2.3 Special significance considerations for birds listed under the Migratory Bird Treaty Act (MBTA)

Listing under the Migratory Bird Treaty Act (MBTA) provides a context for impacts analysis which lowers the threshold of significance for this analysis. Take under the MBTA includes the unlawful pursuit, hunt, take, capture, or kill, of any migratory bird, nest, or egg of any such bird. MBTA listed species that are found near or around Palmyra will be given special significance thresholds to minimize negative impacts to listed birds. All of the birds found on Palmyra Atoll are listed for protection under the MBTA. Therefore, the significance threshold for impacts to birds will be set at an action that causes the mortality of an individual animal.

Under certain circumstances where the goal is eradicating or controlling invasive species, the FWS will provide practitioners with a Special Purpose Permit under the MBTA that allows for the take of listed individuals for "projects where the applicant demonstrates expected benefits to migratory birds. These projects support the Service's bird conservation mandate and mission and are consistent with the Administration's emphasis on control of invasive species" (FWS 2010). The Service will comply fully with all MBTA requirements prior to the implementation of any of the 5 action alternatives.

4.4.3 Impacts of Alternative A (No Action) on Biological Resources

4.4.3.1 Introduction

If no action is taken regarding non-native house mice on the South Farallones, the impacts that mice are having to the islands' biological resources would continue. This section will summarize the impacts that are known and suspected to 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.

4.4.3.2 Mouse impacts to terrestrial and intertidal foragers

4.4.3.2.1 Impacts to burrowing owls

The presence of mice on the Farallones makes the islands a population sink for burrowing owls. The burrowing owls that have been documented overwintering on the South Farallones and preying on storm-petrels have largely been juveniles. Although burrowing owls of all ages arrive on the islands when they become lost at sea 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 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 impacts to burrowing owls, but it may contribute to cumulative negative impacts to the species along with other threats on the mainland.

4.4.3.2.2 Impacts to 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 may limit the amount of food available to salamanders. Furthermore, the food preferences of introduced mice on other islands (Newman 1994) indicate that mice on the South Farallones could prey directly on salamanders but the effect of such predation is unknown.

4.4.3.2.3 Impacts to 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 (Rowe-Rowe et al. 1989, Crafford 1990, Cole et al. 2000) suggest that mice probably have a substantial impact to 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 numerous species including salamanders and migrating birds and bats. Consequently, mouse impacts to invertebrates have the potential to reverberate throughout the South Farallones ecosystem.

4.4.3.3 Mouse impacts to marine foragers

4.4.3.3.1 Impacts to breeding seabirds

Non-native house mice are negatively affecting the populations of burrow- and crevice-nesting seabirds on the South Farallones, particularly ashy and likely Leach's storm-petrels.

Mice are indirectly responsible for a substantial portion of ongoing declines in the breeding populations of ashy storm-petrels, and likely Leach's storm-petrels, due to predation by burrowing owls (PRBO unpubl. data). Burrowing owls are not considered island residents, but each year migrating burrowing owls land on the South Farallones to rest. 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 storm-petrels that arrive on the islands in mid-winter to begin prospecting for nest sites and courtship. Predation by wintering owls accounts for substantial annual mortality in breeding ashy storm-petrels, estimated from counts of bird remains near owl roosts at an average minimum of 67 ashy storm-petrels each year (PRBO unpubl. data). There are other predatory landbirds that visit the South Farallones in migration and winter, including other owl species, but none have had as noticeable an impact on the local biota as the burrowing owl.

Most seabirds, and storm-petrels in particular,

- are long-lived – storm-petrels are known to live at least 35 years;
- mature slowly – storm-petrels generally do not begin breeding until they are 5 years old; and
- have a low rate of reproduction – storm-petrel pairs almost always produce only one egg per year (although they may lay a second egg if the first egg fails) and only 40-75 percent breed successfully each year (Ainley and Boekelheide 1990, PRBO unpubl. data, Ainley 1995).

These characteristics make each breeding adult storm-petrel especially valuable to the reproductive success and survival of the species.

Researchers on the Farallones found that during a recent 20-year period, the population of breeding adult ashy storm-petrels on the South Farallones decreased by about 42 percent (Sydeman et al. 1998). Sydeman et al. identified owl predation, along with western gull predation, egg and chick predation by mice, and long-term habitat changes as the major causes of decline in the South Farallones ashy storm-petrel colony. While Sydeman et al. (1998) speculated that burrowing owl predation was probably considerably less than gull predation, more recent evidence (Mills 2006, PRBO unpubl. data) indicates that owl predation on storm-petrels is higher than previously realized, although still less than predation rates by gulls. These predation patterns are likely similar in Leach's storm-petrels, which are similar in size and behavior to ashy storm-petrels. Leach's storm-petrels range throughout the North Pacific and North Atlantic Oceans, and their population on the Farallones is small in comparison to other Leach's storm-petrel colonies, but this colony appears to have declined substantially based on mist net captures (PRBO unpubl. data; G. McChesney pers. comm.). Owl predation on Leach's storm-petrels is likely contributing to the decline of the Farallones' Leach's storm-petrel population.

In addition to their indirect impacts to storm-petrels, mice may also impact the birds directly. Researchers have observed introduced house mice preying on seabird eggs and chicks on other islands (see Cuthbert and Hilton 2004, Wanless et al. 2007, Angel et al. 2009), and there are a few records of mouse predation on storm-petrel eggs and chicks on the South Farallones (Ainley et al. 1990a). 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, possibly leading to abandonment of active or potential breeding sites.

4.4.3.3.2 Impacts to California brown pelican

Mice are not known to affect the California brown pelican. Pelicans roosting on the South Farallones would not be affected if the No Action alternative is adopted and mice are allowed to remain.

Impacts to Steller sea lion

Mice are not known to affect Steller sea lions. Steller sea lions on and around the South Farallones would not be affected if the No Action alternative is adopted and mice are allowed to remain.

4.4.3.3.3 Impacts to pinnipeds

Mice are not known to affect pinnipeds on the South Farallones. Pinnipeds would not be affected if the No Action alternative is adopted and mice are allowed to remain.

4.4.3.4 Mouse impacts to vegetation

The endemic plants of the Farallones 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).

On the other hand, many 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 affect them in their adopted island habitat. Particularly during the fall, mice on the Farallones commonly consume the seeds of the non-native *hare barely*, which has spread to new areas on the islands in recent years (Coulter and Irwin 2005). 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.

4.4.4 Impacts of Action Alternatives on Biological Resources

4.4.4.1 Impacts to Biological Resources vulnerable to toxicant use

4.4.4.1.1 Analysis framework for impacts from toxicant use

The risk of impacts from brodifacoum or any other rodenticide to individual animals is determined by 2 factors:

- The toxicity of the compound to that individual; and
  19.
- The likelihood that exposure to the compound will result in harm to that individual (Erickson and Urban 2004b).

From the perspective of risks from the rodenticide, the 3 action alternatives differ in both factors in terms of the individual species likelihood of exposure to the toxicant.

4.4.4.1.2 Toxicity

Toxicity to birds and mammals – The toxicity of a particular compound to an individual animal is often expressed in a value known as the "LD_{50}" – the dosage (D) of a toxicant that is lethal (L) to 50 percent of animals in a laboratory test. The EPA has compiled laboratory data for both diphacinone and brodifacoum LD_{50} values for a number of species. However, due to the difficulty and expense of obtaining extensive laboratory data, the LD_{50} values for many species, including most species on the Farallones, remain unknown for brodifacoum. Besides lethal toxicity, there are other physiological effects from ingestion of anticoagulants. Erickson and Urban (2004b) 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 EPA has determined that the toxicity of brodifacoum to all birds, and mammals in general is high and only requires one dose to be lethal (Erickson and Urban 2004b). Furthermore, animals that have a large body mass, such as pinnipeds or cetaceans, would generally need to ingest much more of the compound in order to reach an LD_{50} threshold.

While the concentration of brodifacoum in bait pellets would be consistent, the number of bait pellets that individual animals would need to consume would vary considerably and unpredictably. Furthermore, predators and scavengers can also be exposed to a toxicant through secondary or tertiary pathways by consuming individuals that were previously exposed to the toxicant. It is difficult to predict the amount of toxicant that would be present in these prey animals, and difficult to predict how much a particular predator or scavenger would need to consume to reach a toxic threshold.

Overall, it is difficult to accurately predict risk to birds or mammals based on toxicity data. Instead, risks from the toxicant will be estimated using the animals' risk of exposure. However, the large body mass of animals such as cetaceans, which would likely reduce the risk of toxic effects, will also be taken into account. Additionally, we will assume a worst case scenario to avoid underestimating the number of individuals that will be negatively impacted from brodifacoum.

4.4.4.1.3 Toxicant Exposure

Exposures to toxicants are primarily dependent on 2 factors:

- Food habits, behavior patterns, and other specific characteristics that increase or decrease an animal's exposure to the toxicant; and
- The availability of the toxicant in the local environment.

The toxicant form used for rodent eradication can only effectively be delivered through oral ingestion; animals can either ingest the toxicant by consuming bait pellets (known as "primary exposure"), or by preying or scavenging on other animals that 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 into particles that are too small for most foraging animals to consume, the toxicant is essentially unavailable within the environment. Eventually, even the sub-measurable concentrations of the toxicant remaining from a fully disintegrated pellet would break down into non-toxic compounds including carbon dioxide and water with no toxic intermediate compounds (NPS 2000).

Primary exposure – Herbivorous and omnivorous species are much more likely to consume bait (primary exposure) than carnivorous species (including insectivores) because the bait is composed primarily of grain. None of the carnivorous or insectivorous species on the Farallones would consume bait pellets intentionally as food; however, many insectivorous species will likely consume bait while foraging for insects.

Secondary exposure – Mice and other animals that directly consume bait can also transfer some of the toxicant in their systems to predators or scavengers through secondary exposure. Different organisms show considerable variation in the amount of time that they retain toxicants in their bodies. For vertebrates that are exposed sub-lethally, brodifacoum can be retained in the liver for many months. Rats dosed sub-lethally had brodifacoum concentrations in their liver, which took 350 days to be reduced by 50 percent (Erickson and Urban 2004b). Brodifacoum retention times for most bird species have not yet been determined. For invertebrates, the exact mechanisms of brodifacoum retention are unclear but the general understanding is that most invertebrates only retain brodifacoum briefly in their digestive system and not in body tissues (Booth et al. 2001).

At the Farallones, only a few species are at risk of exposure to the applied rodenticide through a secondary pathway. Mice may be at risk of secondary exposure by consuming crabs and other invertebrates like crickets, dead shorebirds, and other mice that had previously consumed bait. Shorebirds may be at risk of secondary exposure to rodenticide through the consumption of invertebrates that had previously consumed bait. The salamander species at the Farallones may be at risk of secondary exposure to rodenticide through the consumption of invertebrates that had previously consumed bait.

4.4.4.2 Analysis framework for impacts from disturbance

Helicopter operations

The operation of low-flying aircraft throughout the Farallones would likely 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. Pinnipeds on the Farallones are most at risk from helicopter operations, which will be mitigated by slowly approaching hauled out individuals to encourage them to leave the island directly before the bait is applied. Due to the relatively low altitude at which helicopters would fly, the majority of the helicopter noise would be focused in a narrow cone directly underneath them, reducing the area of disturbance for each helicopter pass (Richardson et al. 1995). Animals on shore would likely be exposed to higher-decibel noise than animals in the water; however, researchers at Grupo de Ecología y Conservación de Islas, A.C. (GECI) studied the impacts from helicopter operations to breeding boobies on Isla Isabel and found no significant effect to the birds (GECI video). We do not anticipate that helicopter operations in association with the action alternatives would cause more than a nominal disturbance to wildlife at the Farallones.

During each aerial bait application, all points on the Farallones will most likely be subject to 2 helicopter passes. Over the course of bait application operations, which may entail 2 pulses, there will likely be fewer than 10 days during which the helicopter would operate. The responses of animals to aircraft disturbance and the adverse effects of this disturbance vary considerably between species and different seasons.

Personnel activities

Additional wildlife disturbance could result from personnel traveling by foot across the island (e.g., when hand-broadcasting bait, tending bait stations, and surveying for non-target mortality), or traveling in small boats in the nearshore waters. Personnel dedicated to mouse eradication will be based at the Farallones for around one month under Alternative B, and D, and for up to 2 years under Alternatives C. Following eradication, there will be several monitoring visits to the island for at least 2 years post eradication. There are personnel on the Farallones conducting ongoing research, monitoring, and other management activities year-round, but mouse eradication will increase the number of personnel and the extent of affect to species on the island. Most current monitoring activities take place in discrete and limited areas of the island, whereas mouse eradication operations will require personnel to travel throughout the island. Personnel would be briefed on techniques to reduce wildlife disturbance, but disturbance events will likely still occur.

Comment [g104]: Is this still true?

4.4.4.3 Affect Indices

The following impacts analysis identifies the level of risk from the perspective of bait availability (the amount of time bait will be available through either primary or secondary exposure pathways), risk of mortality from toxicant use (the toxicity of the toxicant to different species based on toxicological properties), toxicant exposure risk level (the number of exposure pathways available to individual species based on feeding ecology and toxicant fate), disturbance risk (the sensitivity to disturbance and the amount of disturbance risk that individuals may be exposed to during operations), extent of the risk within the population (the number of individuals that may be affected from toxicant or disturbance and the affect that they will have to the global or regional breeding population), and the duration of the risk (the period of time that individuals will be exposed to toxicant or disturbance risks). The following indices illustrate the methodology employed to analyze the impacts to each of the identified species for the 5 action alternatives:

- Bait availability
    - Short: Bait or animal tissue with toxicant residue available for up to 26 days
    - Medium: Bait in animal tissue available for 37 – 90 days
    - Long: Toxicant persistent anywhere in the environment for more than 90 days
- Risk of mortality from toxicant use
    - None: No toxicological sensitivity
    - Low: Minor toxicological sensitivity
    - Medium: Moderate toxicological sensitivity
    - High: Severe toxicological sensitivity
- Toxicant exposure risk level
    - None: No exposure pathway
    - Low: Possible exposure pathway
    - Medium: One exposure pathway
    - High: Multiple exposure pathways

- Disturbance risk
  - None: No disturbance pathway
  - Low: Low sensitivity to disturbance
  - Medium: Moderate sensitivity to disturbance
  - High: Severe sensitivity to disturbance
- Extent of toxicant/disturbance risk within a population
  - Individuals: Few individuals affected
  - Island population: Many individuals affected with no affect to the global or regional breeding population
  - Global or regional population: Many individuals affected with impacts to the global or regional breeding population
- Duration of the risk of the toxicant or from disturbance
  - Short: Impacts for up to 2 months
  - Medium: Impacts for more than 2 months and up to 6 months
  - Long: Impacts for more than 6 months

4.4.4.4 Impacts of Alternative B on Biological Resources: Aerial Brodifacoum

Comment [g105]: Please review impacts analysis for alternative B;after the methodology is approved we will add in the analysis for alternatives C and D.

4.4.4.4.1 Impacts on Birds

Generally, birds that primarily eat plant matter such as seeds and fruits would initially be at high risk for primary exposure to brodifacoum. Predators and scavengers would in some cases be at high risk of secondary exposure to brodifacoum. Animals that feed on mice, mouse carcasses, or large ground-dwelling invertebrates such as crickets would initially be at high risk of secondary exposure to brodifacoum. Birds that have a broad, omnivorous diet would initially be at high risk for both primary and secondary exposure.

The risk of exposure (either primary or secondary) in initially high-risk animals (terrestrial herbivores, many predators and scavengers, and omnivores) would begin to decline rapidly within 30 days of the final bait application session as the mouse population declines, bait pellets are consumed or disintegrated, and bait becomes less available to invertebrate consumers. The risk of exposure in these initially high-risk animals would generally be low within 30 days of the final bait application and negligible within a few months thereafter.

On the other hand, birds foraging in the intertidal zone would be at lower risk for primary exposure because pellets that drift into the water would disintegrate and become unavailable within a few hours. Similarly, birds that forage primarily in the intertidal zone and specialize in intertidal invertebrates would initially be at a low risk of secondary exposure. Also, birds that feed primarily on flying insects and “micro-invertebrates” would be at an initially low risk of secondary exposure due to the low likelihood that these classes of invertebrates would be carrying brodifacoum in their systems; this risk would steadily decline to negligible within a few months. The likelihood of exposure in intertidal specialists would decline even more rapidly, becoming negligible within 30 days of the final bait application.

The following is a breakdown of the direct toxicant and disturbance impacts to each of the identified bird species that are likely to be exposed to brodifacoum during the implementation of Alternative B on the South Farallone Islands. Additionally, we have quantified the number of individuals per species that are likely to be adversely affected by Alternative B by assumingthe worst case scenario and considering any individuals that may be present on the island during the eradication operations to be vulnerable to adverse impacts from this action alternative:

<u>*Raptors*</u>*:*

<u>Ferruginous Hawk, Red-tailed Hawk, Sharp-shinned Hawk</u>

Toxicant risk

Ferruginous, Red-tailed, and Sharp-shinned hawks would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Ferruginous, Red-tailed, and Sharp-shinned Hawks consume small mammals, small birds, reptiles, and insects. Based off of the their feeding habits the bait availability for these hawks would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to hawks. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Ferruginous, Red-tailed, and Sharp-shinned Hawks would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Rough-legged Hawk</u>

Toxicant risk

Rough-legged Hawks would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Rough-legged Hawks consume small mammals, small birds, carrion (animal carcasses), and insects. Based off of the their feeding habits the bait availability for these hawks would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to hawks. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Rough-legged Hawks would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Northern Harrier Hawk</u>

Toxicant risk

Northern Harrier Hawks would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Northern Harrier Hawks consume small mammals, small birds, carrion, reptiles, and insects. Based off of the their feeding habits the bait availability for these hawks would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to hawks. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Northern Harrier Hawks would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Cooper's Hawk</u>

Toxicant risk

Cooper's Hawks would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Cooper's Hawks consume small mammals, small birds, and sometimes reptiles. Based off of the their feeding habits the bait availability for these hawks would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to hawks. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Cooper's Hawks would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Merlin, Short-eared Owl, and American Kestrel</u>

Toxicant risk

Merlins, Short-eared Owls, and American Kestrels would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, these species consume small mammals, small birds, and insects. Based off of the their feeding habits the bait availability for these species would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these raptors. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Merlins, Short-eared Owls, and American Kestrels would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Long-eared Owls and Barn Owls</u>

Toxicant risk

Long-eared and Barn Owls would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Long-eared and Barn Owls consume small mammals, small birds, reptiles, and insects. Based off of the their feeding habits the bait availability for these owls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these raptors. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Long-eared and Barn Owls would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Northern Saw-whet Owl</u>

Toxicant risk

Northern Saw-whet Owls would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Northern Saw-whet Owls consume small mammals, and some insects. Based off of the their feeding habits the bait availability for these owls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to owls. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Northern Saw-whet Owls would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>White-tailed Kite</u>

Toxicant risk

White-tailed Kites would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, White-tailed Kites only consume small mammals. Based off of the their feeding habits the bait availability for kites would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is medium due to the single toxicant exposure pathway. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to kites. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

White-tailed Kites would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Bird Species Intended for Mitigation</u>:

<u>Burrowing Owls</u>

Toxicant risk

Burrowing Owls that remain on the island or arrive after they are captured and removed for eradication operations would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Burrowing Owls consume small mammals, small birds, reptiles, and insects. Based off of the their feeding habits the bait availability for these owls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to owls. The extent of the affect will be to the individuals that remain on the island after the eradication team captures and removes as many individuals as possible

Disturbance risk

Burrowing Owls that remain on the island during eradication operations would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island. However, owls that are captured and taken into captivity will experience a high disturbance risk, the extent of the affect will be to the individuals taken into captivity, and the duration will be for the medium term to ensure that they are not released back to the Farallones while the toxicant exposure risk is still high.

- XXX individuals are likely to be exposed to impacts from alternative B.

Peregrine Falcon

Toxicant risk

Peregrine Falcons that remain on the island or arrive after they are captured and removed for eradication operations would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Generally, Peregrine Falcons consume doves, shorebirds, waterfowl, and passerines. Based off of the their feeding habits the bait availability for these falcons would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to falcons. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Peregrine Falcons that remain on the island during eradication operations would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island. However, owls that are captured and taken into captivity will experience a high disturbance risk, the extent of the affect will be to the individuals taken into captivity, and the duration will be for the medium term to ensure that they are not released back to the Farallones while the toxicant exposure risk is still high.

Common Raven

Toxicant risk

Common Ravens that remain on the island or arrive after they are captured and removed for eradication operations would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Ravens are omnivorous and consume marine and other invertebrates, carrion, bird eggs, fruit, and seeds. Based off of the their feeding habits the bait availability for ravens would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to ravens. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Peregrine Falcons that remain on the island during eradication operations would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island. However, owls that are captured and taken into captivity will experience a high disturbance risk, the extent of the affect will be to the individuals taken into captivity, and the duration will be for the medium term to ensure that they are not released back to the Farallones while the toxicant exposure risk is still high.

- XXX individuals are likely to be exposed to impacts from alternative B.

Songbirds:

Hermit Thrush, Cedar Waxwing, and American Robin

Toxicant risk

Hermit Thrushes, Cedar Waxwings, and American Robins would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Hermit Thrushes, Cedar Waxwings, and American Robins consume fruit, insects, and intertidal invertebrates. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to songbirds. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Hermit Thrushes, Cedar Waxwings, and American Robins would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

European Starling

Toxicant risk

European Starlings would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Starlings consume fruit, insects, and seeds. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to starlings. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

European Starlings would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Varied Thrush</u>

Toxicant risk

Varied Thrushes would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Varied Thrushes consume fruit, invertebrates, acorns, and seeds. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to starlings. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

European Starlings would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>American Pipit</u>

Toxicant risk

American Pipit would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Pipits consume invertebrates, and seeds. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to pipits. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

American Pipit would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Black Phoebe

Toxicant risk

Black Phoebes would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Phoebes consume insects and fish. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to phoebes. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Black Phoebes would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Insectivores:

Yellow-rumped Warbler

Toxicant risk

Yellow-rumped Warbler would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Yellow-rumped Warblers consume fruit, insects, and intertidal invertebrates. Based off of the their feeding habits the bait availability for these insectivores would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to insectivores. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Yellow-rumped warbler would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Golden-crowned Kinglet, Ruby-crowned Kinglet, and Western Palm Warbler

Toxicant risk

Golden-crowned Kinglets, Ruby-crowned Kinglet, and Western Palm Warblers would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). These insectivores consume insects, fruit, and seeds. Based off of the their feeding habits the bait availability for these insectivores would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these insectivores. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Golden-crowned Kinglets, Ruby-crowned Kinglets, and Western Palm Warblers would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Townsend's Warbler

Toxicant risk

Townsend's Warblers would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Townsend's Warblers consume insects, and seeds. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these warblers. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Townsend's Warblers would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Resident Sparrows:

Fox Sparrow, White-crowned Sparrow, Golden-crowned Sparrow, Dark-eyed Junco, Western Meadowlark

Toxicant risk

Fox Sparrows, White-crowned Sparrows, Golden-crowned Sparrows, Dark-eyed Juncos, and Western Meadowlarks would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). These species primarily consume invertebrates and seeds. Based off of the their feeding habits the bait availability for these sparrows would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these sparrows. The extent of the affect will be to the island population.

Disturbance risk

Fox Sparrows, White-crowned Sparrows, Golden-crowned Sparrows, Dark-eyed Juncos, and Western Meadowlarks would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

Non-resident Sparrows:

Chipping Sparrow, Spotted Towhee, Savannah Sparrow, White-throated Sparrow, Red-winged Blackbird, Brewer's Blackbird, Purple Finch, Pine Siskin, Lesser Goldfinch

Toxicant risk

Chipping Sparrows, Spotted Towhees, Savannah Sparrows, White-throated Sparrows, Red-winged Blackbird, Brewer's Blackbirds, Purple Finches, Pine Siskins, and Lesser Goldfinches would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). These species primarily consume invertebrates and seeds. Based off of the their feeding habits the bait availability for these sparrows would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the short-term because individuals will only present on the island for a very short period of time. The extent of the affect will be to the few individuals that will be on the island.

Disturbance risk

Chipping Sparrows, Spotted Towhees, Savannah Sparrows, White-throated Sparrows, Red-winged Blackbird, Brewer's Blackbirds, Purple Finches, Pine Siskins, and Lesser Goldfinches would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Violet-green Swallow

Toxicant risk

Violet-green Swallows would be exposed to brodifacoum through secondary exposure pathways by consuming insects that have been exposed to the toxicant. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is medium due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to swallows. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Violet-green Swallows would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B

Anna's Hummingbird

Toxicant risk

Anna's Hummingbirds would be exposed to brodifacoum through secondary exposure pathways by consuming insects that have been exposed to the toxicant. Hummingbirds primarily consume nectar; however, they frequently consume insects while feeding. Therefore, Based off of the their feeding habits the bait availability for these hummingbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is medium due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to hummingbirds. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Anna's Hummingbirds would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative is low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B

Shorebirds:

Wandering Tattler and Black Turnstone

Toxicant risk

Wandering Tattlers and Black Turnstones would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Tattlers and turnstones consume insects and intertidal invertebrates. Based off of the their feeding habits the bait availability for these shorebirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to shorebirds. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Wandering Tattlers and Black Turnstones would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Black Oystercatchers

Toxicant risk

Black Oystercatchers would be exposed to brodifacoum through secondary exposure pathways by consuming other species that have been exposed to the toxicant. Oystercatchers consume marine invertebrates and fish. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to Oystercatchers. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Black Phoebes would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Whimbrel

Toxicant risk

Whimbrels would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Whimbrels consume insects, and seeds. Based off of the their feeding habits the bait availability for these songbirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these shorebirds. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Whimbrels would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Seabirds:

Western Gull

Toxicant risk

Western Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Western Gulls are omnivorous and opportunistic feeders consuming fish, aquatic inverts, birds, eggs, and carrion. Additionally, Western Gulls have been documented eating rodenticide bait pellets on the Farallones and other islands in the region. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Western Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

Ring-Billed Gull

Toxicant risk

Ring-billed Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Ring-billed Gulls are omnivorous and opportunistic feeders consuming fish, insects, mice, and eggs. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Ring-billed Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

California Gull

Toxicant risk

California Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). California Gulls are omnivorous and opportunistic feeders consuming invertebrates, mice, birds, eggs, and fish. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

California Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

Glaucous-winged Gull

Toxicant risk

California Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Glaucous-winged Gulls are omnivorous and opportunistic feeders consuming fish, marine invertebrates, carrion, birds, eggs, and mice. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Glaucous-wing Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

Mew Gull

Toxicant risk

Mew Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Mew Gulls are omnivorous and opportunistic feeders consuming insects, worms, fish, aquatic invertebrates, mice, and carrion. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Mew Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Herring Gull</u>

Toxicant risk

Herring Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Herring Gulls are omnivorous and opportunistic feeders consuming fish, invertebrates, birds, eggs, and carrion. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Herring Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

<u>Hermann's Gull</u>

Toxicant risk

Hermann's Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Hermann's Gulls are omnivorous and opportunistic feeders consuming fish, invertebrates, birds, eggs, and carrion. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Hermann's Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

Thayer's Gull

Toxicant risk

Thayer's Gulls would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Thayer's Gulls are omnivorous and opportunistic feeders consuming fish, invertebrates, berries, eggs, birds, and plants. Additionally, Gulls have been known to eat rodenticide bait islands in the region and around the world. Based off of the their feeding habits the bait availability for these gulls would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these gulls. The extent of the affect will be to the entire Farallones Island population.

Disturbance risk

Thayer's Gulls would be exposed to disturbances from ground, air, and gull hazing operations. Gull hazing will be used as a mitigation measure during aerial baiting operations to help minimize the number of gulls that are likely to consume bait. The impacts associated with disturbance risks for this alternative are high because gulls may be very sensitive to hazing causing them to alter their feeding and roosting habits disruption their normal behavior. The duration of the disturbance will be for the medium-term, and the extent of the affect will be to the entire Farallones Island population.

- XXX individuals are likely to be exposed to impacts from alternative B.

Brown Pelican

Toxicant risk

Brown Pelicans would be exposed to brodifacoum through secondary exposure pathway by consuming fish that have been exposed to the toxicant. Based off of the their feeding habits the bait availability for these seabirds would be for the short-term since pelicans only consume fish and bait pellets dissolve within a few hours after entering the water, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is low since there is only one exposure pathway. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to pelicans. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Brown Pelicans would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

Cackling Goose

Toxicant risk

Cackling Goose would be exposed to brodifacoum through primary and secondary exposure pathways by either directly consuming bait (primary) or consuming other species that have been exposed to the toxicant (secondary). Cackling Goose consume grass, grain, invertebrates, and insects. Based off of the their feeding habits the bait availability for these geese would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is high due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to these geese. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Cackling Goose would be exposed to disturbances from both ground and air operations, which will likely cause them to flush the area to an alternate site on the island. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the few individuals that are seen at this time on the island.

- XXX individuals are likely to be exposed to impacts from alternative B.

4.4.4.4.2 Impacts on Mammals

Non-breeding Pinnipeds:

Stellar's Sea Lion, California Sea Lion, Northern Fur Seal, and Pacific Harbor Seal

Toxicant risk

Stellar's Sea Lions, California Sea Lions, Northern Fur Seals, and Pacific Harbor Seals are at no risk of toxicant exposure because they rarely if ever feed on anything other than marine fish. We would mitigate impacts to fish by hand baiting near the shoreline and utilizing a deflector to prevent bait from entering the waterways; therefore, the extent of the affect is insignificant and does not require further scrutiny.

Disturbance risk

Pinnipeds would be exposed to disturbances from both ground and air operations, which will likely cause them to flee the area potentially injuring themselves or others. The impacts associated with disturbance risks for this alternative are high, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the island population.

Breeding Pinnipeds:

Northern Elephant Seal

Toxicant risk

Northern Elephant Seals are at no risk of toxicant exposure because they rarely if ever feed on anything other than marine fish. We would mitigate impacts to fish by hand baiting near the shoreline and utilizing a deflector to prevent bait from entering the waterways; therefore, the extent of the affect is insignificant and does not require further scrutiny.

Disturbance risk

Northern Elephant Seals would be exposed to disturbances from both ground and air operations, which will likely cause them to flee the area potentially injuring themselves or others. The impacts associated with disturbance risks for this alternative are high, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the island population.

4.4.4.4.3 Bats:

Insectivorous Bats

Toxicant risk

Bats would be exposed to brodifacoum through secondary exposure pathways by consuming insects that have been exposed to the toxicant. Based off of the their feeding habits the bait availability for these bats would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is medium due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to bats. The extent of the affect will be to the few individuals that are seen at this time on the island.

Disturbance risk

Bats will not be disturbed by eradication operations on the South Farallon Island; therefore no further analysis is required.

4.4.4.4.4 Impacts to Herbivores

Salamanders:

Arboreal Salamanders

Toxicant risk

Arboreal Salamanders would be exposed to brodifacoum through secondary exposure pathways by consuming insects that have been exposed to the toxicant. Based off of the their feeding habits the bait availability for these shorebirds would be for the medium-term, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is medium due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to salamanders. The extent of the affect will be to the global population of this subspecies of Arboreal Salamanders since they are endemic to the South Farallon Islands.

Disturbance risk

Arboreal Salamanders would be exposed to disturbances from both ground and air operations, which will likely cause them to flee the area potentially injuring themselves or others. Additionally, they may be crushed by personnel moving around the island since they burrow underground. The impacts associated with disturbance risks for this alternative are high, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the global population of this subspecies of Arboreal Salamanders since they are endemic to the South Farallon Islands.

4.4.4.4.5 Impacts to Fish

Marine Fish:

Marine Fish

Toxicant risk

Marine Fish would be exposed to brodifacoum through secondary exposure pathways by consuming insects that have been exposed to the toxicant. Based off of the their feeding habits the bait availability for these fish would be for the short-term since bait pellets will dissolve within a few hours, the risk of mortality from toxicant use would be high, and the toxicant exposure risk is medium due to the range of secondary toxicant exposure pathways. The duration of the risk will likely be for the medium-term due to the retention time of the toxicant in the tissue of species that provide a secondary exposure pathway to salamanders. The extent of the affect will be to the a few individuals.

Disturbance risk

Marine Fish would be exposed to disturbances from boating operations, which will likely cause them to flee. The impacts associated with disturbance risks for this alternative are low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to individuals.

4.4.4.4.6 Impacts to Invertebrates

Invertebrates:

Intertidal Invertebrates

Toxicant risk

Intertidal Invertebrates are not known to be negatively impacted by rodenticides, and therefore, do not require further analysis of the toxicological impacts.

Disturbance risk

Intertidal Invertebrates would be exposed to disturbances from ground operations, which will likely crush individuals. The impacts associated with disturbance risks for this alternative are low, the duration of the disturbance will be for the short-term, and the extent of the affect will be to a few individuals.

Cave Crickets

Toxicant risk

Cave Crickets are not known to be negatively impacted by rodenticides, and therefore, do not require further analysis of the toxicological impacts.

Disturbance risk

Cave Crickets would be exposed to disturbances from ground operations, which will likely cause them to flee the area and may impact their feeding habits. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to the global population since these crickets are endemic to the South Farallon Islands.

4.4.4.4.7 Impacts to Vegetation

Vegetation

Toxicant risk

Vegetation is not known to be negatively impacted by rodenticides, and therefore, does not require further analysis of the toxicological impacts.

Disturbance risk

Vegetation would be exposed to disturbances from ground operations, which will likely crush individuals and possibly damage plants. The impacts associated with disturbance risks for this alternative are medium, the duration of the disturbance will be for the short-term, and the extent of the affect will be to a few plants.

4.4.4.4.8 Impacts Table for Alternative B on Biological Resources: Aerial Broadcast of Brodifacoum

Table X. Impacts of Alternative B on Biological Resources

Species	Bait avail-ability[1]	Risk mortality - toxicant use[2]	Toxicant exposure risk level[3]	Disturbance risk[4]	Extent of risk within a population[5]		Duration of risk[6]	
					toxicant	disturbance	toxicant	disturbance
Raptors (general)[7]	Medium	High	High	Low	Individ.	Individ.	Medium	Short
White-tailed Kite	Medium	High	Medium	Low	Individ.	Individ.	Medium	Short
Peregrine Falcon[8]	Medium/ None	High/ None	High/ None	Medium/ High	Individ.	Individ.	Medium /None	Short/ Medium
Burrowing Owl[8]	Medium/ None	High/ None	High/ None	Medium/ High	Island/ Individ.	Island/ Individ.	Medium /None	Short/ Medium
Common Raven[8]	Medium/ None	High/ None	High/ None	Low/ High	Individ.	Individ.	Medium /None	Short/ Medium
Western Gull	Medium	High	High	High	Island	Island	Medium	Medium
Gulls[9]	Medium	High	High	High	Island	Island	Medium	Medium
Brown Pelican	Short	High	Low	Medium	Individ.	Individ.	Medium	Short

Cackling Goose	Medium	High	High	Low	Individ.	Individ.	Medium	Short
Shorebirds[10]	Medium	High	High	Medium	Individ.	Individ.	Medium	Short
Songbirds[11]	Medium	High	High	Low	Individ.	Individ.	Medium	Short
Insectivores[12]	Medium	High	High	Medium	Individ.	Individ.	Medium	Short
Resident Sparrows[13]	Medium	High	High	Medium	Island	Island	Medium	Short
Non-resident Sparrows[14]	Medium	High	High	Low	Individ.	Individ.	Short*	Short
Violet-green Swallow & Anna's Hummingbird	Medium	High	Medium	Low	Individ.	Individ.	Short	Short
Northern Elephant Seal	Medium	None	None	High	None	Island	None	Short
Pinnipeds[15]	Medium	None	None	High	None	Island	None	Short
Bats	Medium	High	Medium	Low	Individ.	Individ.	Medium	Short
Fish	Short	High	Medium	Low	Individ.	Individ.	Short	Short
Intertidal Invertebrates	Short	None	Medium	Low	Individ.	Individ.	Short	Short
Salamanders	Medium	High	Medium	High	Global	Global	Medium	Short
Camel Cricket	Medium	None	Medium	Medium	Global	Global	Medium	Short
Vegetation	None	None	None	Medium	None	Individ.	None	Short

[1] None: No bait availability; Short: Bait or mice with toxicant residue available for up to 36 days; Medium: Bait in mouse excrement or animal tissue available for 37-90 days; Long: Toxicant persistent anywhere in the environment for more than 90 days. [2] None: No toxicological sensitivity; Low: Minor toxicological sensitivity; Medium: Moderate toxicological sensitivity; High: Severe toxicological sensitivity. [3] None: No exposure pathway; Low: Possible exposure pathway; Medium: One exposure pathway; High: Multiple exposure pathways. [4] None: No disturbance pathway; Low: Low sensitivity to disturbance; Medium: Moderate sensitivity to disturbance; High: Severe sensitivity to disturbance. [5] Individual (Individ.): Few individuals affected; Island population (Island): Many individuals affected with no affect to the global or regional breeding population; Global or regional population (Global): Many individuals affected with impacts on the global or regional breeding population. [6] Short: Impacts for up to 2 months; Medium: Impacts for more than 2 months and up to 6 months; Long: Impacts for more than 6 months. [7] Ferruginous hawk, rough-legged hawk, red-tailed hawk, sharp-shinned hawk, northern harrier, Cooper's hawk, American kestrel, merlin, barn owl, long-eared owl, short-eared owl, northern saw-whet owl. [8] Two outcomes listed: First – individuals remaining on island / Second – individuals captured and held in captivity. [9] Ring-billed gull, California gull, herring gull, Thayer's gull, glaucous-winged gull, Heermann's gull, mew gull. [10] Wandering tattler, black turnstone, black oystercatcher, whimbrel. [11] Hermit thrush, American robin, varied thrush, cedar waxwing, European starling, American pipit, black phoebe. [12] Yellow-rumped warbler, Townsend's warbler, palm warbler , golden-crowned kinglet, ruby-crowned kinglet. 13 + 14: Spotted towhee, chipping sparrow, savannah sparrow, fox sparrow, white-throated sparrow, white-crowned sparrow, golden-crowned sparrow, dark-eyed junco, red-winged blackbird, western meadowlark, Brewer's blackbird, purple finch, pine siskin, lesser goldfinch. [15] California sea lions, northern fur seal, Steller sea lion, Pacific harbor seal.

4.4.4.5 Impacts of Alternative C on Biological Resources: Bait Station with Brodifacoum

Comment [g106]: Add analysis in next draft

4.4.4.6 Impacts of Alternative D on Biological Resources: Phased Aerial Brodifacoum

Comment [g107]: Add analysis in next draft

4.5 Consequences: Social and Economic Environment

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

4.5.1 Refuge Visitors and Recreation

4.5.1.1 Analysis framework for 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, which draws tourists throughout the year. 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 significant.

4.5.1.2 Alternative A: No action

It is unlikely that the impacts that mice would continue to have to the South Farallones ecosystem would be perceptible to boaters near the islands. While the ashy and Leach's storm-petrel populations would likely continue to be negatively impacted, these birds are nocturnal at the colony and forage far offshore and thus are rarely seen near the island. Overall, taking no action with regard to non-native mice would be unlikely to have any direct or indirect impacts to the value of the South Farallones to Refuge visitors.

4.5.1.3 Alternative B: Aerial Brodifacoum

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. If flocks of roosting seabirds, particularly gulls or pelicans, are flushed during helicopter operations the flocks would be visible to boaters offshore, but only during the short period that helicopters would be operational. 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 and other appropriate venues.

4.5.1.4 Alternative C: Bait Station with Brodifacoum

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. If flocks of seabirds, particularly gulls, pelicans, or common murres, are flushed during bait station maintenance or helicopter operations, the flocks would be visible to boaters offshore. 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 and other appropriate venues.

4.5.1.5 Alternative D: Phased Aerial Brodifacoum

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. If flocks of roosting seabirds, particularly gulls or pelicans, are flushed during helicopter operations the flocks would be visible to boaters offshore, but only during the short period that helicopters would be operational. 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 and other appropriate venues.

4.5.2 Fishing Resources

4.5.2.1 Analysis framework for 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 significant.

4.5.2.2 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.

4.5.2.3 Alternative B: Aerial Brodifacoum

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. If the State of California completes the establishment of Southeast Farallon Island Marine Reserve, barring fishing from the waters immediately surrounding the Farallones, before the proposed action is implemented, the impact of this action to fisheries would be moot.

Comment [g108]: Is this true now?

4.5.2.4 Alternative C: Bait Station with Brodifacoum

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. If the State of California completes the establishment of Southeast Farallon Island Marine Reserve, barring fishing from the waters immediately surrounding the Farallones, before the proposed action is implemented, the impact of this action to fisheries would be moot.

Comment [g109]: Is this true now?

4.5.2.5 Alternative D: Phased Aerial Brodifacoum

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. If the State of California completes the establishment of Southeast Farallon Island Marine Reserve, barring fishing from the waters immediately surrounding the Farallones, before the proposed action is implemented, the impact of this action to fisheries would be moot.

Comment [g110]: Is this true now?

4.5.3 Historical and Cultural Resources

4.5.3.1 Analysis framework for historical and cultural resources

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)). 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.

Comment [g111]: Have we consulted with the archaeologist?

4.5.3.2 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.

4.5.3.3 Alternative B: Aerial Brodifacoum

Alternative B would not involve activities that would require soil disruption or any other actions that would affect the historical or cultural resources on the South Farallones.

4.5.3.4 Alternative C: Bait Station with Brodifacoum

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.

Comment [g112]: Have we started to develop this final bait station grid? We should include a bit more detail on the impact for the final draft.

4.5.3.5 Alternative D: Phased Aerial Brodifacoum

Alternative D would not involve activities that would require soil disruption or any other actions that would affect the historical or cultural resources on the South Farallones.

4.6 Consequences: Cumulative Impacts

4.6.1 Assessing Cumulative Impacts

The NEPA regulations require Federal agencies to consider not just the direct and indirect impacts of an action but also the cumulative impacts to which an action would contribute. Analyzing cumulative impacts on the South Farallones requires consideration of 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 occur at this time. Furthermore, there are no foreseeable future human actions on the island that are likely to negatively impact the island's environment, because the land is being managed in perpetuity as a National Wildlife Refuge. However, many of the species of the Farallones are still recovering from severe past impacts, including the impacts of introduced rabbits on the South Farallones, hunters and egg collectors that visited the islands, and past oil spills and other pollution. Also, many of the species that utilize the South Farallones have large ranges. These far-ranging populations may have been impacted in the past, may be currently experiencing unrelated impacts, or may be at risk of impacts from reasonably foreseeable consequences in the future, elsewhere in their ranges.

Comment [g113]: This section needs to include past, present, and future project analysis for cumulative impacts. Refer to Palmyra!

4.6.2 Cumulative Impacts Under Alternative A (No Action)

The impacts that mice are having to 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 to storm-petrels at the colony, in combination with possible major future changes in the productivity of the marine waters of the California Current ecosystem on which these storm-petrels depend, could ultimately result in the disappearance of the South Farallones ashy and Leach's storm-petrel colonies. However, the likelihood of this kind of future cumulative impact to 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 to any other (non-biological) resources on the South Farallones.

4.6.3 Cumulative Impacts Under Alternative B

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 to 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 effects of these future actions would be, at this point, purely speculative.

4.6.4 Cumulative Impacts Under Alternative C

Alternative C could result in major 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 within the Refuge, 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 time 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.

4.6.5 Cumulative Impacts Under Alternative D

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

Alternative D 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 effects of these future actions would be, at this point, purely speculative.

4.7 Irreversible and Irretrievable Impacts

4.7.1 Alternative A (No Action)

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 and Leach's storm-petrels in particular, their recent population declines indicate a risk for an irreversible decline in the future. However, at this time there is no strong evidence to support this assertion.

4.7.2 Alternative B

Mouse eradication would likely eliminate the overwintering burrowing owl population on the South Farallones, although this would be to the benefit of the individual owls that arrive on the islands because they would continue their migrations rather than attempting to overwinter in the poor habitat of the South Farallones. Mouse eradication would also likely result in positive population-level changes for ashy and Leach's storm-petrels.

Project activities under Alternative B would require a commitment of funds that would then be unavailable for use on other Service projects. At some point, commitment of funds (for purchase of supplies, payments to contractors, etc.) would be irreversible; once used, these funds would be irretrievable. Nonrenewable or nonrecyclable resources committed to the project (such as helicopter fuel, bait, and bait stations) would also represent an irreversible or irretrievable commitment of resources.

4.7.3 Alternative C

Mouse eradication would be likely to eliminate the overwintering burrowing owl population on the South Farallones, although this would be to the benefit of the individual owls that arrive on the islands because they would continue their migrations rather than attempting to overwinter in the poor habitat of the South Farallones. Mouse eradication would also be likely to result in positive population-level changes for ashy and Leach's storm-petrels.

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

Similar to Alternative B, project activities would require a commitment of funds (for purchase of supplies, payments to contractors, etc.) that would be irreversible; once used, these funds would be irretrievable. Nonrenewable or nonrecyclable resources committed to the project (such as helicopter fuel, bait, and bait stations) would also represent an irreversible or irretrievable commitment of resources.

4.7.4 Alternative D

Mouse eradication would likely eliminate the overwintering burrowing owl population on the South Farallones, although this would be to the benefit of the individual owls that arrive on the islands because they would continue their migrations rather than attempting to overwinter in the poor habitat of the South Farallones. Mouse eradication would also likely result in positive population-level changes for ashy and Leach's storm-petrels.

Project activities from Alternative D would require a commitment of funds that would then be unavailable for use on other Service projects. At some point, commitment of funds (for purchase of supplies, payments to contractors, etc.) would be irreversible; once used, these funds would be irretrievable. Nonrenewable or nonrecyclable resources committed to the project (such as helicopter fuel, bait, and bait stations) would also represent an irreversible or irretrievable commitment of resources.

4.8 Short-term Uses and Long-term Productivity

An important goal of the Service is to maintain the long-term ecological productivity and integrity of the biological resources on the Refuge. The action alternatives are designed to contribute to the long-term ecological productivity of the South Farallones, and would not result in short-term uses of the resources that would counteract this long-term productivity. Any short-term negative impacts to the islands' biological resources would be outweighed by the ecosystem's long-term restoration through the eradication of mice.

5. Consultation and Coordination

5.1. Introduction

TO BE COMPLETED

5.2. Regulatory Framework of the Alternatives

5.2.1. Federal Laws

National Environmental Policy Act
Endangered Species Act
Marine Mammal Protection Act
Migratory Bird Treaty Act
Clean Water Act (CWA), as amended (formally, the Water Pollution Control Act, USC 33 1251 et seq.)
National Historic Preservation Act (NHPA) of 1966, as amended)
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947, as amended
Coastal Zone Management Act (CZMA) of 1972, as amended
Archaeological Resources Protection Act of 1979, as amended, 16 USC 470
Wilderness Act of 1964

Archaeological Resources Protection Act, 16 U.S.C. 460, et seq.
Native American Graves Protection and Repatriation Act of 1990 (25 USC 3000-3013, as amended)
Curation of Federally Owned and Administered Archeological Collections (36 CFR 79)
Executive Memorandum – Government-to-Government Relations with Native American Tribal Governments (59 FR 85, April 29, 1994)
Executive Order 13007 – Indian Sacred Sites (61 FR 104, May 24, 1996)
Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments (65 FR 218, November 9, 2000)

5.2.2. California State Laws and Authorities

California Coastal Commission
Regional Water Quality Control Board
Pesticide regulations?

California Department of Fish and Game – The California Department of Fish and Game (CDFG) has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitats necessary for biologically sustainable populations of those species (California Fish and Game Code Section 1802). California's fish and wildlife resources, including their habitats, are held in trust for the people of the California by the CDFG (California Fish and Game Code Section 711.7). The CDFG's fish and wildlife management functions are implemented through its administration and enforcement of the Fish and Game Code (Fish and Game Code Section 702). The CDFG is entrusted to protect state-listed threatened and endangered species under the California Endangered Species Act (Fish and Game Code Sections 2050-2115.5) (CESA).

The CDFG generally does not have jurisdiction to manage or regulate natural resources on federal lands, such as the Farallon Islands, where the federal government has exclusive jurisdiction. It also does not regulate federal government agency activities. Although the CDFG does not regulate fish and wildlife resources on the Farallones, the Service regularly coordinates with the CDFG to ensure the proper protection of the island's natural resources. Thus, while CESA restrictions do not apply to the proposed restoration project on the South Farallones, the Service would continue to coordinate with CDFG regarding actions that could potentially affect state-listed species and the proposed conservation measures designed to avoid or minimize adverse effects.

5.3. Inter-Agency Scoping and Review

U.S. Coast Guard
Gulf of the Farallones National Marine Sanctuary (NOAA – Sanctuaries)
Golden Gate National Recreation Area (NPS)
Natural Resource Agency Trustees for the S.S. Luckenbach and associated oil spills
- California Department of Fish & Game
- National Oceanic and Atmospheric Administration
- U.S. Fish & Wildlife Service
- National Park Service

U.S. EPA
National Wildlife Research Center (USDA-APHIS)
CA EPA
National Marine Fisheries Service (NOAA)
U.S. Fish & Wildlife Service – Ecological Services

5.4. Public Scoping and Review

As part of the project scoping process, the Service opened a 45-day public comment period from April 14, 2006 through May 29, 2006 during which interested members of the public were encouraged to comment on the scope of the project and the important environmental issues to be addressed in NEPA analysis. The Service received substantive comments from 15 individuals or organizations during this comment period, as well as at least three requests to be added to a distribution list for future information on the proposed project. The Service took all substantive comments into consideration during the preparation of this EA.

This Draft Environmental Assessment will be made available for review by the public, and the Service will again open a 45-day comment period to allow the public to provide input on the content of the EA. This comment period will include at least one public information session, during which Service staff and partners will be available to provide information and answer questions in person. Availability of the Draft EA and information on the comment period and public information sessions will be advertised in the Federal Register, by mail to all interested parties who have requested information, and in local media as appropriate. After the comment period closes, the Service will address all substantive comments received, make changes to the EA if necessary, and circulate the Final EA along with all substantive public comments and/or a summary of public comments if a large number are received.

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

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6. Terms, Abbreviations, and References

6.1. Terms

Anticoagulant
Arthropod
Bait station
Carnivorous
Control
Eradication
Farallones
Haulout
Herbivorous
Hopper
Hyperpredation
Intertidal
Invertebrate
LC50
LD50
Molt
Omnivorous
Pinniped
Piscivorous
Seabird
South Farallones
The Refuge
The Service

6.2. Abbreviations

CCP
CDFG
CEQ
CWA
DDT
DPS
EA
EIS
EPA
ESA
FIFRA
FNWR
FONSI
GFNMS
GPS

IHA
MBTA
MMPA
NEPA
NHPA
NOAA
PPE
PRBO
SHPO
USFWS

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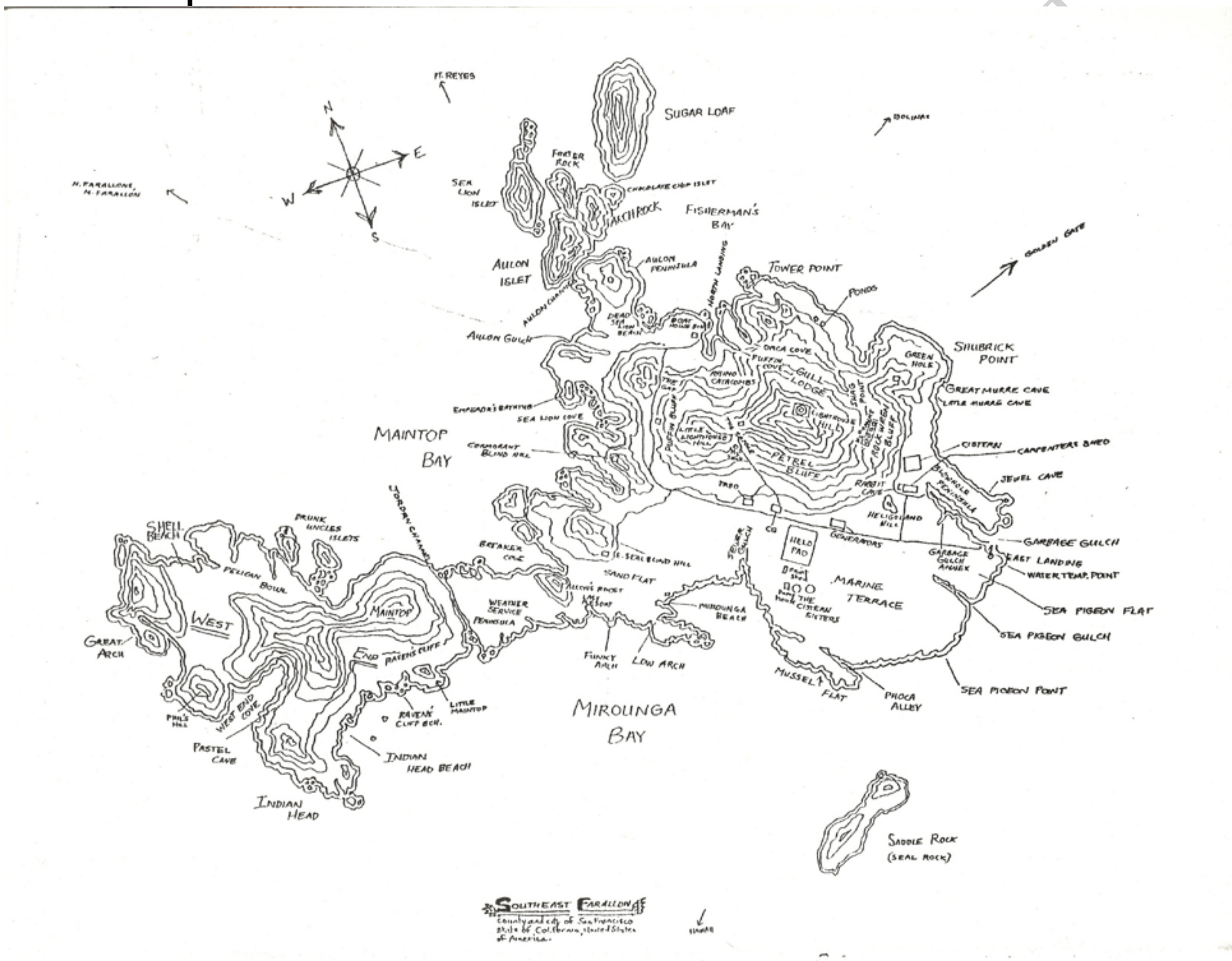
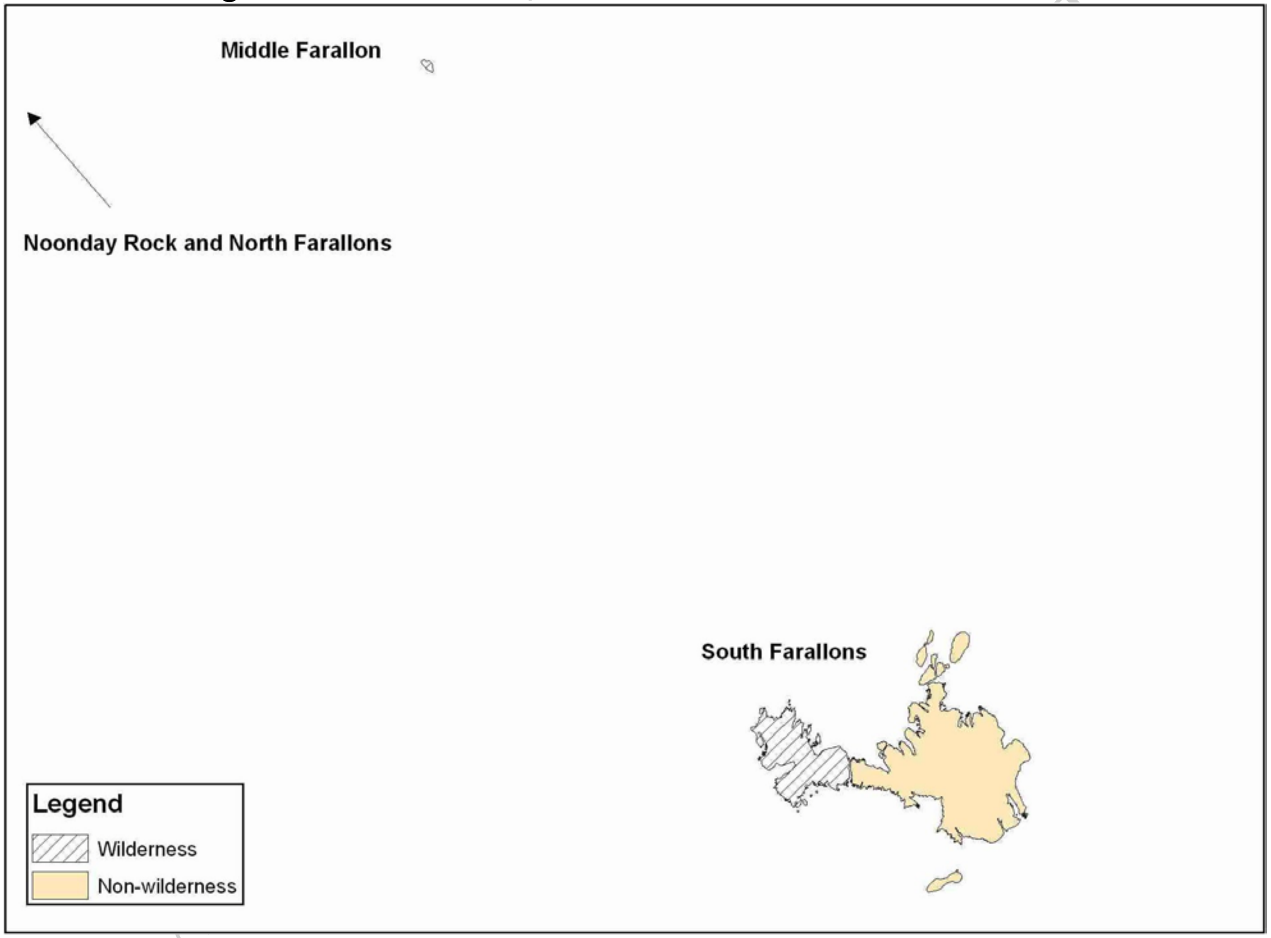
Appendix A. Map of the South Farallon Islands.



Appendix B. Designated Wilderness, South Farallon Islands.



Appendix C. Regular breeding birds on the South Farallones

Deleted: Breeding

Common name	Scientific name
Leach's storm-petrel	*Oceanodroma leucorhoa*
Ashy storm-petrel	*Oceanodroma homochroa*
Brandt's cormorant	*Phalacrocorax penicillatus*
Double-crested cormorant	*Phalacrocorax auritus*
Pelagic cormorant	*Phalacrocorax pelagicus*
Black oystercatcher	*Haematopus bachmani*
California gull	*Larus californicus*
Western gull	*Larus occidentalis*
Common murre	*Uria aalge*
Pigeon guillemot	*Cepphus columba*
Cassin's auklet	*Ptychoramphus aleuticus*
Rhinoceros auklet	*Cerorhinca monocerata*
Tufted puffin	*Fratercula cirrhata*

Appendix D. Risk profiles of birds on the South Farallones

Methods

We synthesized published bird records from DeSante and Ainley 1980, Ainley and Boekelheide 1990, Richardson et al. 2003, and unpublished bird records from PRBO and USFWS, into a single database. The published sources each present bird records grouped roughly into three “seasons” with similar dates. Richardson et al. use the following seasonal definitions, which we used except where noted:

1. Fall = July 15 – December 19
2. Winter = December 20 – February 28 (or 29)
3. Spring = March 1 – July 14

The published sources also specifically identified birds that were present for more than three weeks at a time during the winter, categorized as “winter residents.”

We calculated the average occurrence rate of each bird species per season, and assigned abundance “scores” adapted from DeSante and Ainley (1980):

- Abundant = 90 birds per season or greater
- Common = 30-89 birds per season
- Fairly common = 10-29 birds per season
- Uncommon = 3-9 birds per season
- Rare = 1-2 birds per season
- Very rare = 1/3 - 1 bird per season
- Extremely rare = less than 1/3 bird per season

In most cases, we then removed birds that were extremely rare or very rare in all seasons. To identify bird species present under Alternative B, which would occur within a discrete time period, we removed birds that were extremely rare or very rare specifically in winter. However, in some cases, we included birds that were classified as extremely rare or very rare based on published bird records, but were identified by PRBO and/or USFWS biologists as likely to be present.

Birds present under Alternative B

Herbivores (Alternative B risk profile: *initially high-risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	**References**
Canada goose	*Branta Canadensis*	Very rare	Extremely rare	Richardson et al. 2003; FWS pers. comm.
Fox sparrow	*Passerella iliaca*	Very rare	Rare	Richardson et al. 2003; PRBO unpubl. data
White-crowned sparrow	*Zonotrichia leucophrys*	Very rare	Very rare	Richardson et al. 2003; PRBO unpubl. data
Golden-crowned sparrow	*Zonotrichia atricapilla*	Very rare	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Dark-eyed junco	*Junco hyemalis*	Rare	Extremely rare	Richardson et al. 2003
Pine siskin	*Carduelis pinus*	Rare	Extremely rare	Richardson et al. 2003

Predators/scavengers* (Alternative B risk profile: *initially high-risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	**References**
Northern harrier	*Circus cyaneus*	Possible	Absent	Richardson et al. 2003; PRBO unpubl. data
Red-tailed hawk	*Buteo jamaicensis*	Possible	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Black-bellied plover	*Pluvialis squatarola*	Very rare	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Killdeer	*Charadrius vociferus*	Uncommon	Very rare	Richardson et al. 2003
Black oystercatcher	*Haematopus bachmani*	Common	Common	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Heermann's gull	*Larus heermanni*	Uncommon	Rare	Richardson et al. 2003
Mew gull	*Larus canus*	Uncommon	Very rare	Richardson et al. 2003

D. Risk profiles for birds

Predators/scavengers* (Alternative B risk profile: *initially high-risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	**References**
California gull	*Larus californicus*	Common	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Herring gull	*Larus argentatus*	Abundant	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Thayer's gull	*Larus thayeri*	Uncommon	Extremely rare	Richardson et al. 2003
Western gull	*Larus occidentalis*	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Glaucous-winged gull	*Larus glaucescens*	Abundant	Common	Richardson et al. 2003; PRBO unpubl. data
Barn owl	*Tyto alba*	Possible	Extremely rare	PRBO unpubl. data
Burrowing owl	*Athene cunicularia*	Extremely rare	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Long-eared owl	*Asio otus*	Possible	Absent	Richardson et al. 2003; PRBO unpubl. data
Short-eared owl	*Asio flammeus*	Possible	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Northern saw-whet owl	*Aegolius acadicus*	Possible	Absent	PRBO unpubl. data
Hermit thrush	*Catharus guttatus*	Uncommon	Very rare	Richardson et al. 2003
American robin	*Turdus migratorius*	Fairly common	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Varied thrush	*Ixoreus naevius*	Rare	Extremely rare	Richardson et al. 2003
European starling	*Sturnus vulgaris*	Abundant	Abundant	Richardson et al. 2003
Western meadowlark	*Sturnella neglecta*	Very rare	Uncommon	Richardson et al. 2003

*Not including specialists in birds, intertidal organisms, flying insects or micro-invertebrates

Other terrestrial birds* (Alternative B risk profile: *initially low risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	
Sharp-shinned hawk	*Accipiter striatus*	Possible	Absent	Richardson et al. 2003; PRBO unpubl. data
Peregrine falcon	*Falco peregrinus*	Very rare	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Wandering tattler	*Tringa incana*	Very rare	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Willet	*Tringa semipalmata*	Extremely rare	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Whimbrel	*Numenius phaeopus*	Extremely rare	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Ruddy turnstone	*Arenaria interpres*	Very rare	Uncommon	Richardson et al. 2003
Black turnstone	*Arenaria melanocephala*	Uncommon	Common	Richardson et al. 2003; PRBO unpubl. data
Black phoebe	*Sayornis nigricans*	Very rare	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Yellow-rumped warbler	*Dendroica coronata*	Fairly common	Uncommon	Richardson et al. 2003; PRBO unpubl. data

*Specialists in birds, intertidal organisms, flying insects or micro-invertebrates

Marine foragers (Alternative B risk profile: *negligible risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	**References**
Surf scoter	*Melanitta perspicillata*	Fairly common	Fairly common	Richardson et al. 2003
Pacific loon	*Gavia pacifica*	Abundant	Rare	Richardson et al. 2003

Marine foragers (Alternative B risk profile: *negligible risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	**References**
Common loon	*Gavia immer*	Fairly common	Extremely rare	Richardson et al. 2003
Eared grebe	*Podiceps nigricollis*	Abundant	Abundant	Richardson et al. 2003
Western / Clark's grebe	*Aechmophorus occidentalis / A. clarkii*	Rare	Very rare	Richardson et al. 2003
Northern fulmar	*Fulmarus glacialis*	Abundant	Absent	Richardson et al. 2003
Sooty shearwater	*Puffinus griseus*	Fairly common	Absent	Richardson et al. 2003
Ashy storm-petrel	*Oceanodroma homochroa*	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Brown pelican	*Pelecanus occidentalis*	Abundant	Absent	Richardson et al. 2003; PRBO unpubl. data
Brandt's cormorant	*Phalacrocorax penicillatus*	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Pelagic cormorant	*Phalacrocorax pelagicus*	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Red phalarope	*Phalaropus fulicarius*	Fairly common	Absent	Richardson et al. 2003
Black-legged kittiwake	*Rissa tridactyla*	Abundant	Absent	Richardson et al. 2003
Common murre	*Uria aalge*	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Ancient murrelet	*Synthliboramphus hypoleucus*	Fairly common	Rare	Richardson et al. 2003

D. Risk profiles for birds

Marine foragers (Alternative B risk profile: *negligible risk*)

		Abundance index		
Bird	**Scientific name**	**Winter**	**Winter residents**	**References**
Cassin's auklet	*Ptychoramphus aleuticus*	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Rhinoceros auklet	*Cerorhinca monocerata*	Uncommon	Uncommon	DeSante & Ainley 1980; Ainley & Boekelheide 1990

Birds present under Alternative C

Herbivores (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Greater white-fronted goose	*Anser albifrons*	Fairly common	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Brant	*Branta bernicla*	Abundant	Extremely rare	Extremely rare	Common	Richardson et al. 2003
Canada goose	***Branta canadensis***	**Fairly common**	**Very rare**	**Extremely rare**	**Extremely rare**	**Richardson et al. 2003**
Mourning dove	*Zenaida macroura*	Fairly common	Extremely rare	Absent	Uncommon	Richardson et al. 2003
Horned lark	*Eremophila alpestris*	Uncommon	Absent	Absent	Extremely rare	Richardson et al. 2003
American (Water) pipit	*Anthus rubescens*	Abundant	Extremely rare	Absent	Very rare	Richardson et al. 2003

D. Risk profiles for birds

Herbivores (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Spotted towhee	*Pipilo maculates*	Fairly common	Absent	Absent	Rare	Richardson et al. 2003
Chipping sparrow	*Spizella passerina*	Common	Extremely rare	Absent	Fairly common	Richardson et al. 2003
Clay-colored sparrow	*Spizella pallida*	Fairly common	Absent	Extremely rare	Rare	Richardson et al. 2003
Brewer's sparrow	*Spizella breweri*	Uncommon	Absent	Absent	Rare	Richardson et al. 2003
Vesper sparrow	*Pooecetes gramineus*	Fairly common	Absent	Absent	Very rare	Richardson et al. 2003
Lark sparrow	*Chondestes grammacus*	Uncommon	Extremely rare	Absent	Very rare	Richardson et al. 2003
Savannah sparrow	*Passerculus sandwichensis*	Abundant	Absent	Extremely rare	Uncommon	Richardson et al. 2003
Fox sparrow	***Passerella iliaca***	**Common**	**Very rare**	**Rare**	**Uncommon**	**Richardson et al. 2003; PRBO unpubl. data**
Lincoln's sparrow	*Melospiza lincolnii*	Common	Absent	Absent	Fairly common	Richardson et al. 2003
White-throated sparrow	*Zonotrichia albicollis*	Fairly common	Absent	Absent	Very rare	Richardson et al. 2003
White-crowned sparrow	***Zonotrichia leucophrys***	**Abundant**	**Very rare**	**Very rare**	**Common**	**Richardson et al. 2003; PRBO unpubl. data**
Golden-crowned sparrow	***Zonotrichia atricapilla***	**Abundant**	**Very rare**	**Uncommon**	**Fairly common**	**Richardson et al. 2003; PRBO unpubl. data**
Dark-eyed junco	***Junco hyemalis***	**Abundant**	**Rare**	**Extremely rare**	**Common**	**Richardson et al. 2003**

D. Risk profiles for birds

Herbivores (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Lapland longspur	*Calcarius lapponicus*	Fairly common	Absent	Absent	Extremely rare	Richardson et al. 2003
Lazuli bunting	*Passerina amoena*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Bobolink	*Dolichonyx oryzivorus*	Uncommon	Absent	Absent	Very rare	Richardson et al. 2003
Pine siskin	***Carduelis pinus***	**Common**	**Rare**	**Extremely rare**	**Rare**	**Richardson et al. 2003**

Species in **bold** may be present during bait broadcast. Species not in bold are unlikely to be present during broadcast.

Predators/scavengers* (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
American wigeon	*Anas americana*	Uncommon	Absent	Absent	Absent	Richardson et al. 2003
Mallard	*Anas platyrhynchos*	Uncommon	Absent	Absent	Extremely rare	Richardson et al. 2003
Northern pintail	*Anas acuta*	Abundant	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Green-winged teal	*Anas crecca*	Fairly common	Extremely rare	Absent	Absent	Richardson et al. 2003

D. Risk profiles for birds

Predators/scavengers* (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Black-bellied plover	***Pluvialis squatarola***	**Common**	**Very rare**	**Fairly common**	**Rare**	**Richardson et al. 2003; PRBO unpubl. data**
Semipalmated plover	*Charadrius semipalmatus*	Fairly common	Absent	Absent	Absent	Richardson et al. 2003
Killdeer	***Charadrius vociferus***	**Fairly common**	**Uncommon**	**Very rare**	**Very rare**	**Richardson et al. 2003**
Black oystercatcher	***Haematopus bachmani***	**Common**	**Common**	**Common**	**Common**	**DeSante & Ainley 1980; Ainley & Boekelheide 1990**
Spotted sandpiper	*Actitis macularius*	Uncommon	Absent	Extremely rare	Very rare	Richardson et al. 2003
Wandering tattler	*Tringa incana*	Common	Very rare	Fairly common	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Willet	*Tringa semipalmata*	Fairly common	Extremely rare	Fairly common	Very rare	Richardson et al. 2003; PRBO unpubl. data
Whimbrel	*Numenius phaeopus*	Common	Extremely rare	Fairly common	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Marbled godwit	*Limosa fedoa*	Fairly common	Absent	Absent	Extremely rare	Richardson et al. 2003
Ruddy turnstone	*Arenaria interpres*	Fairly common	Very rare	Uncommon	Rare	Richardson et al. 2003
Black turnstone	*Arenaria melanocephala*	Abundant	Uncommon	Common	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Surfbird	*Aphriza virgata*	Uncommon	Very rare	Very rare	Very rare	Richardson et al. 2003
Western sandpiper	*Calidris mauri*	Common	Extremely rare	Absent	Absent	Richardson et al. 2003

D. Risk profiles for birds

Predators/scavengers* (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Least sandpiper	*Calidris minutilla*	Fairly common	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Pectoral sandpiper	*Calidris melanotos*	Fairly common	Absent	Absent	Extremely rare	Richardson et al. 2003
Short-billed dowitcher	*Limnodromus griseus*	Common	Absent	Absent	Very rare	Richardson et al. 2003
Long-billed dowitcher	*Limnodromus scolopaceus*	Fairly common	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Northern flicker (yellow- + red-shafted)	*Colaptes auratus*	Fairly common	Very rare	Very rare	Uncommon	Richardson et al. 2003
Swainson's thrush	*Catharus ustulatus*	Common	Absent	Absent	Uncommon	Richardson et al. 2003
Hermit thrush	***Catharus guttatus***	**Common**	**Uncommon**	**Very rare**	**Fairly common**	**Richardson et al. 2003**
American robin	***Turdus migratorius***	**Fairly common**	**Fairly common**	**Extremely rare**	**Uncommon**	**Richardson et al. 2003; PRBO unpubl. data**
Varied thrush	***Ixoreus naevius***	**Fairly common**	**Rare**	**Extremely rare**	**Uncommon**	**Richardson et al. 2003**
Northern Mockingbird	*Mimus polyglottos*	Uncommon	Extremely rare	Absent	Rare	Richardson et al. 2003
Starling	***Sturnus vulgaris***	**Abundant**	**Abundant**	**Abundant**	**Uncommon**	**Richardson et al. 2003**
Cedar waxwing	*Bombycilla cedrorum*	Common	Very rare	Absent	Uncommon	Richardson et al. 2003
Western tanager	*Piranga ludoviciana*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003

D. Risk profiles for birds

Predators/scavengers* (Alternative C risk profile: *primarily low risk; high risk during bait broadcast*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003
Black-headed grosbeak	*Pheucticus melanocephalus*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003
Red-winged blackbird	*Agelaius phoeniceus*	Fairly common	Extremely rare	Absent	Rare	Richardson et al. 2003
Western meadowlark	***Sturnella neglecta***	**Common**	**Very rare**	**Uncommon**	**Rare**	**Richardson et al. 2003**
Brewer's blackbird	*Euphagus cyanocephalus*	Common	Very rare	Extremely rare	Uncommon	Richardson et al. 2003
Brown-headed cowbird	*Molothrus ater*	Common	Absent	Absent	Fairly common	Richardson et al. 2003
Bullock's oriole	*Icterus bullockii*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Purple finch	*Carpodacus purpureus*	Fairly common	Extremely rare	Extremely rare	Uncommon	Richardson et al. 2003
House finch	*Carpodacus mexicanus*	Fairly common	Extremely rare	Absent	Fairly common	Richardson et al. 2003
Lesser goldfinch	*Carduelis psaltria*	Common	Extremely rare	Absent	Rare	Richardson et al. 2003

*Not including *mouse predators*, specialists in birds, intertidal organisms, flying insects or micro-invertebrates
Species in **bold** may be present during bait broadcast. Species not in bold are unlikely to be present during broadcast.

D. Risk profiles for birds

Mouse predators/scavengers (Alternative C risk profile: *initially high risk; high risk again during bait broadcast; otherwise low risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Great blue heron	*Ardea herodias*	Uncommon	Extremely rare	Extremely rare	Very rare	Richardson et al. 2003
Northern harrier	*Circus cyaneus*	Uncommon	Possible	Absent	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Red-tailed hawk	*Buteo jamaicensis*	Possible	Possible	Extremely rare	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Rough-legged hawk	*Buteo lagopus*	Rare	Extremely rare	Extremely rare	Absent	Richardson et al. 2003
American kestrel	*Falco sparverius*	Fairly common	Very rare	Very rare	Extremely rare	Richardson et al. 2003
Heermann's gull	*Larus heermanni*	Abundant	Uncommon	Rare	Uncommon	Richardson et al. 2003
Mew gull	*Larus canus*	Fairly common	Uncommon	Very rare	Rare	Richardson et al. 2003
Ring-billed gull	*Larus delawarensis*	Uncommon	Very rare	Absent	Very rare	Richardson et al. 2003
California gull	*Larus californicus*	Abundant	Common	Extremely rare	Common	Richardson et al. 2003; PRBO unpubl. data
Herring gull	*Larus argentatus*	Abundant	Abundant	Fairly common	Common	Richardson et al. 2003; PRBO unpubl. data
Thayer's gull	*Larus thayeri*	Uncommon	Uncommon	Extremely rare	Uncommon	Richardson et al. 2003
Western gull	*Larus occidentalis*	Abundant	Abundant	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Glaucous-winged gull	*Larus glaucescens*	Abundant	Abundant	Common	Abundant	Richardson et al. 2003; PRBO unpubl. data

D. Risk profiles for birds

Barn owl	*Tyto alba*	Possible	Possible	Extremely rare	Extremely rare	PRBO unpubl. data
Burrowing owl	*Athene cunicularia*	Uncommon	Extremely rare	Uncommon	Very rare	Richardson et al. 2003; PRBO unpubl. data
Long-eared owl	*Asio otus*	Rare	Possible	Absent	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Short-eared owl	*Asio flammeus*	Uncommon	Possible	Extremely rare	Extremely rare	Richardson et al. 2003; PRBO unpubl. data
Northern saw-whet owl	*Aegolius acadicus*	Possible	Possible	Absent	Absent	PRBO unpubl. data

Other terrestrial birds* (Alternative C risk profile: *low to negligible risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Sharp-shinned hawk	*Accipiter striatus*	Fairly common	Possible	Absent	Absent	Richardson et al. 2003; PRBO unpubl. data
Merlin	*Falco columbarius*	Uncommon	Absent	Absent	Absent	Richardson et al. 2003
Peregrine falcon	*Falco peregrinus*	Fairly common	Very rare	Uncommon	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Wandering tattler	*Tringa incana*	Common	Very rare	Fairly common	Fairly common	Richardson et al. 2003; PRBO unpubl. data
Willet	*Tringa semipalmata*	Fairly common	Extremely rare	Fairly common	Very rare	Richardson et al. 2003; PRBO unpubl. data
Whimbrel	*Numenius phaeopus*	Common	Extremely rare	Fairly common	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Ruddy turnstone	*Arenaria interpres*	Fairly common	Very rare	Uncommon	Rare	Richardson et al. 2003

Other terrestrial birds* (Alternative C risk profile: *low to negligible risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Black turnstone	*Arenaria melanocephala*	Abundant	Uncommon	Common	Uncommon	Richardson et al. 2003; PRBO unpubl. data
Vaux's swift	*Chaetura vauxi*	Common	Absent	Absent	Very rare	Richardson et al. 2003
Anna's hummingbird	*Calypte anna*	Fairly common	Very rare	Absent	Rare	Richardson et al. 2003
Rufous / Allen's hummingbird	*Selasphorus rufus/S. sasin*	Uncommon	Absent	Absent	Fairly common	Richardson et al. 2003
Western wood-pewee	*Contopus sordidulus*	Fairly common	Absent	Absent	Common	Richardson et al. 2003
Willow flycatcher	*Empidonax traillii*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Pacific-slope / Cordilleran flycatcher	*Empidonax difficilis / E. occidentalis*	Common	Absent	Absent	Fairly common	Richardson et al. 2003
Black phoebe	*Sayornis nigricans*	Fairly common	Very rare	Uncommon	Very rare	Richardson et al. 2003; PRBO unpubl. data
Say's phoebe	*Sayornis saya*	Uncommon	Absent	Extremely rare	Very rare	Richardson et al. 2003
Cassin's Vireo	*Vireo plumbeus / V. cassinii / V. solitaries*	Uncommon	Absent	Absent	Rare	Richardson et al. 2003
Warbling vireo	*Vireo gilvus*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Tree swallow	*Tachycineta bicolor*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003
Violet-green swallow	*Tachycineta thalassina*	Common	Absent	Absent	Uncommon	Richardson et al. 2003

D. Risk profiles for birds

Other terrestrial birds* (Alternative C risk profile: *low to negligible risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Rough-winged swallow	*Stelgidopteryx serripennis / S. ruficollis*	Uncommon	Absent	Absent	Very rare	Richardson et al. 2003
Cliff swallow	*Petrochelidon pyrrhonota*	Uncommon	Absent	Absent	Very rare	Richardson et al. 2003
Barn swallow	*Hirundo rustica*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Red-breasted nuthatch	*Sitta canadensis*	Common	Absent	Absent	Rare	Richardson et al. 2003
Winter wren	*Troglodytes troglodytes*	Uncommon	Extremely rare	Extremely rare	Very rare	Richardson et al. 2003
Golden-crowned kinglet	*Regulus satrapa*	Common	Absent	Absent	Uncommon	Richardson et al. 2003
Ruby-crowned kinglet	*Regulus calendula*	Abundant	Very rare	Extremely rare	Common	Richardson et al. 2003; PRBO unpubl. data
Tennessee warbler	*Vermivora peregrina*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003
Orange-crowned warbler	*Vermivora celata*	Fairly common	Absent	Extremely rare	Common	Richardson et al. 2003
Nashville warbler	*Vermivora ruficapilla*	Fairly common	Absent	Absent	Rare	Richardson et al. 2003
Yellow warbler	*Dendroica petechia*	Common	Absent	Absent	Fairly common	Richardson et al. 2003
Chestnut-sided warbler	*Dendroica pensylvanica*	Uncommon	Absent	Absent	Rare	Richardson et al. 2003
Magnolia warbler	*Dendroica magnolia*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003

D. Risk profiles for birds

Other terrestrial birds* (Alternative C risk profile: *low to negligible risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Yellow-rumped warbler	*Dendroica coronata*	Abundant	Fairly common	Uncommon	Common	Richardson et al. 2003; PRBO unpubl. data
Black-throated gray warbler	*Dendroica nigrescens*	Fairly common	Absent	Extremely rare	Rare	Richardson et al. 2003
Townsend's warbler	*Dendroica townsendi*	Common	Extremely rare	Extremely rare	Fairly common	Richardson et al. 2003
Hermit warbler	*Dendroica occidentalis*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003
Palm warbler	*Dendroica palmarum*	Common	Absent	Extremely rare	Rare	Richardson et al. 2003; PRBO unpubl. data
Blackpoll warbler	*Dendroica striata*	Fairly common	Absent	Absent	Rare	Richardson et al. 2003
American redstart	*Setophaga ruticilla*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Ovenbird	*Seiurus aurocapilla*	Uncommon	Absent	Absent	Uncommon	Richardson et al. 2003
MacGillivray's warbler	*Oporornis tolmiei*	Fairly common	Absent	Absent	Uncommon	Richardson et al. 2003
Common yellowthroat	*Geothlypis trichas*	Fairly common	Absent	Absent	Fairly common	Richardson et al. 2003
Wilson's warbler	*Wilsonia pusilla*	Common	Absent	Absent	Abundant	Richardson et al. 2003

*Specialists in birds, intertidal organisms, flying insects or micro-invertebrates

D. Risk profiles for birds

Marine foragers (Alternative C risk profile: *negligible risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Greater scaup	*Aythya marila*	Uncommon	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Surf scoter	*Melanitta perspicillata*	Common	Fairly common	Fairly common	Common	Richardson et al. 2003
Pacific loon	*Gavia pacifica*	Abundant	Abundant	Rare	Abundant	Richardson et al. 2003
Common loon	*Gavia immer*	Common	Fairly common	Extremely rare	Uncommon	Richardson et al. 2003
Eared grebe	*Podiceps nigricollis*	Abundant	Abundant	Abundant	Abundant	Richardson et al. 2003
Western/Clark's grebe	*Aechmophorus occidentalis / A. clarkii*	Fairly common	Rare	Very rare	Uncommon	Richardson et al. 2003
Black-footed albatross	*Phoebastria nigripes*	Rare	Extremely rare	Absent	Uncommon	Richardson et al. 2003
Northern fulmar	*Fulmarus glacialis*	Abundant	Abundant	Absent	Common	Richardson et al. 2003
Pink-footed shearwater	*Puffinus creatopus*	Abundant	Absent	Absent	Common	Richardson et al. 2003
Buller's shearwater	*Puffinus bulleri*	Abundant	Absent	Absent	Absent	Richardson et al. 2003
Sooty shearwater	*Puffinus griseus*	Abundant	Fairly common	Absent	Abundant	Richardson et al. 2003
Short-tailed shearwater	*Puffinus tenuirostris*	Fairly common	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Black-vented shearwater	*Puffinus opisthomelas*	Abundant	Extremely rare	Absent	Very rare	Richardson et al. 2003

D. Risk profiles for birds

Marine foragers (Alternative C risk profile: *negligible risk*)

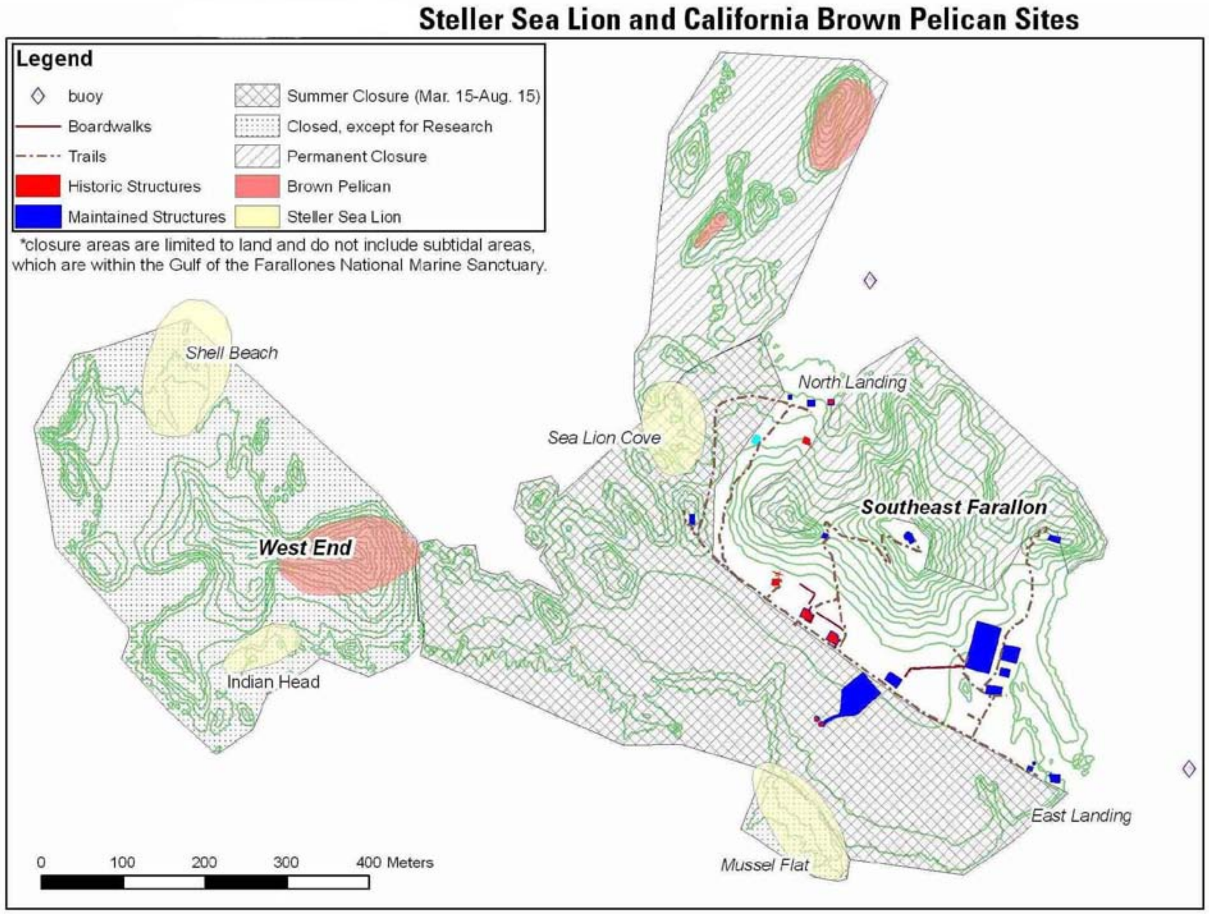
		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Leach's storm-petrel	*Oceanodroma leucorhoa*	Absent	Absent	Absent	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Ashy storm-petrel	*Oceanodroma homochroa*	Abundant	Abundant	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Brown pelican	*Pelecanus occidentalis*	Abundant	Abundant	Absent	Abundant	Richardson et al. 2003; PRBO unpubl. data
Brandt's cormorant	*Phalacrocorax penicillatus*	Abundant	Abundant	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Double-crested cormorant	*Phalacrocorax auritus*	Rare	Absent	Absent	Common	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Pelagic cormorant	*Phalacrocorax pelagicus*	Abundant	Abundant	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Red-necked phalarope	*Phalaropus lobatus*	Abundant	Absent	Absent	Abundant	Richardson et al. 2003
Red phalarope	*Phalaropus fulicarius*	Abundant	Fairly common	Absent	Abundant	Richardson et al. 2003
Black-legged kittiwake	*Rissa tridactyla*	Common	Abundant	Absent	Abundant	Richardson et al. 2003
Elegant tern	*Sterna elegans*	Abundant	Absent	Absent	Absent	Richardson et al. 2003
Pomarine jaeger	*Stercorarius pomarinus*	Fairly common	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Parasitic jaeger	*Stercorarius parasiticus*	Uncommon	Extremely rare	Absent	Extremely rare	Richardson et al. 2003
Common murre	*Uria aalge*	Abundant	Abundant	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990

D. Risk profiles for birds

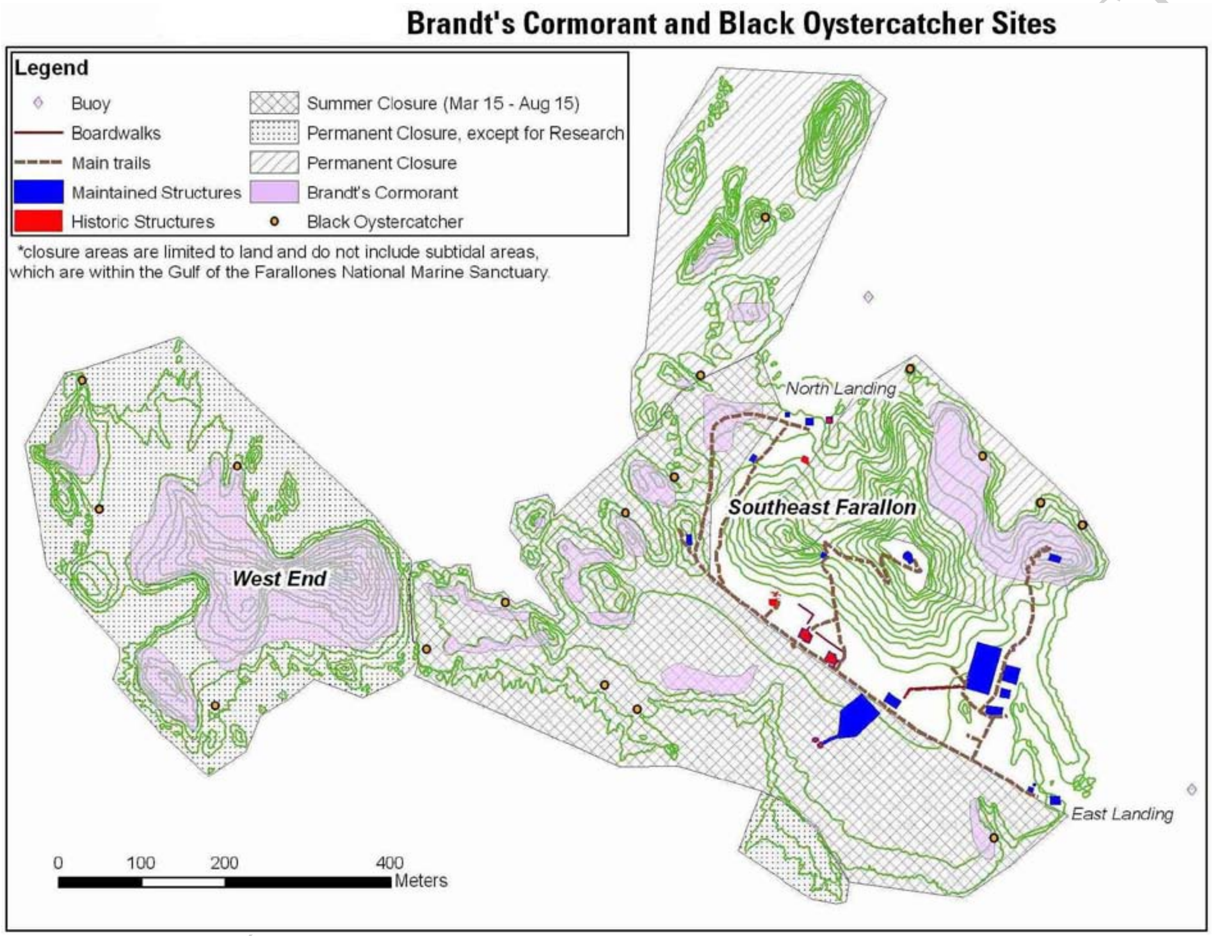
Marine foragers (Alternative C risk profile: *negligible risk*)

		Abundance index				
Bird	**Scientific name**	**Fall**	**Winter**	**Winter residents**	**Spring**	**References**
Pigeon guillemot	*Cepphus columba*	Abundant	Very rare	Very rare	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Ancient murrelet	*Synthliboramphus hypoleucus*	Uncommon	Fairly common	Rare	Rare	Richardson et al. 2003
Cassin's auklet	*Ptychoramphus aleuticus*	Abundant	Abundant	Abundant	Abundant	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Rhinoceros auklet	*Cerorhinca monocerata*	Uncommon	Uncommon	Uncommon	Uncommon	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Tufted puffin	*Fratercula cirrhata*	Common	Absent	Absent	Common	DeSante & Ainley 1980; Ainley & Boekelheide 1990
Belted kingfisher	*Megaceryle alcyon*	Uncommon	Extremely rare	Very rare	Very rare	Richardson et al. 2003

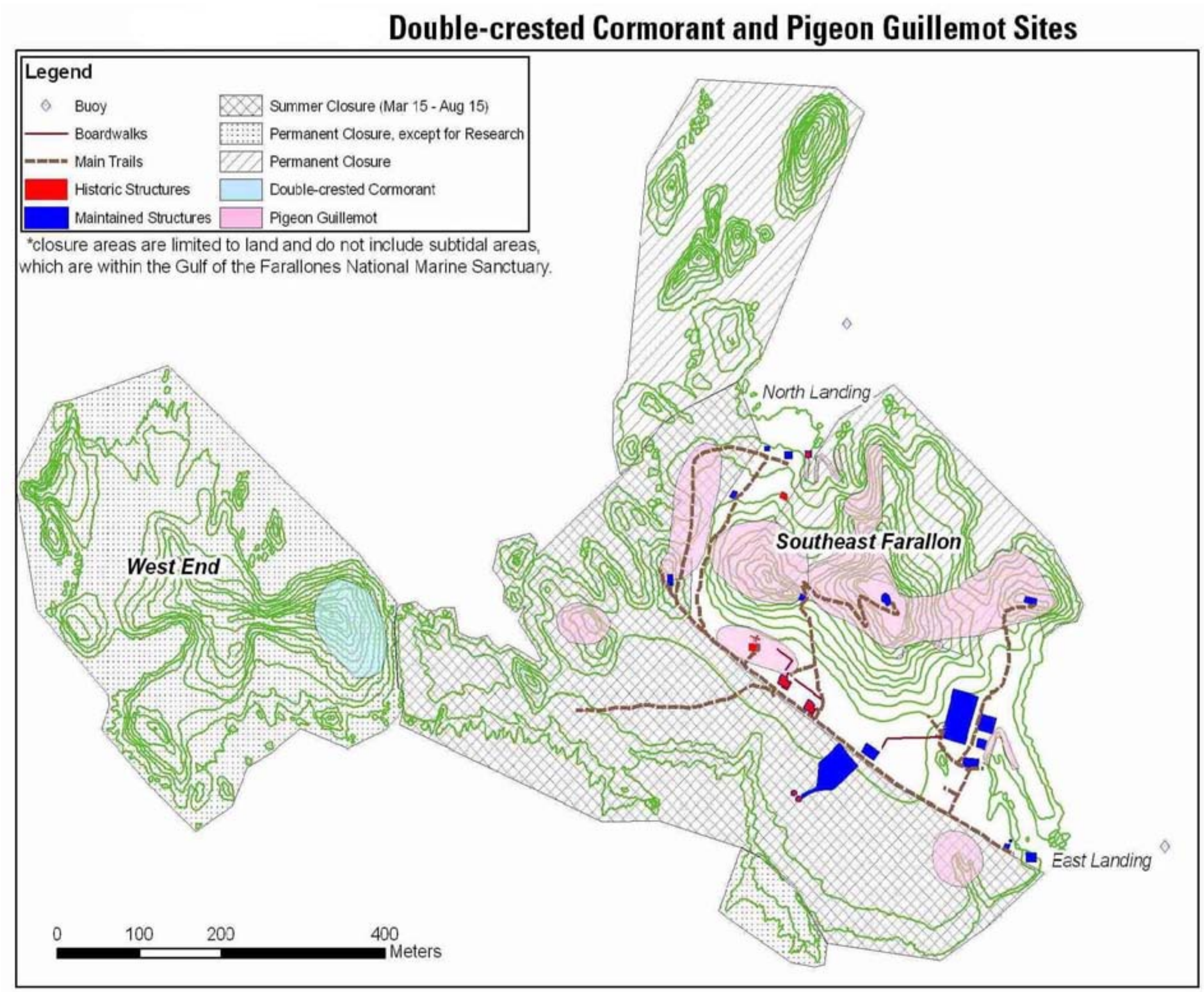
Appendix E. Distribution of ESA-listed species, South Farallon Islands



Appendix F. Seabird nesting and roosting areas, South Farallon Islands

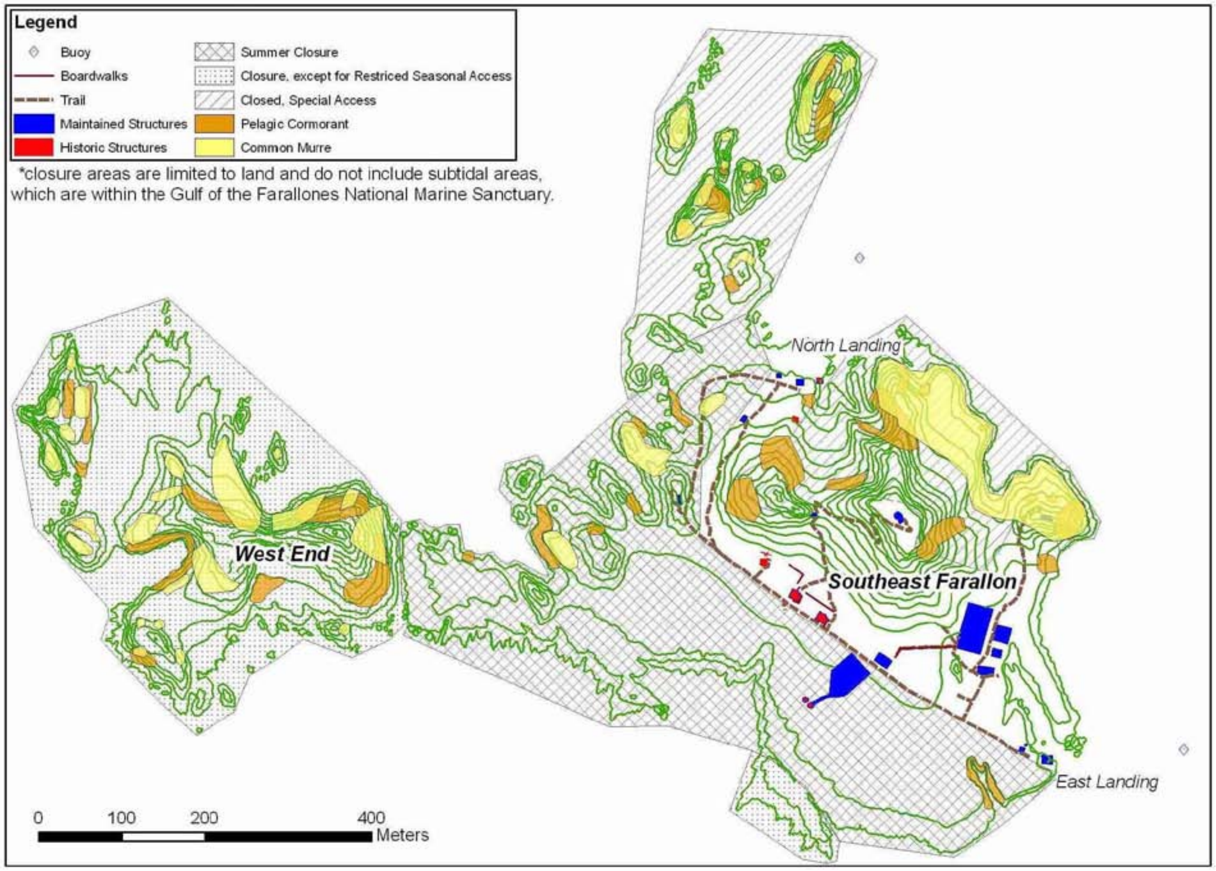


F. Seabird nesting and roosting areas

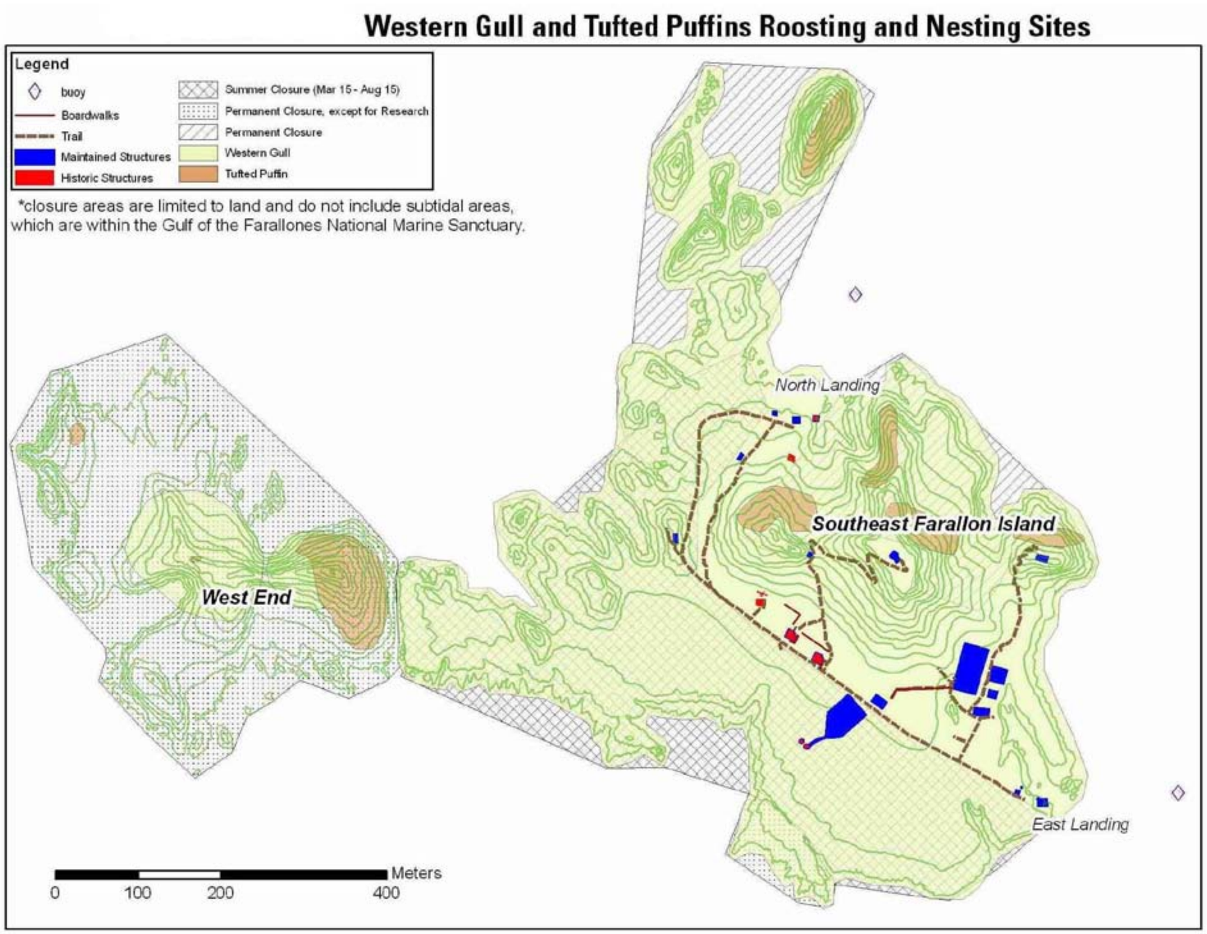


F. Seabird nesting and roosting areas

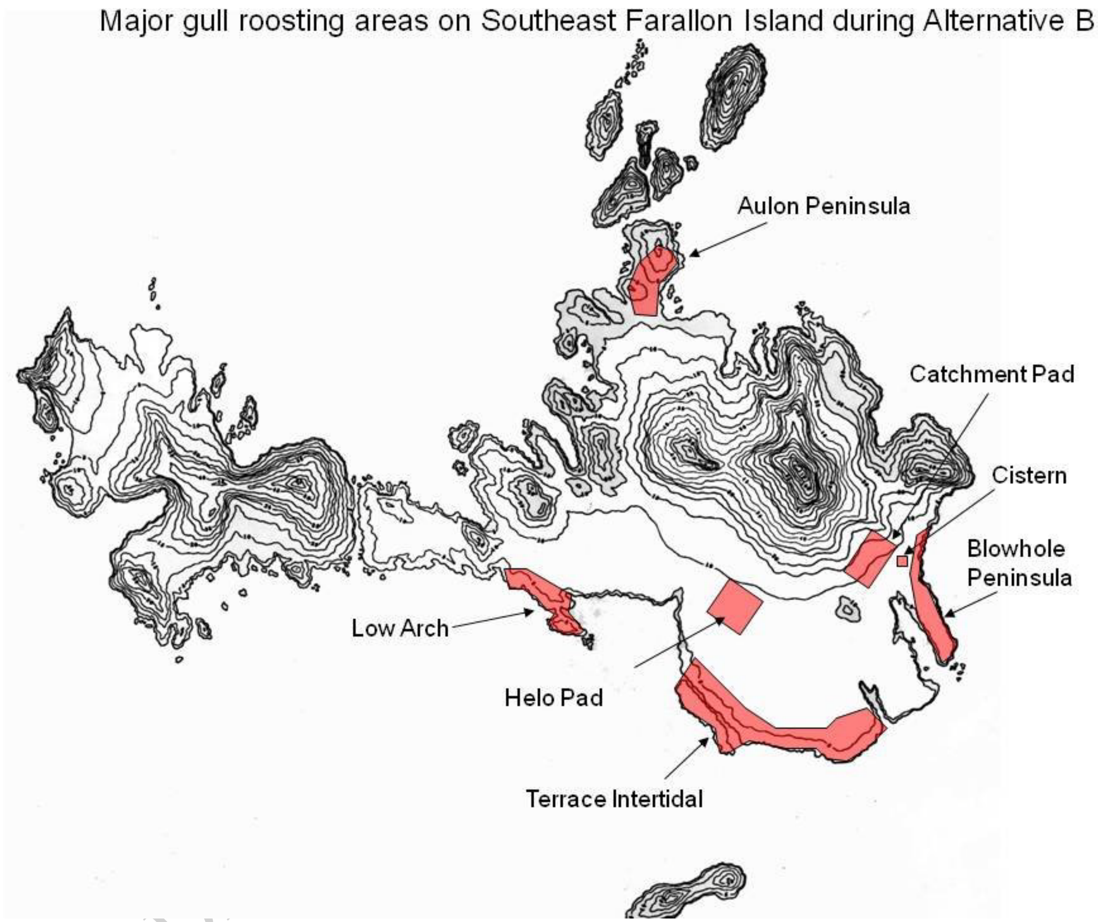
Pelagic Cormorant and Common Murre sites



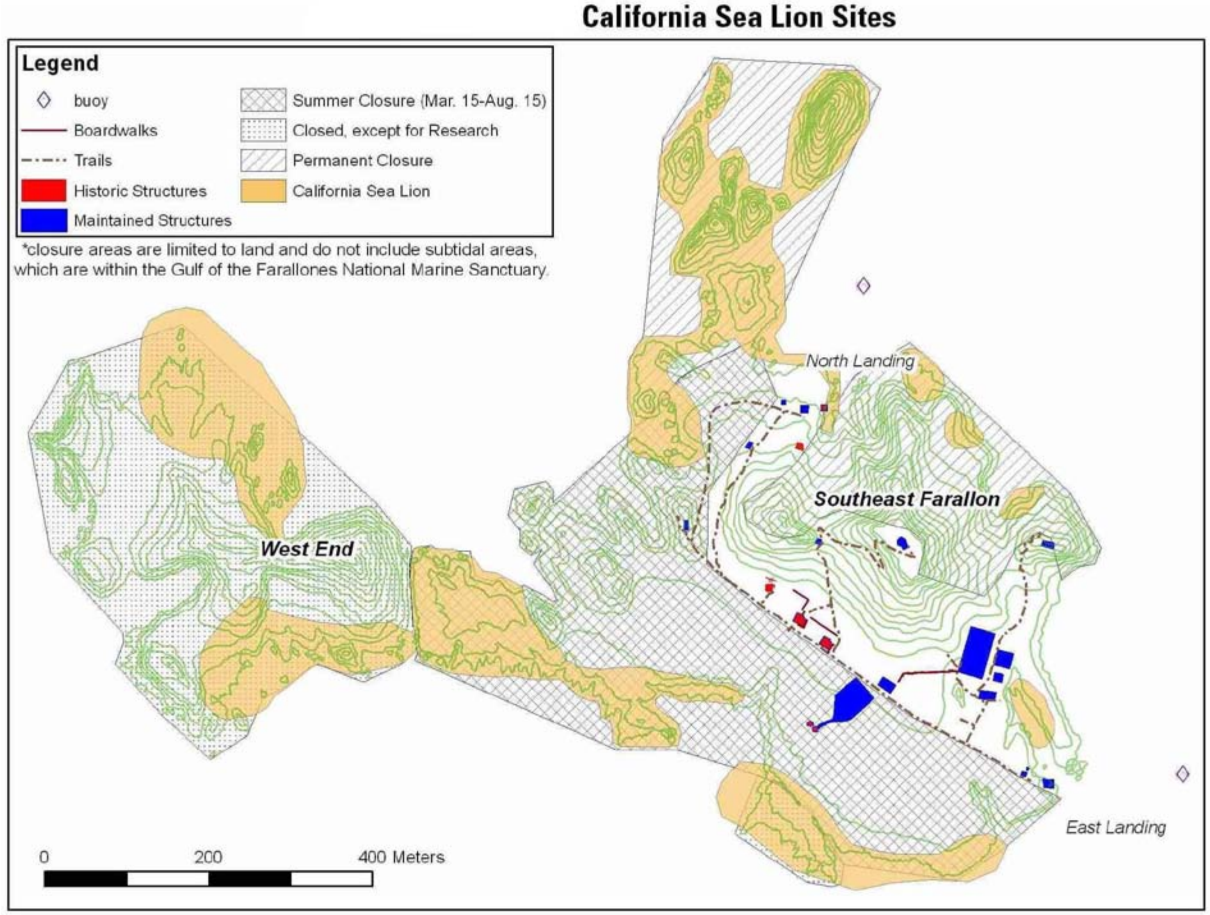
F. Seabird nesting and roosting areas



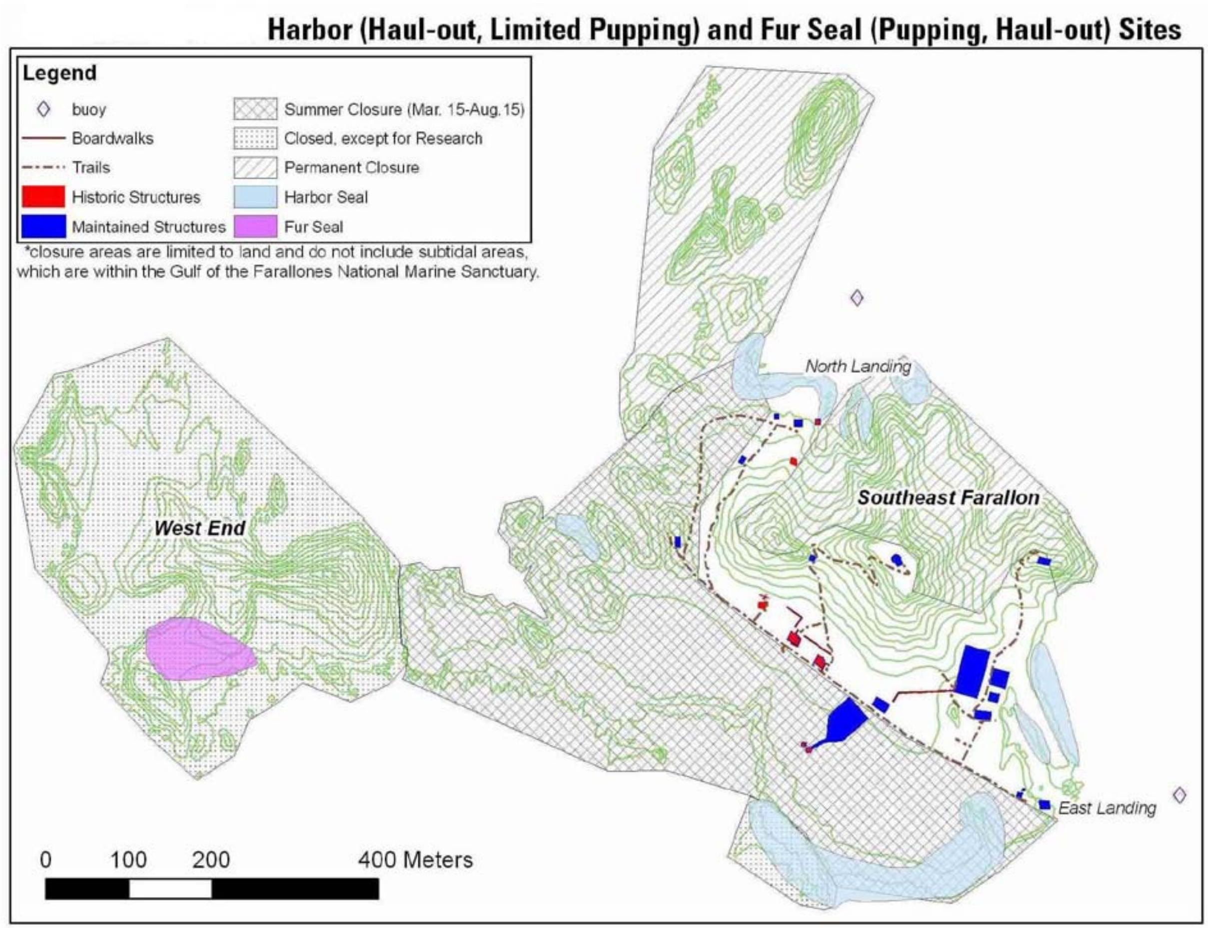
F. Seabird nesting and roosting areas



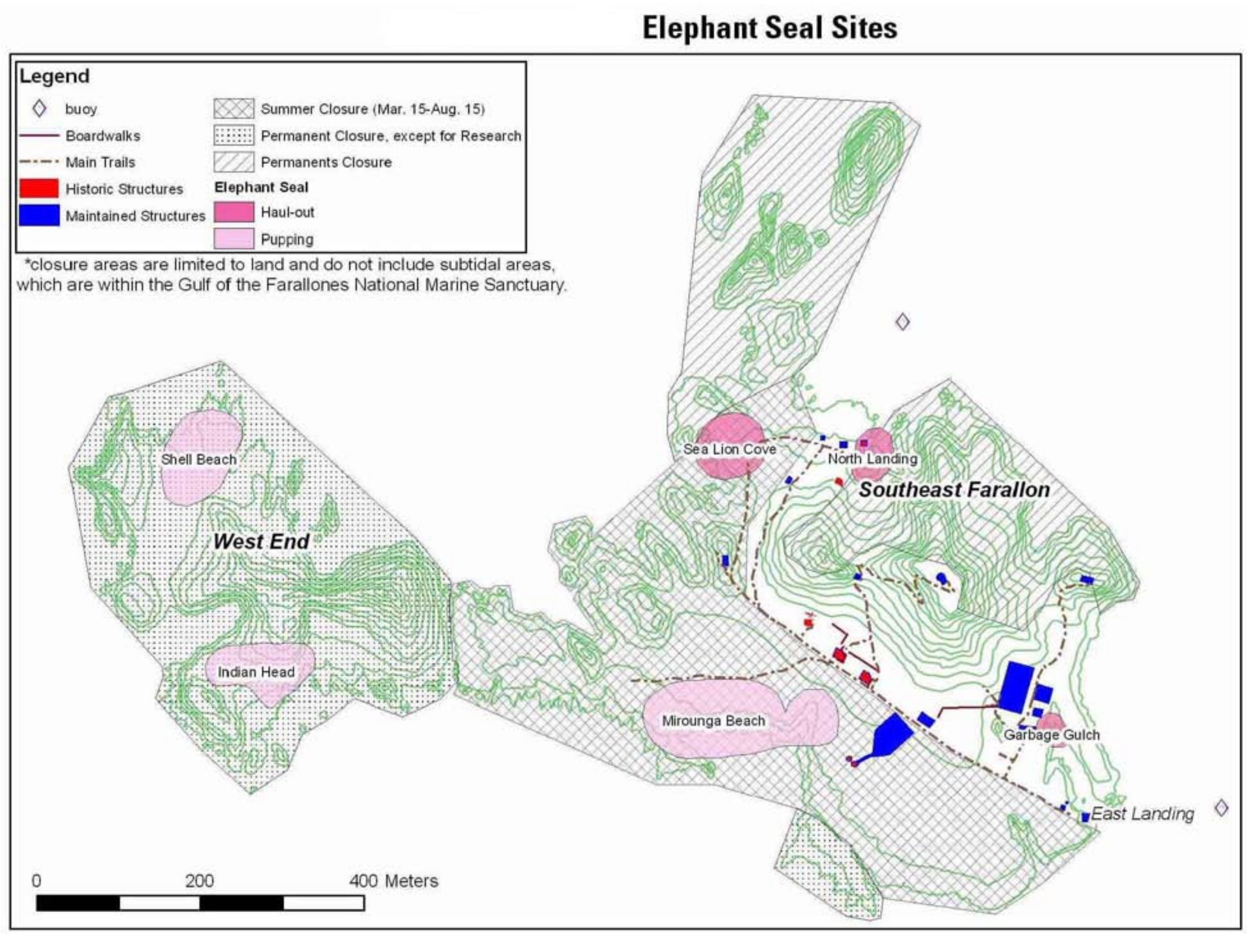
Appendix G. Pinniped breeding and haulout sites, South Farallon Islands



G. Pinniped breeding and haulout sites



G. Pinniped breeding and haulout sites



Appendix H. Intertidal organisms of the Farallones

Intertidal Species List Compilation, February 1993 through November 2006

Abietinaria sp.
Acanthomysis sp.
Acarnus erithacus
Achelia chelata
Achelia nudiscula
Achelia spinoseta
Acmaea mitra
Acrochaetium prophyrae
Acrochaetium sp.
Acrosiphonia coalita
Aglaophenia inconspicua
Aglaophenia latrirostris
Ahnfeltia cornucopiae
Ahnfeltia fastigiata
Ahnfeltiopsis leptophylla
Ahnfeltiopsis linearis
Alaria marginata
Alia carinata
Allopora porphyra
Allorchestes anceps
Alpheus dentipes
Ammothea hilgendorfi
Amphiodia occidentalis
Amphipholis squamata
amphipod
Amphissa columbiana
Amphissa versicolor
Anaata spongigartina
Analipus japonicus
Anatanais normani
Anisodoris noblis
annelid
Anotrichium furcellatum
Antho lithophoenix
Anthopleura elegantissima
Anthopleura xanthogrammica
Antithamnion dendroidum
Antithamnion densum
Aplidium californicum
Aplysilla glacialis
Aplysilla polyraphis
Arabella iricolor
Archidistoma ritteri
arthropod
ascidian (biege)
Audouinella subimmersa
Aurelia aurita
Axocielita originalis
Balanophyllia elegans
Balanus amphitrite
Balanus cariosus
Balanus glandula
Balanus nubilus
Balanus sp.
Balcis thersites
Bangia sp.
Barentsia benedeni
Barleeia haliotiphila
Barleeia subtenuis
Bittium purpureum
Bittium schrichtii
Blidingia minima var. vexata
blue green algae
Bornetia californica
Bossiella corymbifera
Bossiella dichotoma
Bossiella plumosa
Bossiella schmittii
Branchioglossum bipinnatifidum
Branchioglossum undulatum
Bryopsis corticulans
bryozoan
Cadlina modesta
Calliarthron tuberculosum
Calliostoma canaliculatum
Callithamnion biseriatum
Callithamnion pikeanum
Callophyllis cheilosporioides
Callophyllis crenulata
Callophyllis flabellulata
Callophyllis heanophylla
Callophyllis linearis
Callophyllis obtusifolia
Callophyllis pinnata
Callophyllis sp.
Callophyllis violacea
Cancer antennarius
Cancer magister
Cancer productus
Caprella californica
Centroceras clavulatum
Ceramium eatonianum
Ceramium gardneri
Ceramium pacificum
Cerithiopsis carpenteri
Chama arcana
Chiharaea bodegensis
Chondracanthus canaliculatus

H. Intertidal organisms

Chondracanthus corymbiferus
Chondracanthus exasperatus
Chondracanthus harveyanus
Chondracanthus spinosus
Chthamalus dalli
Cirolana harfordi
Cirrilicarpus sp.
Cladophora columbiana
Cladophora graminea
Cladophora sp.
Clathria sp.
Clathromorphum parcum
Codium fragile
Codium setchellii
Coilodesme californica
Colpomenia peregrina
Compsonema serpens
Constantinea simplex
Corallina officinalis
Corallina pinnatifolia
Corallina vancouveriensis
Corallophila eatoniana
Corolla spectabilis (Pteropod)
Corynactis californica
Costaria costata
Crepidula adunca
Crepidula nummaria
Crepidula perforans
Crepipatella lingulata
crustose coralline
Cryptochiton stelleri
Cryptomya californica
Cryptoplerua farlowiana
Cryptopleura corallinara
Cryptopleura crispa
Cryptopleura lobulifera
Cryptopleura rosacea
Cryptopleura ruprechtiana
Cryptopleura violacea
Cumagloia andersonii
Cymakra aspera
Cystodytes lobatus
Cystoseira osmundacea
Daphana californica
Delesseria decipiens
Derbesia marina
Dermasterias imbricata
Desmarestia herbacea
Desmarestia ligulata
Desmarestia munda
diatom
Diaulula sandiegensis
Dictyoneurum californicum
Didemnum carnulentum
Dilsea californica
Diplodonta orbella
Dirona picta
Discurria scutum
Doto columbiana
Egregia menziesii
Elasmopus serricatus
Endocladia muricata
Endocladia viridis
Endophyton ramosum
Entermorpha flexuosa
Enteromorpha clathrata
Enteromorpha compressa
Enteromorpha intestinalis
Epiactis prolifera
Epitonium tinctum
Erythrophyllum delesserioides
Erythrotrichia carnea
Erythrotrichia pulvinata
Eurystomella bilabiata
Exosphaeroma inornata
Fabia subquadrata
Farlowia compressa
Farlowia conferta
Farlowia mollis
Fauchea fryeana
Fauchea laciniata
Faucheocolax attenuata
Flustrellidra corniculata
Gastroclonium subarticulatum
gastropod
Gelidium coulteri
Gelidium purpurascens
Gelidium pusillum
Gelidium robustum
Gelidium sp.
Geodia mesotriaence
Goniotrichopsis sublittoralis
Gracilariophila oryzoides
Gracilariopsis lemaneiformis
Granula margaritula
Grateloupia doryphora
Grateloupia filicina
Griffithsia pacifica
Gymnogongrus chiton
Halichondria panicea
Haliclona (biege)
Haliclona (biege, gold)
Haliclona (gold)
Haliclona (purple)
Haliclona permollis
Haliclona sp.
Halicystis ovalis
Haliotis cracherodii

H. Intertidal organisms

Haliotis racherodii
Haliotis rufescens
Halosaccion glandiforme
Halymenia schizymenioides
Halymenia templetonii
Hemigrapsus nudus
Henricia leviuscula
Hermissenda crassicornis
Herposiphonia parva
Herposiphonia plumula
Hiatella arctica
Higginsia sp.
Hildenbrandia occidentalis
Hildenbrandia prototypus
Hildenbrandia rubra
Hildenbrandia sp.
Hincksia sandriana
Hinnites giganteus
Hipponix craniodes
Hommersandia palmatifolia
Hopkinsia rosacea
Hyale grandicornis
hydrozoans (brown)
Hymenena coccinea
Hymenena flabelligera
Hymenena multiloba
Ianiropsis kincaidi
Idotea fewkesi
Idotea resecata
Idotea schmitti
Idotea sp.
Idotea stenops
Idotea urotoma
Idotea wosnesenskii
Irus lamellifer
Ischnochiton regularis
Janczewskia gardneri
Katharina tunicata
Kellia laperousii
Lacuna cistula
Lacuna marmorata
Lacuna porrecta
Lacuna sp.
Lacuna unifasciata
Laminaria ephemera
Laminaria farlowii
Laminaria setchellii
Laminaria sinclarii
Laminaria sp.
Lasaea subviridis
Leachiella pacifica
Leathesia difformis
Leathesia sp.
Lecythorychus hilgendorfi
Lepidochitona dentiens
Leptasterias hexactis
Leptasterias puscilla
Leptasterias sp.
Leucandra heathi
Leucilla nuttingi
Leucosolenia eleanor
Ligia occidentalis
Ligia pallasii
Ligia sp.
Limnoria algarum
Lissodendoryx topsenti
Lithophyllum dispar
Lithophyllum grumosum
Lithophyllum proboscideum
Lithothamnium sp.
Lithothrix aspergillum
Littorina keenae
Littorina planaxis
Littorina scutulata
Littorina sitkana
Littorina sp.
Littorophiloscia richardsonae
Lophopanopeus leucomanus
Lottia asmi
Lottia digitalis
Lottia gigantea
Lottia instabilis
Lottia limantula
Lottia pelta
Lottia strigatella
Lottia sp.
Lottia triangularis
Loxorhyncus crispatus
Macclintockia scabra
Macrocystis integrifolia
Macrocystis pyrifera
Maripelta rotata
Mastocarpus jardinii
Mastocarpus papillatus
Mazzaella affinis
Mazzaella californica
Mazzaella cordata
Mazzaella cornucopiae
Mazzaella flaccida
Mazzaella heterocarpa
Mazzaella leptorhynchos
Mazzaella linearis
Mazzaella rosea
Mazzaella splendens
Mazzaella volans
Melanosiphon intestinalis
Melita californica
Melobesia marginata
Melobesia mediocris
Membranoptera dimorpha
Mesophyllum conchatum

H. Intertidal organisms

Mesophyllum lamellatum
Metacaprella anomala
Microcladia borealis
Microcladia coulteri
Milneria minima
Mitrella tuberosa
Modiolus capax
Modiolus carpenti
Mopalia ciliata
Mopalia muscosa
Musculus pygmaeus
Mycale psila
Myriogramme sp.
Myriogramme spectabilis
Myriogramme variegata
Mytilus californianus
Mytilus edulis
Myxilla incrustans
Neoptilota densa
Neoptilota hypnoides
Neoptilota sp.
Neorhodomela larix
Nereis guberi
Nereocystis luetkeana
Nienburgia andersoniana
Nienburgia sp.
Nitophyllum sp.
Notoacmea insessa
Notoacmea persona
Nucella canaliculata
Nucella emarginata
Nucella sp.
Nuttallina californica
Nymphopsis spinosissima
Obelia sp.
Ocenebra atropurpurea
Ocenebra interfossa
Ocenebra lurida
Octopus dofleini
Octopus rubescens
Odonthalia floccosa
Odostomia sp.
Oedignathus inermis
Oligochinus lighti
Onchidella borealis
Opalia wroblewskyi
Ophiopholis aculeata
Ophiothrix spiculata
Ophlitaspongia pennata
Opuntiella californica
Osmundea spectabilis
Pachygrapsus crassipes
Pachygrapsus nudus
Pagurus hirsutiusculus
Pagurus samuelensis
Pagurus sp.
Palciphorella velatta
Paracerceis cordata
Parallorchestes ochotensis
Paraxanthia taylorii
Patiria miniata
peanut worm
Penitella conradi
Petaloconchus montereyensis
Petalonia fascia
Petricola carditoides
Petrocelis phase
Petrolisthes cinctipes
Petrospongium rugosum
Peyssonelliopsis epiphytica
Peyssonnelia meridionalis
Peyssonnelia pacifica
Peyssonnelia sp.
Phascolosoma agassizii
Philobrya setosa
Phragmatopoma californica
Phycodrys setchellii
Phyllochaetopterus prolific
Phyllospadix scouleri
Pikea californica
Pikea pinnata
Pilayella sp.
Pisaster giganteus
Pisaster ochraceus
Pleonosporium vancouverianum
Plocamium cartilagineum var. *pacificum*
Plocamium oregonum
Plocamium pacificum
Plocamium sp.
Plocamium violaceum
Pollicipes polymerus
Polycheria osborni
Polyneura latissima
Polysiphonia hendryi
Polysiphonia pacifica
Polysiphonia saraticeri
Polysiphonia sp.
Porcellio americanus
Porifera sp.
Porphyra gardneri
Porphyra lanceolata
Porphyra nereocystis
Porphyra perforata
Porphyra sp.
Postelsia palmaeformis
Prasiola sp.
Prasiola meridionalis
Prionitis australis
Prionitis cornea

H. Intertidal organisms

Prionitis angusta (formerly *filiformis*)

Prionitis lanceolata

Prionitis linearis

Prionitis lyallii

Pronitis sp.

Protothaca staminea

Pseudolithophyllum neofarlowii

Pterochondria woodii

Pterocladia caloglossoides

Pterocladia capillacea

Pterosiphonia baileyi

Pterosiphonia bipinnata

Pterosiphonia dendroidea

Pterothamnion villosum

Pterygophora californica

Ptilota filicina

Ptilothamnionopsis lejolisea

Pugetia fragilissima

Pugetia fragilissima

Pugettia gracilis

Pugettia producta

Pugettia sp.

Pycnoclayella stanleyi

Pycnogonum rickettsi

Pycnogonum stearnsi

Pycnopodia helianthoides

Ralfsia sp.

Rhodochorton purpureum

Rhodymenia californica

Rhodymenia callophyllidoides

Rhodymenia pacifica

Rhodymenia sp.

Ritterella aequalisphonis

Rhodymeniocolax botryoides

Rostanga pulchra

Sahlingia subintegra

Sarcodiotheca gaudichaudii

Schimmelemannia plumosa

Scinaia confusa

Scypha sp.

Scyra acutifrons

Scytosiphon dotyii

Scytosiphon lomentaria

Scytosiphon simplicissimus

Semibalanus cariosus

Semibalanus sp.

Serpula vermicularis

Smithora naiadum

Spirorbis borealis

Spongia idia

Spongonema tomentosum

Stelletta clarella

Stenogramma interrupta

Streblonema sp.

Strongylocentrotus droebachiensis

Strongylocentrotus franciscanus

Strongylocentrotus purpuratus

Styela montereyensis

Stylantheca prophyra

Stylonema alsidii

Suberites sp.

Tealia crassicornis

Tealia lofotensis

Tectura persona

Tectura scutum

Tedania gurjanovae

Tegula brunnea

Tegula funebralis

Tethya aurantia

Tetraclita rubescens

Thelepus crispus

Tiffaniella snyderae

Titanoderma dispar

Tonicella lineata

Toxidocia sp.

Transennella tantilla

Trimusculus reticulatus

Triopha catalinae

Triopha maculata

tropical green

tunicate

Ulothrix flacca

Ulothrix laetevirens

Ulothrix pseudoflacca

Ulva californica

Ulva conglobata

Ulva lactuca

Ulva lobata

Ulva sp.

Ulva taeniata

Urospora sp.

Weeksia reticulata

October 2007 addendum – DRAFT Species Identification

Weeksia reticulata, range extension
Chondria nidifica, range extension

H. Intertidal organisms

Codiales (unknown species from the Order)
Cryptoleura ruprectian

Appendix I. Brodifacoum toxicity model

For the purpose of estimating individual impacts, representative LD50 values can be used 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.

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 (e.g.sparrow), 100 g (e.g. turnstone), and 1000 g (e.g. western gull), compared to average daily food intakes for each of these size classes:

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 these same size classes. Other than mice, bats are the only mammal taxon on the islands that would fall within the size range of these estimates. All bat species potentially present on the Farallones (see Section 3.4.3.3) are less than 25 g. Erickson and Urban's (2004) model estimates that mammals in this size class would need to consume roughly 10% of their daily food intake as bait pellets to reach an LD50 threshold. This food-intake model is not applicable to pinnipeds, which are orders of magnitude larger than 1000 g.

The following table lists the estimates provided by these models for a number of species present at the South Farallones:

I. Brodifacoum toxicity model

Taxon	Est. mass	Appr. amt of bait to reach LD50 of 0.4 mg/kg	% avg. daily food intake#
Greater white-fronted goose	2,075 g (4.57 lb)	21.6 g (0.76 oz)	>20%
California brown pelican*	Small adult: 1.83 kg (4.03 lb)	19 g (0.67 oz)	>20%
Double-crested cormorant*	2,000 g (4.41 lb)	20.8 g (0.73 oz)	>20%
Red-necked phalarope*	32 g (0.07 lb)	0.33 g (0.01 oz)	~4%
California gull**	432 g (0.95 lb)	4.49 g (0.16 oz)**	10-20%
Western gull**	879 g (1.94 lb)	9.14 g (0.32 oz)**	~20%
Glaucous-winged gull**	Similar to WEGU	Similar to WEGU**	~20%
Allen's hummingbird***	3 g (0.007 lb)	0.03 g (0.001 oz)	<4%
Steller sea lion*	Pup: 45 kg (100 lb)	720 g (1.6 lb)	NA
	Adult: 1,088 kg (2,400 lb)	17,400 g (38.4 lb)	NA
Northern elephant seal*	Pup: 34 kg (75 lb)	544 g (1.2 lb)	NA
	Adult: 2,300 kg (5,071 lb)	36,800 g (81.1 lb)	NA

* These figures are presented for comparative purposes only, because these species are carnivorous and forage exclusively in the marine ecosystem and brodifacoum ingestion would need to occur either accidentally or through an intermediate prey species (such as fish) that previously consumed bait pellets, an unlikely scenario (Section 4.2.3.2).

** Because 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.

*** These figures are presented for comparative purposes only, because these birds would only be exposed to brodifacoum indirectly through prey animals.

Appendix J. Special Considerations under MMPA

In addition, the Service and its contractors would monitor the response of pinnipeds to all activities, including helicopter operations, bait station installation and maintenance, and other project tasks to ensure compliance with the Marine Mammal Protection Act (MMPA) and the ESA. This observational monitoring is discussed in detail in Appendix J.

Appendix K. Minimum Requirements Analysis Under the Wilderness Act

See Appendix K for a detailed "Minimum Requirements Analysis" for non-native house mouse eradication on the South Farallones.