Final Environmental Assessment

Eradication of Polynesian Rats (*Rattus exulans*) from Mokapu Island, Hawai‘i

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Prepared in compliance with the National Environmental Policy Act and Hawai‘I HRS 343 and all associated regulations.

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Executive Summary

The purpose of this project is to restore the native species and habitats on Mokapu Island by eradicating introduced rats (*Rattus exulans*) that are known to eat seabird eggs and chicks, native plants, and native invertebrates. Eradicating rats would help these native species recover in an offshore islet habitat safe from many alien species and other disturbances. The operational objective is to expose all rats to a lethal dose of rodenticide, eradicating rats from the island to create suitable conditions for restoration of native plants and seabirds.

The U.S. Fish and Wildlife Service, in cooperation with the Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife and the Wildlife Services proposes to eradicate Polynesian rats from Mokapu Island using the anticoagulant rodenticide diphacinone (0.005% active ingredient) applied by aerial broadcast, using a helicopter. Bait will not be applied if winds exceed 35 miles per hour or if significant rainfall is predicted within 5 days. Other bait application methods such as bait stations are not feasible, primarily because it is not possible for workers to safely access all areas of the steep island to distribute bait.

Follow-up efficacy monitoring will be done on the accessible portions of the island ridgeline but would not be possible on many of the steeper areas. If post-operation monitoring indicates that rats persist and it is evident that the active ingredient diphacinone is responsible for the failure, bait containing brodifacoum (0.0025% active ingredient) could be used the following winter. However, diphacinone has been shown to be an effective toxicant for rats in Hawaii and elsewhere and is preferred because of the reduced impacts to nontarget species, such as birds and reptiles, both through consumption of bait (direct impacts) and/or through consumption of prey that has consumed the bait (secondary impacts).

Operations would be conducted during the winter months (January through March or until the rat breeding season begins). During this time, alternate rat foods (like seabirds) and rat populations are at their lowest and they are not breeding, seabirds are not present or present in low numbers on Mokapu, and human uses of north shore waters around Mokapu are infrequent or impossible due to winter ocean conditions.

Nonetheless, notices would be posted and published in Molokaʻi newspapers notifying the public before the bait broadcasts would occur. Water and tissue samples would be collected after eradication and tested for rodenticide residues. Test results will be made public.

Quarantine restrictions will be incorporated to prevent rodents and other alien species from reinvading Mokapu. Project personnel and other future visitors to Mokapu will be required to inspect all equipment, gear, and clothing to make sure that they are not accidentally bringing alien species onto the island.

Mokapu is a roughly 10-acre island located approximately 0.7 miles off the north coast of Molokaʻi just east of the Kalaupapa Peninsula. The island is a State Seabird Sanctuary and is section 5(b) ceded land. Mokapu rises steeply out of the water to 360 feet above sea level, ending in a narrow summit ridge. Like the nearby islands of Okala and Huelo, Mokapu supports some of the best native coastal plant habitat in Hawaiʻi, with 29 native plant species, several of which are rare and vulnerable. *Peucedanum sandwicense*, a large perennial herbaceous plant, listed as threatened under the Endangered Species Act of 1973 as amended (ESA), and *Lepidium bidentatum* var. *o-waihiense*, a succulent herbaceous plant, a species of concern, are found on Mokapu. In 2003, the USFWS designated critical habitat on Mokapu for *P. sandwicense*, and for *Tetramolopium rockii*, a perennial shrub, and *Brighamia rockii*, a succulent perennial plant found on nearby adjacent islands. Although *T. rockii* and *B. rockii* are not currently found on Mokapu, establishing populations there would be an important step towards species recovery. Polynesian rats on Mokapu are believed to be preventing the regeneration of *Pritchardia*, *Diospyros*, and *Pittosporum* by eating seeds and young plants. Several seabird species nest on Mokapu and rats are known to eat seabird eggs, young, and adults.

Although no human uses are documented on the island, local fishermen visit waters around Mokapu, primarily in the summer months. No negative impacts to cultural activities or historic sites are anticipated.

The USFWS and the Hawai‘i Department of Land and Natural Resources (DLNR) are joint lead agencies on this EA per NEPA, and DLNR is the approving agency per HRS 343.

Analysis of impacts of diphacinone and brodifacoum is conducted on the potential for:

- transport of rodenticides through soils and water
- impacts of rodenticides on terrestrial and marine invertebrates through ingestion
- impacts on nearshore fish and marine invertebrates from ingestion of rodenticide bait
- impacts on human health
- impacts on birds present on Mokapu in the winter, including certain species of native seabirds, nonnative passerine birds, and a nonnative barn owl from direct ingestion of rodenticide bait and ingestion of food that might have rodenticide residues in their tissues.
- Impacts on three species of nonnative lizard from direct ingestion of bait and ingestion of invertebrates that might have rodenticide residues in their tissues.

This EA was used by the State Office of Planning to determine project consistency with the enforceable policies under the Coastal Zone Management Act. The proposed actions are fully consistent with the Hawai‘i State Comprehensive Wildlife Conservation Plan and the General Plan for the County of Maui. A permit from the Hawai‘i Department of Agriculture will be needed for aerial application of rodenticide on Mokapu. No state permit requirement is required for project actions within the Conservation District, but a permit from DOFAW is required for operations on the island, which is a designated Hawai‘i State Seabird Sanctuary. The Hawai`i State Historic Preservation Officer determined that the project will have no adverse effects on historic properties.

A Finding of No Significant Impact (FONSI) per NEPA is appropriate based on analysis in Chapter 3, and no significant impacts have also been determined per HRS 343.

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1.0 PURPOSE AND NEED

1.1 Introduction

1.1.1 Summary of the Proposed Action

The U.S. Fish and Wildlife Service (USFWS), in cooperation with the Hawai‘i Department of Land and Natural Resources, Division of Forestry & Wildlife (DOFAW) and the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA APHIS WS, or WS) proposes to eradicate Polynesian rats (*Rattus exulans*) from Mokapu Island, using the anticoagulant rodenticide diphacinone (0.005% active ingredient) applied by aerial broadcast. Bait will not be applied if winds exceed 35 miles per hour or if significant rainfall is predicted within 5 days. Operations would be conducted only during the winter months (January through March or until the rat breeding season begins) when alternate rat foods (like seabirds) and rat populations are lowest, migratory native nontarget species are not present or present in low numbers, and human uses of north shore waters are infrequent or impossible due to winter ocean conditions. Monitoring of rat presence and abundance would be conducted pre- and post-operation. If post-operation monitoring indicates that rats persist and it is evident that the active ingredient diphacinone is responsible for the failure, bait containing brodifacoum (0.0025% active ingredient) could be used the following winter, if aerial broadast of this bait type is approved. However, diphacinone has been shown to be an effective toxicant for rats in Hawai‘i and elsewhere and is preferred because of the reduced impacts to nontarget species, both through consumption of bait (direct impacts) and/or through consumption of prey that has consumed the bait (secondary impacts). Actions are also planned to attempt to ensure that Polynesian rats do not return to the island from the main Hawaiian Islands by insuring that island visitors inspect all gear to make sure that no rodents are accidentally reintroduced. The public will be notified prior to bait broadcast and water and tissue samples will be tested after the operation for rodenticide residues. See Chapter 2 for more detailed descriptions of the proposed action and alternatives and Chapter 3 for more information on diphacinone and brodifacoum and their impacts.

Mokapu is a roughly 10-acre island located approximately one kilometer (0.7 miles) off the north coast of Moloka‘i just east of the Kalaupapa Peninsula (Fig. 1). Mokapu rises steeply out of the water, at slopes ranging from 45 degrees to vertical, to 110 m (360 feet) above sea level ending in a narrow summit ridge (Fig. 2). The island is a Hawai‘i State Seabird Sanctuary managed by DOFAW, supporting white-tailed tropicbirds (*Phaethon lepturus;* koa‘e), red-tailed tropicbirds (*P. rubricauda;* koa‘e ‘ula), black noddies (*Anous minutus;* noio), and wedge-tailed shearwaters (*Puffinus pacificus;* ‘ua‘u). Rats are known to eat the eggs and young of these and other seabirds.

Like the nearby islands of Okala and Huelo, Mokapu supports some of the best native coastal plant habitat in Hawai‘i, with 29 native plant species, several of which are rare and vulnerable. The island is dominated by native shrubs, but retains small groves of native lama trees (*Diospyros* spp.), some native palm trees *Pritchardii hillebrandii*, which dominate nearby Huelo, and 11 of the last 14 individuals of the shrub *Pittosporum halophilum* (endemic to Moloka‘i). *Peucedanum sandwicense*, a large perennial herbaceous plant, listed as threatened under the Endangered Species Act of 1973 as amended (ESA), and *Lepidium bidentatum* var. *o-waihiense*, a succulent herbaceous plant, a species of concern, are also found on Mokapu. In 2003, the USFWS designated critical habitat on Mokapu for *P. sandwicense*, and for *Tetramolopium rockii*, a perennial shrub, and *Brighamia rockii*, a succulent perennial plant found on nearby islands. Although *T. rockii* and *B. rockii* are not currently found on Mokapu, establishing populations there would be an important step towards species recovery. Nonnative plant species are also found on the island. Polynesian rats on Mokapu are believed to be preventing the regeneration of *Pritchardia*, *Diospyros*, and *Pittosporum* by eating seeds and young plants (Wood and LeGrande, unpubl. report).

No visitors are known to land on Mokapu by boat due to its difficult access but fishing does occur around Mokapu and along the north shore of Moloka‘i, mostly during the summer when the ocean is calmer.

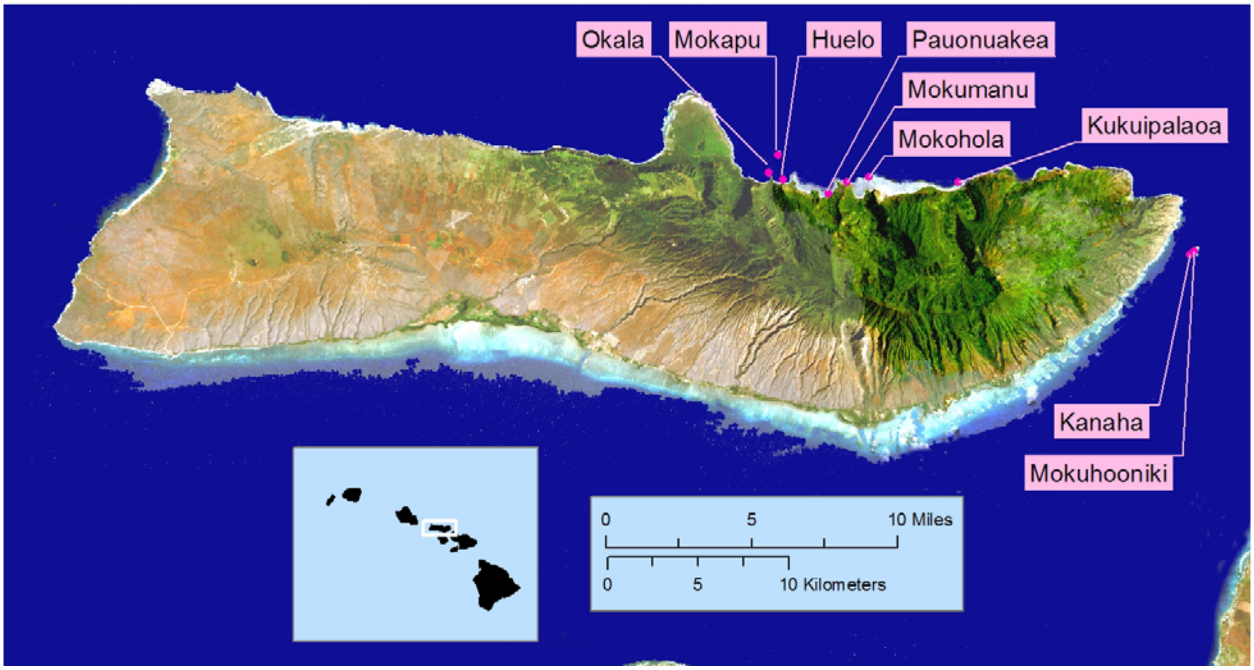

Fig. 1. Location of Mokapu Island off the north shore of Moloka‘i

Fig. 2. Mokapu Island (Photo by C. Swenson, USFWS)

Objectives

DOFAW and the Service are interested in removing non-native rats from Mokapu to increase native plant and seabird recruitment. The operational objective is to expose all rats to a lethal dose of rodenticide, eradicating rats from the island.

The restoration objectives, to be achieved through rat eradication, are to:

- protect the remaining native ecosystems and their plant and animal components on Mokapu;
- create conditions supportive of increasing populations of native seabirds that breed on Mokapu;
- create conditions supportive of increasing populations of native plants on Mokapu;
- create conditions supportive for increasing the numbers and distribution of existing populations of the federally threatened plant *Peucedanum sandwicense* on Mokapu; and
- create conditions for future translocations of native plant species, including listed plants having designated critical habitat, to Mokapu.

Diphacinone has been approved for such purposes by the U.S. Environmental Protection Agency (EPA) and the Hawaiʻi Department of Agriculture. The approved label for diphacinone is included as Appendix D. Use of brodifacoum for conservation purposes is under review by the EPA, and will only be used if approved, and then only if any eradication failure can be associated directly to the use of diphacinone and not to any other factors (Section 2.4.3).

1.2 The Role of Invasive Rodents in Island Biodiversity

S.L. Olson (1989) states: "It is only when we turn to islands that man's negative impact on biotic diversity can be truly appreciated." At least one-third of all species of birds in the world are endemic to islands. It is evident from the fossil record that species diversity of birds on virtually all oceanic islands was reduced at least 30% to 50% since man became part of oceanic island ecosystems, and perhaps as much as one-quarter of all recent avian species have been eradicated "within an instant of geologic time." Due to mankind's expansion and exploration, the historic rate of human-assisted transport of nonnative organisms worldwide is unprecedented. However, it is difficult to realistically quantify man's impacts because of lack of island paleontological data which would help in understanding the original ecosystems (Olson 1989).

Oceanic islands contain a disproportionate share of the world's unique species and are especially vulnerable to the impacts of invasions by nonnative species. Most such invasions typically are random, unplanned events, except for the introduction of biological control agents and large mammals (Soulé 1990, Zavaleta 2002). Few oceanic islands have escaped problems caused by biological invasions; over 80% of all islands worldwide have been invaded by some species of invasive rodent. Oceanic islands typically support plant and animal communities with relatively little biological diversity and simplified trophic webs, as well as high numbers of species that are endemic to particular isolated islands. These ecosystems are highly susceptible to disturbances caused by invasions of invasive species, and most species extinction events have occurred or are occurring in these insular ecosystems (Courchamp et al. 2002).

Some species of seabirds in particular may be susceptible to rodent and other invasive mammalian species predation because they exhibit life history patterns involving long life spans, high adult survival, delayed reproductive maturity, small clutch size, and long fledgling periods, resulting in low annual productivity. Many seabirds also nest on the ground or in burrows or crevices where small mammalian ground predators such as rodents can reach eggs, chicks and even adults. Not having evolved with rodents or other mammalian predators, these bird species typically have not developed behavioral defenses against predators. The most vulnerable species of seabirds are smaller species of ground or burrow/crevice nesters which feed away from coastlines in the deeper waters of the continental shelf or open oceans. This behavior increases the vulnerability of eggs to depredation and/or fledglings to predation (Moors and Atkinson 1984).

Rodents are usually introduced to islands from shipwrecks or vessels, or by the import of foodstuffs and other materials or equipment to islands. Since the beginning of European expansion and exploration, the rate of human-assisted transport of nonnative organisms has been unprecedented, and some of the competitive generalists, such as rodents, have rapidly colonized new habitats. Such invasions have changed ecological balance and damaged native ecosystems, sometimes permanently (Atkinson 1977, Diamond 1989, Coblenz 1990).

1.2.1 Relationships of Invasive Mammals to Island Ecosystems and Extinctions of Native Wildlife

1.2.1.1 Introduction

Invasions of nonnative invasive species are the second greatest cause of human-induced extinctions of native wildlife, after loss and fragmentation of habitat (Courchamp et al. 2002). The control and eradication of invasive species remains among the most urgent of all management activities (Diamond 1989, Soulé 1990).

Over 90% of extinctions of bird species that have occurred since the 1600s are birds endemic to oceanic islands, even though such birds are a small percentage of the total number of species globally. Nonnative invasive predators, especially feral house cats and rodents, have been identified as the major factors in these extinctions (Diamond 1989, Moors et al. 1992). The current rate of extinctions is far higher than the natural rate because of the effects of the recently accelerated rate of human activities as agents of dispersal of invasive species. The current rate may be fifty to several hundred times greater than previously estimated (Diamond 1985).

At least three factors are likely to contribute to extinctions of island species due to introduced mammals:

- Island populations of individual species tend to be smaller than their mainland counterparts, and smaller populations have a higher risk of extinction;
- Since islands are inherently smaller than mainland areas, the number of sites supporting contiguous habitat for a particular insular species will typically be fewer; and
- In the absence of predators, some oceanic island species lose their behavioral defense adaptations against predators (Diamond 1985).

The last factor is the most critical for species inhabiting isolated islands in the Hawaiian chain.

When rodents are introduced to a rodent-free island, their populations typically increase rapidly to fill the carrying capacity of the new habitat (irruptions). Rodent populations are cyclic and these population cycles are mostly associated with weather conditions, resource availability and disease. Sometimes carrying capacity can be exceeded during times of rapid population growth when favorable conditions are present until equilibrium is reestablished (Courchamp et al. 2002). This may initiate (or compound if already occurring) the incidence of depredation or predation above that which may be observed during rodent population lows. Therefore, rodents' population level impacts on species of concern may oscillate from none to great in both space and time.

Rodents have been documented as causing reductions or extinctions of many different types of animals, such as land snails, insects, amphibians, lizards, turtles, snakes and small mammals (Moors et al. 1992). Rodents can also change the vegetation communities on oceanic islands (Campbell 1978, Moors et al. 1992, Allen et al. 1994, King and Moller 1997, Campbell 2002, Wilson et al. 2003). Since rodents are efficient predators of invertebrates, herpetofauna, and birds, they can also indirectly affect the numbers of plants by their influence on populations that directly affect presence and abundance of plant species (Campbell 1978, Scowcroft and Sakai 1984, Allen et al. 1994, Campbell and Atkinson 1999, Campbell 2002, Campbell and Atkinson 2002, Wilson et al. 2003, Udy 2004, Maron et al. 2006). Rodents may also affect nutrient cycling. For example, if rodents reduce seabird numbers, the amount of marine-derived guano deposited on the island would be diminished. This effect and the resultant ecological changes in soil fertility and vegetation from the substantial loss of seabird guano have been documented when predatory mammals have decreased colonial seabird populations (Mac et al. 1998, Maron et al. 2006).

Since trophic webs on oceanic islands are often very simplified, with little ecological or taxonomic redundancy (when a species is extirpated, no other species exists to fulfill the ecological role the missing species played), dramatic increases in introduced mammalian predators may lead to major imbalances in the whole ecosystem. Declines in populations of endemic or indigenous species are often the first impact and may lead to further damage at the ecosystem level in terms of shifts in relative abundances of species, extirpation of species from some suitable habitats, or even extinctions. Therefore, conservationists generally agree on the need to control rodents introduced to oceanic islands. However, because of complex interactions between indigenous and introduced mammalian predators, it is often difficult to characterize their impact on the native ecosystem (Courchamp et al. 2002), especially since baseline ecological data are generally not available prior to the invasion occurring and post-operation monitoring of ecological results is limited (Zavaleta 2002). Evidence of island bird population declines is often circumstantial or anecdotal, and few data are available to conclude that rodents are solely or primarily responsible for some bird species extinctions. In addition, evidence of predation on small vertebrates is also difficult to obtain, so population declines may be misunderstood. Impacts on invertebrates are even less studied than on birds, but there is little doubt that impacts can be quite large. However, despite the lack of certainty, of the successful operations conducted, positive ecological responses have been documented in both plant and animal communities.

Hawai‘i has many introduced mammalian predators, including three species of rats (brown or Norway rat, roof, black, or ship rat, and Polynesian rat), feral cats, small Indian mongoose (*Herpestes auropunctatus*), and house mice (*Mus musculus*), with Polynesian rats being present for approximately 1,500 years, and the remaining species introduced since the late 1700s through the mid-1900s (Atkinson 1977).

1.2.1.2 Historical Decreases and Extirpations of Birds on Oceanic Islands from Introductions of Invasive Predatory Mammals

Atkinson (1985) conducted a comprehensive literature analysis of the spread of three species of rats around the world. He notes that, of the 123 major island groups in his study, only 22 (18%) were likely rat-free. However, at least 20 of the 22 island groups included individual rat-free islands that are biologically valuable. Because seabird populations are not dependent on the land for food, nesting can still occur on isolated islands or stacks within island groups that are free from invasive rodents and other mammalian predators. However, with the estimated minimum rate of invasion being over six islands every 20 years, with the peak occurring during World War II, the number of rat-free islands may now be lower.

Atkinson (1985) reported predation by brown rats on gray-faced petrel (*Pterodroma macroptera*) chicks, sooty shearwater chicks (*Puffinus griseus*), peregrine falcon chicks (*Falco peregrinus*), winter wrens (*Troglodytes troglodytes*), song sparrows (*Melospiza melodia*), curlews (*Numenius arquata*) and curlew sandpipers (*Calidris ferruginea*), as well as depredation of their eggs and mallard duck (*Anas platyrhynchos*) eggs in New Zealand.

Further, Atkinson (1985) reported islands where brown rats (sometimes in conjunction with cats and other introduced invasive predators such as opossum and mongoose) have been implicated in population declines or extinctions of bird species, including:

- Society Island near Tahiti: Tahitian rail (*Rallus pacificus*), Tahitian sandpiper (*Prosobonia leucoptera*) and two species of parakeets (*Cyanoramphus zealandicus* and *C. ulietanus*);
- Campbell Island, New Zealand: Campbell Island teal (*Anas aucklandica nesiotis*) and sooty shearwater, Bermuda Island petrel (*Pterodroma hasitata*) and Audubon's shearwater (*Puffinus iherminieri*); and
- The Falkland Islands: tussock bird (*Conclodes antarcticus*), southern house wren (*Troglodytes aedon*), and Antarctic prion (*Pachyptila desolata*).

Antarctic pipits (*Anthus antarcticus*), ground nesting seabirds endemic only to South Georgia Island, may be excluded from areas occupied by brown rats, as they are never found nesting in habitat occupied by brown rats, but are common in areas that the rats are prevented from accessing by the presence of large glaciers (Pye and Bonner 1980). Statistical analysis on the Virgin Islands indicated that increasing rat abundance correlated with significant declines in bird diversity in xeric forest habitats (Campbell 1991).

Atkinson (1977 and 1985) also documents islands where black rats (also sometimes in conjunction with cats and other introduced invasive predators) have been implicated in major declines or extinctions of birds, including perching birds, since black rats are more agile climbers and spend substantially more time in trees than brown rats (Atkinson 1985, King 1990, Innes 2001). The most well-known and documented cases of population declines and extinctions after black rat introductions to islands include (Atkinson 1977 and 1985):

- Lord Howe Island (1918): extinction of vinous-tinted thrush (*Turdus xanthopus vinitinctus*), robust silvereye (*Zosterops strenua*), Lord Howe warbler (*Gerygone* *insularis*), Lord Howe fantail (*Rhipisura fuliginosa fuliginosa*), and Lord Howe starling (*Aplonis fuscus hullianus*);

- Midway Island (mid-1940s): rapid extinction (within 18 months) of Laysan finch (*Psittirostra cantans cantans*) and Laysan rail (*Porzana palmeri*), with major declines in Bonin petrel (*Pterodroma hypoleuca*) and canary (*Serinus canaria*);
- Big South Cape Island, New Zealand (1962): rapid extinction (within three years) of South Island saddleback (*Philesturnus carunculatus*), Stewart Island robin (*Petroica australis rakiura*), Steward Island fernbird (*Bowdleria punctata*), Stewart Island snipe (*Coenocorypha aucklandica*), and Stead's bush wren (*Xenicus longipes*), and rapid declines in yellow-crowned parakeet (*Cyanoramphus auriceps*), red-crowned parakeet (*Cyanoramphus novaezelandiae*), and bellbird (*Anthornis melanura*). Several species of large invertebrates were reduced and a flightless weevil became extinct (King 1990).

Atkinson (1985) observed that, based on the literature, 27 of 53 bird species listed as potential prey of brown rats are seabird species. Using stable isotope tissue analysis (which traces the source of general foods eaten by an individual animal using the measurable radioactive breakdown of specific mineral isotopes of carbon, sulfur and nitrogen), Hobson et al. (1999) inferred that brown rats were obtaining some of the protein portion of their diet from ancient murrelets, although the technique could not determine between scavenging and actual predation or whether it was adults, chicks, or eggs and does not assess the relative importance of plant and animal foods.

Atkinson (1985 and 1994) concluded that small endemic bird species living on island groups located north of 15 degrees north latitude; not having intrinsic anti-predator behaviors; with long incubation and/or fledgling periods; feeding offsite in the ocean; and nesting in burrows, crevices or on the ground are most vulnerable to predation. If nesting coincides with seasonal peaks in rodent numbers (such as in late summer and fall in temperate areas), then the risk of predation is also increased. Bird populations which do not re-nest after losing a brood or that normally raise only one brood in a season are also more vulnerable to productivity loss. Species of seabird that leave chicks unattended in the nest are also more vulnerable to predation by rodents (Atkinson 1985, Moors et al. 1992, Thibault 1995).

Impacts caused by invasive rats after initial invasion can also be inferred from the positive results of eradication projects. Eradication of invasive rats from islands in New Zealand, Hawai‘i, and elsewhere has demonstrated increases in the number of seabird species in available habitat, as well as seabirds numbers and nest success. On Whale Island, New Zealand, breeding success of grey-faced petrels increased markedly and consistently in the years after the brown rat population on the island was reduced and eventually eradicated (Imber et al. 2000). Polynesian rat eradication on Midway Atoll resulted in dramatic increases of Bonin petrels (Seto 1996). In the two years immediately following the control of black rats from Mokoli`i Island near O`ahu, nesting success of wedge-tailed shearwaters increased rapidly, from only one chick fledging in the three years prior to rat eradication to 185 chicks fledging the second year after eradication (D. Smith pers. comm.). It has also succeeded in increasing forest birds, such as an endemic pigeon, for example, in New Zealand (Innes et al. 2004).

1.2.2 History of Rodent Eradication Projects on Oceanic Islands

The eradication of an invasive rodent population is defined as the complete removal of all the individuals of a population, down to the last potentially reproducing individual, or reduction of a population density to below sustainable levels. After preventing the introduction of an invasive species in the first place, eradication is generally considered the best strategy for addressing invasive rodents on islands, but may be limited in some circumstances by high costs or technical obstacles. However, if implemented properly and reinvasion is prohibited, it only has to be done once, with less rodenticide required for the one-time eradication than long-term control, making eradication both more cost-effective in the long run and with potentially fewer impacts on nontarget species. Eradication of rodents from islands, once thought to be impossible, is now an accepted conservation management tool (Courchamp et al. 2002).

Decades of research have shown that, although difficult, eradication is feasible if six fundamental criteria can be met. The essential elements of successful eradication project are:

- no immigration of rodents from other areas;
- all target animals are placed at risk by the bait distribution and density;
- the rate of removal of individuals from a population exceeds the rate of increase at all population densities;
- the presence of target animals can be detected at low densities;
- cost/benefit analysis favors eradication over control; and
- public and political support for eradication exists.

Although much is now known about the details of how to ensure that these criteria are met, this by no means implies they always are or can be met for every attempted eradication project. In fact, even today attempts at rodent eradication can fail, sometimes at a very great cost.

Throughout the more than forty-year history of the development of the techniques necessary to accomplish larger, more difficult and more remote rodent eradication projects, there is a dearth of published and available information on failed attempts at rodent eradication. An examination of almost 250 worldwide rodent eradication operations conducted over 45 years indicates the difficulty still inherent to the task.

More than 95% (233) of successful operations have been on islands less than 500 ha (1,200 acres) in size, 4% (10) have been on islands between 500 and 2,000 ha (1,200 to 5,000 acres), and only two operations (<1%) were greater than 2,000 ha (5,000 acres) – the operations on Langara Island (using bait stations) 3,105 ha (7,673 acres) off the coast of British Columbia, and Campbell Island (aerial broadcast of brodifacoum) 11,300 ha (27,923 acres) in subantarctic New Zealand.

Many island rodent eradication projects have been successfully conducted worldwide using anticoagulant rodenticides, including warfarin, pindone, diphacinone, bromadiolone and brodifacoum. To date, most of these projects have used brodifacoum because its far greater toxicity is perceived to impart a greater chance of success (Taylor and Thomas 1989, Taylor and Thomas 1993, Murphy and Ohashi 1993, Burbidge and Morris 2002, Morris 2002, Donlon et al. 2003, Howald et al. 2005). However, it is important to remember that efficacy and toxicity are not synonymous terms. Efficacy is a complex interaction of many factors. As noted, the eradication of rodents on islands has been successfully implemented using the less-toxic anticoagulant rodenticides warfarin, pindone, diphacinone and bromadiolone (Merton 1961, Merton 1962, Witmer et al. 2001, and Dunlevy and Scharf 2007) and has sometimes failed during operations using brodifacoum (Howald et al. 2006, Clout and Russell 2006).

Seedling numbers of many tree and shrub species increased substantially after brown rat and Polynesian rat eradication (Allen et al. 1994, Campbell and Atkinson 1999). On Anacapa Island, California, radar detection of Xantus' murrelets (*Synthliboramphus hypoleucus*), a species proposed for California threatened status, increased over 100% in two years during and immediately after the eradication of black rats from the island, indicating a dramatic increase in nesting activity after eradication (Hamer et al. 2003). Qualitatively, McClelland (2002) in New Zealand found that rodent eradication projects on several islands resulted in obvious positive effects, including increases in the number of large insects and many native bird and lizard species, and observations of invertebrates and lizards not previously recorded on the treated islands. On Île de la Possession in the southern Indian Ocean, the reproductive success of burrowing white-chinned petrels (*Procellaria aequinoctialis*) increased to 50% from 16% during a multi year black rat control project (Jouventin et al. 2003).

Oceanic islands are fragile ecosystems that have been seriously disrupted by invasive mammalian predators. Control of invasive predators is one of the few justifiable opportunities for large-scale experimental manipulation of island ecosystems. Eradication of invasive rodents is an opportunity to simultaneously answer important scientific questions and restore native biodiversity. Taking the risk of a carefully reasoned, well-planned but uncertain action would be the better course than losing a species or habitat of concern (Coblenz 1990). However, Zavaleta (2002) found it surprising that, since the ultimate goal of most eradication projects is to restore diversity and the functioning of native ecosystems and protect native species, most cases do not describe an active pursuit of conservation/restoration goals through specific steps like restoration planning or monitoring. Most cases simply include pre-eradication and post-eradication monitoring for missed target animals (efficacy monitoring) and trends for impacts on nontarget species (ecological monitoring). Without pre-eradication monitoring of ecological baseline conditions, managers cannot avert or plan for any undesirable impacts. Without post-eradication monitoring, managers cannot identify unanticipated effects or know when to revise adaptive management approaches to resolve those effects. Also, Zavaleta (2002) expresses concern with the loss of valuable knowledge when projects do not include pre-and post-eradication monitoring of changes to ecosystem components and systems.

If one lesson only were to be learned from past failures or semi-successes, it is that a restoration project cannot be limited merely to eradication. A thorough pre-eradication assessment and long-term post-eradication monitoring (not limited to those communities directly linked to the eradicated species, as there can be unexpected indirect consequences) are both necessary. Only in this way will the best chances of true success—full and durable ecosystem restoration—be ensured (Courchamp et al. 2002).

In conclusion, it is clear that invasive rodents can decrease native biodiversity and cause substantial declines and even extirpations or extinctions of native flora and fauna on isolated oceanic islands in some cases. Evidence is strong that eradicating invasive rodents can assist in the recovery of native plant and animal populations which have been documented to be declining due to the negative impacts of rodents. Rodent control and eradication on islands should accomplish ecosystem restoration goals if the ecosystems are being inhibited by negative impacts due to rodents. However, collecting pre-eradication baseline data is essential for understanding currently poorly-understood Hawaiian Island ecosystems and ensuring that the eradication project is planned and implemented appropriately for meeting specific restoration goals (Moors et al. 1992, Zavaleta 2002) and future objectives.

1.2.3 History and Impacts of Invasive Rodents within the Main Hawaiian Islands

The Hawaiian Islands are the most isolated archipelago in the world, situated in the middle of the Pacific Ocean more than 2,000 miles from the nearest continent. Because of its extreme isolation, relatively few life forms survived the rigors of the ocean crossing to reach the islands. Fewer still were able to successfully establish populations on the archipelago over its 70 million year history. Those that did found a diversity of climatic and geological conditions that provided an enormous range of habitats. With an extremely limited gene flow from their distant original populations, colonists rapidly adapted to their new environments. For many such colonists, unique adaptations occurred simultaneously among populations that were isolated from one another on an island and between islands. Hawaiʻi surpasses the Galapagos Islands in the number and variety of species that evolved from a small set of colonizing ancestors. The Hawaiian archipelago has been described as its own biogeological province that possesses the world's highest degree of endemism, including 90% for the terrestrial species (Mitchell et al. 2005).

The arrival of the Polynesians approximately 1,600 years ago and, increasingly, with the arrival of western European explorers and settlers in the late 1700s and 1800s, contributed to the destruction of native habitats and introduced many new threats to which the islands' species had never been exposed, including three species of rats. For more than 70 million years, the evolution of new species greatly exceeded losses to extinction. Yet, after the arrival of humans, including prehistoric Polynesians, to the islands, numerous species began the precipitous decline to extinction. These losses include half the bird life, hundreds of endemic plant species, and undoubtedly thousands of lesser known taxa such as terrestrial insects, spiders, and snails that were lost before they were even described. Today, with less than 0.2% of the land area of the United States, the Hawaiian Islands support more than 30% of the nation's species listed under the Endangered Species Act, including 317 taxa of plants and animals (Kirch 1982, Mac et al. 1998, Mitchell et al. 2005).

Before human arrival, the estimated rate of successful new colonizations was one species every 35,000 years over a 70-million-year period. Over the last two centuries, the rate of introductions of nonnative plant species has been more than 40 species per year, with 861 or 11% of those species now established with reproducing populations. It is estimated that up to 30% of all established species in Hawaiʻi are nonnative. Approximately 10% of these species are highly invasive or pose significant threats to Hawaiian ecosystems (Mac et al. 1998, Mitchell et al. 2005). Hawaiʻi is well known as the extinction capital of the United States, possessing one-third of the species federally listed as endangered (Mac et al. 1998).

Prior to the arrival of humans, only two species of terrestrial mammal were found in the Hawaiian Islands – the Hawaiian hoary bat (*Lasiurus cinereus;* ʻalae keʻokʻo) and an undescribed bat known from prehistoric bone deposits. Currently, four species of rodents, feral domestic cats and small Indian mongooses are found widely throughout the Hawaiian Islands. Of the four rodent species, the Polynesian rat arrived with the early Polynesian settlers and is found throughout the main Hawaiian Islands (Hess et al. *in press*, Tomich 1986). Because the introduction of rats to Hawai'i perhaps as early as 1,500 years ago, its major influences on the native plants and animals are assumed to have occurred long before Europeans arrived at the archipelago. It has been documented to prey on ground-nesting seabird species, including the Bulwer's petrel and wedge-tailed shearwater (Tomich 1986). The black rat arrived in O'ahu sometime after 1870, and reached the island of Hawai'i approximately 10 to 15 years later. Because the black rat is arboreal, it had substantially greater effects on passerine birds than the Brown and Polynesian rats, primarily by predating on eggs, nestlings, and sometimes adult birds and competing for food (Atkinson 1977).

In Hawai'i, predation on 20 bird species or depredation of their eggs by introduced small mammals has been recorded, although this represents only a portion of the total number of Hawaiian bird species likely preyed upon. Polynesian rats are known to prey on ground-nesting seabirds and could well have extirpated numerous forest birds nesting on or near the ground. Factors that influence the frequency and severity of predation on particular bird species include life history, morphology, species behavior, abundance and behavior of the predators, and ecological conditions where predator and prey interact. Especially vulnerable bird species exhibit life history characteristics such as delayed maturity and/or extended incubation and nestling development periods (longer times in the nest and/or on or near the ground), smaller clutch sizes and highly specialized feeding behavior. Morphological characteristics, such as body size, egg size and eggshell thickness relative to predator body size, and behavioral adaptations such as aggressiveness, nest placement and concealment, and roost site selection also influences vulnerability to predation. Species with breeding seasons that coincide with seasonal peaks in the predator population are also more vulnerable to predation (Lindsey et al. *in press*).

Atkinson (1977) argues that the introduction of the black rat in the late 1800s was the primary cause of the sudden extinction of 30 species or subspecies of endemic Hawaiian forest birds between 1890 and 1910. Since then, the black rat has continued to have negative effects on Hawai'i's landbirds. Black rat caused the extinction of the Laysan Rail from its last refuge of Midway Atoll, and contributed to the extirpation of the Midway population of Laysan finch (Fisher and Baldwin 1946; Tomich 1986).

Furthermore, nest depredation by black rats has been implicated as the primary cause of the decline of the endangered O'ahu 'elepaio (*Chasiempis sandwichensis ibidis*) (VanderWerf 2001). Another nest depredation study that focused on multiple bird species in the rainforest of Maui found that in areas of high rat density, the nest depredation rate by black rats can reach 50% (Stone et al. 1985, cited in Amarasekare 1993). In areas of high nest densities, it has been suggested that even a small population of rats can have a significant negative effect because rats will feed on them opportunistically whenever they encounter a nest. Rats have been confirmed to take eggs and prey upon nestlings of the Maui 'alauahio (*Paroreomyza montana*; Baker and Baker 2000), and the puaiohi, or small Kaua'i thrush (*Myadestes palmeri*) (T. Ka'iakapu, pers. comm.).

Rats contribute to the decline of *Achatinella mustelina*, a tree-snail endemic to a mountain range on O'ahu (Hadfield et al. 1993). Rats have also been documented to feed on endemic crickets and weevils (F. Howarth unpublished data, pers. comm.).

Depredation on tree seeds by Polynesian rats in New Zealand has been found to severely reduce the regeneration of a small group of coastal trees. On islands with Polynesian rats, depressed recruitment allows only occasionally trees to establish in specialized and difficult-to-access sites where seed can escape detection. The species most affected are those with large seeds that are easy for the rats to find and eat (Campbell and Atkinson 1999). Rats eat the seeds, bark, fruits, leaves and shoots of Hawaiian plants. Rats strip the bark of koa (*Acacia koa*) saplings, girdling and killing the young trees (Scowcroft and Sakai 1984). The endemic vetch (*Vicia menziessii*) has also been girdled by rats (Clarke et al. 1982, L. Pratt, pers. comm.). Rat herbivory has been shown to prevent reproduction in the wild of *Hibiscadelphus* sp. (Baker and Allen 1978) and *Pittosporum* sp. (L. Pratt, pers. comm.). Seed depredation by rats has also affected populations of *Pritchardia* spp. (Beccari and Rock 1921, Male and Loeffler 1997).

1.2.4 Impacts of Rats on Mokapu

It is highly likely that the presence of rats has terminated or slowed the recruitment of the threatened *Peucedanum sandwicense* as well as *Pritchardia*, *Pittosporum*, and *Diospyros* along with other native plant taxa on Mokapu (K. Wood and M. LeGrande 2003, unpubl. report). Nearby Huelo Island, which has no rats but is otherwise quite similar to Mokapu, is dominated by a healthy *Pritchardia* palm forest; the last one in the main Hawaiian Islands. Rats are known to eat *Pritchardia* seeds and their presence on Mokapu is believed to be preventing the recovery and may be contributing to the decline of this rare, endemic species. In 2006, only 12 mature *Pritchardia* palms and one seedling were found on Mokapu (Ken Wood, unpubl. data). Likewise, only 11 *Pittosporum*, about 20 *Peucedanum*, and two small groves of *Diospyros* remain on Mokapu. In addition, observations from other Pacific islands document that rats eat eggs, and sometimes prey upon the young and adults of three of the seabird species known to be nesting on Mokapu; red-tailed and white-tailed tropicbirds and wedge-tailed shearwaters.

1.3 USFWS and DOFAW Invasive Species Policies

The Invasive Species Specialist Group of IUCN defines invasive species as "organisms (usually transported by humans) which successfully establish themselves in, and then overcome, otherwise intact, pre-existing native ecosystems." They further state: "Species suddenly taken to new environments…often…thrive, and they become invasive." Executive Order 13112 defines an invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." Therefore, in this EA, the term "invasive" will be used to mean any nonnative species introduced into an area that causes ecological harm.

The key characteristics of an invasive species involve the following factors:

- the human-induced introduction of a species occurring outside of its historically known natural range
- potential dispersal and establishment of the species within the new suitable habitat, and
- resulting damage to the native ecology, the economy, or human health.

Not only are invasive species highly adaptable, but typically they encounter favorable conditions in their new environment, and their rapid establishment can be facilitated by the availability of more or better resources, fewer or less efficient native competitors and predators, and/or a more advantageous habitat (Courchamp et al. 2002).

Restoration of native biological diversity by removing invasive species and preventing further introductions is a major priority of the USFWS and DOFAW, consistent with its mission and

USFWS policy for managing refuges for biological diversity, integrity, and environmental health (601 FW 3, 2001). In this policy, the USFWS defines the following terms:

- **Biological diversity** encompasses the variety of life and its processes, the genetic differences among them, and the communities and ecosystems in which they occur.
- **Biological integrity** is the biotic composition, structure, and functioning at the genetic, organism and community levels comparable to historic conditions.
- **Environmental health** is the composition, structure, and functioning of abiotic features comparable with historic conditions. Historic conditions include the composition, structure, and functioning of ecosystems resulting from natural processes that are believed, based on sound professional judgment, to have been present prior to substantial human-related changes to the landscape.

The USFWS policy as stated in 601 FW 3 (2001) is to, first, maintain existing levels of biological integrity, diversity and environmental health at the refuge scale; and secondly, to restore lost or severely degraded elements of integrity, diversity, and environmental health at the refuge scale and other appropriate landscape scales where it is feasible and supports achievement of refuge purposes and mission. The policy recognizes that applications of chemicals may be necessary to maintain biological integrity and fulfill refuge purposes. The policy also focuses on preventing the introduction of invasive species, detecting and controlling populations of invasive species, and providing for restoration of native species and habitat conditions in invaded ecosystems.

Hawai‘i’s Comprehensive Wildlife Conservation Plan (CWCP; Mitchell et al. 2005) identified seven objectives that are necessary for the long-term conservation of Hawai‘i’s native wildlife of which the first two are related to protection of native species and habitats and management of invasive species:

1) Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive;
2) Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication.

Under the first objective, a high priority was identified to remove introduced mammals, including rats, from important habitats to establish ungulate and predator-free areas on each island, including landscape-level predator management.

Under the second objective, high priority actions include continuing coordination of invasive species prevention, management and control programs for county, state, Federal and private sector entities through existing entities and mechanisms, as well as to continue research on effective management methods and tools for introduced vertebrates and other taxa, including rats.

The CWCP (Mitchell et al. 2005) discusses the future needs for the State Seabird Sanctuaries off Moloka‘i (including seven offshore islands, including Mokapu), as focusing on removal of small mammalian predators and restoring native vegetation habitat. The specific species of concern (called Species of Greatest Conservation Needs; SGCN) that are applicable to Mokapu are the wedge-tailed shearwater (‘ua’u kani), brown booby (‘a; *Sula leaucogaster*), Bulwer’s petrel (‘ou), white-tailed tropicbird (koa’e kea), and red-tailed tropicbird (koe’a ‘ula).

1.4 Hawai'i Invasive Rodent Actions and Consistency with Environmental Laws and Executive Orders

Using New Zealand's successes in controlling and eradicating invasive rodents as a model, Hawai'i has been at the forefront of efforts in the United States to adapt agricultural and commensal rodent control and eradication techniques to native ecosystem conservation areas. Developing rodenticide application techniques and obtaining registrations for them in Hawai'i has been pursued with the goal of conservation of plants and animals, while allowing natural and active restoration or recovery of species impacted by introduced rodents. This has been carried out by substantially reducing rodent populations in valuable native ecosystems on the main Hawaiian Islands and by eradicating them from uninhabited offshore islands and remote atolls. Beginning in 1990, the WS (then called Animal Damage Control) eradicated rats from four remote Pacific atolls where rats were having devastating impacts on seabird colonies (Hess et al. *in press*):

1) Conducted with the USFWS and the Samoan Department of Wildlife and Marine Resources, targeted Polynesian rats on uninhabited Rose Atoll (17 acres), American Samoa, using brodifacoum (0.005% active ingredient) in bait stations. Although the first attempt controlled but failed to eradicate rats, a subsequent application with bromethalin (0.01% active ingredient), an acute neurotoxin, completed the eradication.
2) WS and the Hawai'i Department of Land and Natural Resources (DLNR) eradicated Polynesian rats in 1993 from 348-acre Green Islet, Kure Atoll (Northwestern Hawaiian Islands; NWHI) using techniques similar to those used on Rose Atoll.
3) WS and U.S. Navy eradicated black rats from Eastern Islet (362 acres) and Spit Islet (3 acre) at Midway Atoll, using the same techniques used at Rose Atoll for Eastern Island and snap-trapping on Spit Islet.
4) The U.S. Navy eradicated rats on 1,300-acre Sand Islet at Midway Atoll using bait stations and live traps. Sand Islet is the largest and the only inhabited island in the United States from which rats have been removed. Since this project, the NWHI are now free of invasive small mammals.

The last attempted eradication on a Pacific atoll (black rats from Palmyra Atoll, in the equatorial Line Islands in 2001) was by far the most complex, involving approximately 742 acres and 52 islets, most of which were densely vegetated. This operation failed due to insufficient funding, inadequate professionally trained personnel, and interference with bait stations by several species of land crabs.

In 2002, the Offshore Islet Restoration Committee (OIRC) was formed to restore selected small offshore islands around the Main Hawaiian Islands. To date only black rat eradication on tiny Mokoli'i near O'ahu using diphacinone in bait stations has been completed (Hess et al. *in press*).

Successful eradication of rabbits from Lehua Island, off the coast of Ni'ihau, was conducted in 2006. A rat eradication project there, using diphacinone, is planned (U.S. Fish and Wildlife Service 2005).

The U.S. Air Force, jointly with the USFWS and WS is planning an eradication project involving Polynesian rats (feral cats were almost eradicated by 2007) on 2,000-acre Wake Atoll. Wake Atoll supports 15 species of breeding seabirds. Rats have been observed feeding on ground-nesting Christmas shearwater chicks (*Puffinus nativitatis*) with supposition of impacts on adults as well. This atoll also has two species of land crabs. This project is intended to restore native forests and seabirds as well as provide the opportunity to translocate the Guam rail (*Rallus owstoni*) to replace the similar Wake rail, which was brought to extinction during World War II due to hunting pressure from the Japanese after coexisting with rats since at least the 1800s.

These past, existing and proposed projects are fully consistent with and contribute to complying with Executive Order 13112 of February 3, 1999, *Invasive Species,* which requires Federal agencies whose actions may affect the status of invasive species to, subject to the availability of appropriated funds and within Administrative budgetary limits, use relevant programs and authorities to:

- Prevent the introduction of invasive species;
- Detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner;
- Monitor invasive species populations accurately and reliably;
- Provide for restoration of native species and habitat conditions in ecosystems that have been invaded;
- Conduct research on invasive species and develop technologies to prevent introduction of and provide for environmentally sound control of invasive species; and
- Promote public education on invasive species and the means to address them.

Under Executive Order 13186 of January 11, 2001, *Responsibilities of Federal Agencies to Protect Migratory Birds,* the USFWS is given authority to recognize and promote the great ecological and economic value of migratory birds to the United States and other countries by promoting the conservation of migratory bird populations. The Executive Order states that each Federal agency shall, to the extent permitted by law and subject to the availability of appropriated funds and within Administration budgetary limits, and in harmony with agency missions:

- Support the conservation intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions;
- Restore and enhance the habitat of migratory birds, as practicable;
- Prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable;
- Design migratory bird habitat and population conservation principles, measures, and practices, into agency plans and planning processes (natural resources, land management, and environmental quality planning);
- Ensure that environmental analyses of Federal actions required by NEPA or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern;
- Identify where unintentional take of migratory birds reasonably attributable to agency actions is having, or is likely to have, a measurable negative effect on migratory bird populations, focusing on species of concern, priority habitats and key risk factors.

This environmental assessment (EA) contributes to continuing pursuit of these goals, consistent with Executive Orders 13112 and 13186 and Federal and state policy, by planning and implementing hand and aerial broadcast applications of diphacinone on small offshore islands with established invasive rodent populations to restore the natural habitats of native seabirds and plants.

This EA is prepared consistent with the National Environmental Policy Act (NEPA), its Council on Environmental Quality (CEQ) implementing regulations at 40 CFR 1500-1508, and HRS 343 and its implementing regulations at HAR 11-200, Department of Interior NEPA manuals 516 DM 1, 2, and 8 (USFWS) and other pertinent Federal and State of Hawaiʻi laws and regulations (Section 1.4).

1.5 Scope of Analysis and Decisions to be Made

1.5.1 Scope of Decisions to be Made

This EA:

- Explains the impacts that invasive rodents have on island ecosystems and those of Hawaiʻi and Mokapu Island in particular;
- Describes the proposed action in detail;
- Predicts and contrasts adverse impacts that might be associated with the use of diphacinone and brodifacoum for rodent eradication;
- Describes compliance with various state and federal laws applicable to Mokapu Island; and
- Identifies mitigation measures to be applied, as appropriate, to specific conditions and resources.

This EA does not include eradication of any invasive animal or plant other than rats currently existing on Mokapu. No other invasive mammalian species are known on Mokapu. This EA also does not include eradication of introduced rodents on Alau Island off the coast of Maui, as the presence of introduced rodents has not been confirmed on Alau. If, in the future, introduced rodents are confirmed to be present on Alau, affirmative compliance with the CZMA has been completed for Alau based on the November 8, 2007, draft EA and will not need to be conducted again unless the proposed protocols for eradication of rodents on Alau change in such as way as to require additional consultation.

The USFWS, in cooperation with DOFAW and WS, will use this EA and other appropriate documents to determine if:

1. The proposed rodent eradication project, as described, might have significant impacts requiring analysis in an Environmental Impact Statement (EIS).
2. No action should be taken on Mokapu Island.
3. The USFWS/DOFAW/WS should conduct the proposed eradication project as described using primarily diphacinone, with the capability to use brodifacoum under specific circumstances if approved.

The USFWS and the Hawaiʻi Department of Land and Natural Resources (DLNR) are joint lead agencies on this EA per NEPA, and DLNR is the approving agency per HRS 343.

This EA will be in effect until the target invasive rats are eradicated from Mokapu, unless either the proposed action is modified and/or new information is available that the effects would be different than those anticipated and documented in this EA. If the effects would be different, then this document would need to be supplemented (40 CFR 1502.9(c)).

The use of any other rodenticides, chronic or acute, such as chlorophacinone, zinc phosphide or cholecalciferol will also require a supplement to this document, dependent upon the degree of difference between the analyses in this document and predicted efficacy and impacts of the additional rodenticide(s). The use of any other rodenticide than those evaluated in this EA (diphacinone and brodifacoum) is also dependent on U.S. Environmental Protection Agency (EPA) approval under FIFRA (Section 1.5.3).

A Finding of No Significant Impact (FONSI) per NEPA is anticipated based on analysis in Chapter 3 and no significant impacts have also been determined per HRS 343 (Section 3.11).

DOFAW and the USFWS contacted all the organizations and individuals listed in Appendix C during the preparation of this EA. Public comment was also invited on the draft version of this document. Only Federal funds will be used for the proposed operations, with state operational support.

1.5.2 Relationship of this EA to Other EAs for Rat Eradication

The USFWS and DOFAW prepared a joint NEPA/HRS 343 environmental assessment for invasive rat and rabbit eradication on Lehua Island, a 290-acre island located off the north shore of Niʻihau (U.S. Fish and Wildlife Service 2005, Finding of No Significant Impact signed 2005). The rabbits were eradicated in 2006. Eradication of rats from Lehua is being planned to occur approximately one year after the Mokapu project. Mokapu Island, a State Seabird Sanctuary, was identified for rat eradication to protect listed plant species and to provide improved conditions for seabird breeding.

1.5.3 Relationship of the Proposed Actions to Rodenticide Approval for Field Application under FIFRA

The proposed action involves use of the rodenticides diphacinone and brodifacoum for controlling and eradicating invasive rodents on Mokapu Island in the State of Hawaiʻi. The use of rodenticides in the United States is regulated by the U.S. Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Pursuant to that law, any general or specific use of a particular rodenticide formulation for meeting particular rodent research, control or eradication objectives, sometimes even in a particular location using identified methods, must be formally approved by the EPA, with very specific use requirements and restrictions identified on the label. An entity must apply to the EPA for approval and registration of such labels for specific uses of specific rodenticides.

The EPA registration application process for a rodenticide label approval is an involved and typically lengthy process, incorporating laboratory and field studies and research that may be conducted by the company proposing to make the rodenticide commercially available, the proposed user(s), or a combination of both.

This process of registering a pesticide is a scientific, legal, and administrative procedure through which EPA examines the ingredients of the pesticide; the particular site, or animal on which it is to be used; and the amount, frequency, and timing of its use. In evaluating a pesticide registration application, EPA assesses a wide variety of potential human health and environmental effects associated with use of the product. The producer of the pesticide must provide data from tests done according to EPA guidelines. These tests evaluate whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish and plants, including endangered species and non-target organisms, as well as possible contamination of surface water or ground water from leaching, runoff, and broadcast drift. Potential human risks range from short-term toxicity to long-term effects such as cancer and reproductive system disorders.

EPA also must approve the language that appears on each pesticide label. A pesticide product can only be used legally according to the directions on the approved label. The consideration and approval process can cost millions of dollars and take years for completion, and may not result in approval for the requested use of the particular rodenticide.

The EPA can consider applications for rodenticide use under four processes described in FIFRA:

- **Federal Registration Actions (Section 3 of FIFRA):** Under Section 3 of FIFRA, EPA can register pesticides for use throughout the United States. Some pesticides are registered by EPA for more limited use in certain states. In addition, States, Tribes and Territories can place further restrictions on EPA-registered products used or sold within their own jurisdictions.
- **State-Specific Registrations (Section 24(c) of FIFRA):** Under Section 24 (c) of FIFRA, a state may issue a state-specific registration for a new pesticide product for any requested use, or a federally-registered product for an additional use, as long as there is a demonstrated special local need. A state registration is subject to EPA review, comment and or disapproval within 90 days.
- **Emergency Exemptions (Section 18 of FIFRA):** Under Section 18 of FIFRA, EPA can allow State and Federal agencies to permit the unregistered use of a pesticide in a specific geographic area for a limited time if emergency pest conditions exist. Usually, this arises when growers and others encounter a pest problem on a site for which there is either no registered pesticide available, or for which there is a registered pesticide that would be effective but is not yet approved for use on that particular site. Also, exemptions can be approved for public health and quarantine reasons.
- **Experimental Use Permits (EUPs) (Section 5 of FIFRA):** Under Section 5 of FIFRA, EPA can allow manufacturers or others to field test pesticides under development. An EUP is required for experimental field tests on 10 acres or more of land or one acre or more of water.

In the United States, many commercial rodenticides products have been registered by EPA, each with specific labeling restrictions under FIFRA Section 3. Some of these formulations have also been approved for special local needs under FIFRA Section 24(c), and emergency exemptions under FIFRA Section 18 to conduct rodent eradication field projects in conservation areas to restore ecological processes and protect endangered species.

Currently, a Section 24(c) registration for diphacinone in bait stations (Ramik® Mini Bars, 0.005% diphacinone) and a nationwide label under Section 3 for all application methods, including aerial broadcast (Ramik® Green 0.005% diphacinone, a 1/2 inch pellet) permit conservation uses in Hawaii. In addition, a Section 24(c) registration package has been submitted to the Hawai‘i Department of Agriculture for broadcast application of diphacinone (Ramik Green 0.005% diphacinone, a 3/4 inch pellet) for conservation purposes. It is important to note that the two products currently registered for conservation use in Hawaii have had national registrations for use in and around buildings for many years. They are among the most commonly used rat poisons by homeowners and pest control companies. In addition, Ramik® Mini Bars have a 24(c) registration for use in macadamia nut orchards.

Two Section 3 applications for two brodifacoum formulations (Bell Laboratories 0.0025% active ingredient) for bait station, hand and aerial broadcast for conservation purposes has been submitted (10/06) to the EPA and are currently under review. Until brodifacoum is registered for conservation purposes in the United States, it cannot be used on this or any other rodent control or eradication project, unless it is approved under Section 5 or 18 of FIFRA in the interim. However, it is included in the proposed action because of the slight potential that if the proposed operation should fail in eradicating rats and the cause of the failure can be tied only to the use of diphacinone and not any other factors, then brodifacoum may be used as a backup the following winter if it is approved for use.

The impact analysis incorporated into this document regarding impacts of the rodenticides on nontarget species is based on the existing labels for the diphacinone and draft labels submitted to the EPA for brodifacoum. If any future approved label(s) incorporate different requirements that may result in different impacts, then this document may need to be supplemented if adverse impacts associated with label modifications would be different than those evaluated in this document.

1.6 Other Laws/Executive Orders Applicable to Rodent Eradication

1.6.1 Coastal Zone Management Act in Hawai‘i

The Coastal Zone Management Act (CZMA) is a Federal law that delegates authority to states with approved management plans, including Hawai‘i, to restore and protect coastal waters and resources. The federal regulations at 15 CFR 930 and state statutes, regulations and guidance interact to provide the framework for State management of the coastal resources.

The boundaries of the Hawaiian coastal zone encompass all the lands and waters of the area within the 3 mile limit of the territorial seas. This includes all transitional and intertidal areas, salt marshes, saltwater wetlands, islands and beaches.

Coastal Zone Management Act regulations at 15 CFR 930.33 state that the boundary of a State's coastal zone must exclude lands owned, leased, held in trust or whose use is otherwise by law subject solely to the discretion of the Federal government, its officers or agents; this, however, does not remove Federal agencies from the obligation of complying with the consistency provisions of Section 307 of CZMA, which require the Federal government to consult with, cooperate with and, to the maximum extent practicable, coordinate Federal activities with other interested Federal agencies and conduct Federal activities consistent with approved state management plans.

Federal regulations at 15 CFR 930.30-930.46 require "all Federal agency activities, including development projects affecting any coastal use or resource will be undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of approved management plans." "To the maximum extent practicable" is defined as "fully consistent with the enforceable policies of [state] management plans unless full consistency is prohibited by existing law applicable to the Federal agency" (15 CFR 930.32).

"Enforceable Policies" are state policies which are legally binding through state constitutional provisions, laws, regulations, land use plans, ordinances, judicial or administrative decisions, by which a State exerts control over private and public land and water uses and natural resources in a coastal zone and which are incorporated in an approved management plan. They contain standards of sufficient specificity to guide public and private uses, and the state must base any objections to proposed actions within the coastal zone on the enforceable policies (15 CFR 930.11(h)).

The Hawaiʻi Office of State Planning has the authority to review Federal actions or actions on Federal lands for compliance the states implementing law (HRS 205A).

The Federal regulations also provide for environmentally beneficial activities: "The State and Federal agencies may agree to exclude environmentally beneficial activities (either on a case by case basis or for a category of activities) from further state agency consistency review. Environmentally beneficial activity means an activity that protects, preserves, or restores the natural resources of the coastal zone. The State agency shall provide for public participation under section 306(d)(14) of the Act for the State agency's consideration of whether to exclude environmentally beneficial activities." (15 CFR 930.33 (a)(4)). These acts and their federal equivalents are discussed below.

The State of Hawaiʻi law for implementing the federal Coastal Zone Management Act is HRS 205A: Coastal Zone Management.

The following state enforceable policies have also been identified as potentially applicable:

- HRS 149A: Hawaiʻi Pesticides Law
- HRS 195D and HAR 13-124: Conservation of Aquatic Life, Wildlife, and Land Plants (endangered species)
- HRS Chapter 6E: Historic Preservation
- HRS 342D and HAR 11-54: Water Pollution and Water Quality Standards

The analysis in support of the CZMA Negative Determination regarding compliance with state policies and the enforceable policies submitted to the Hawaiʻi Office of State Planning is located in Section 3.9.

1.6.2 State of Hawaiʻi Code for Pesticide Control

In addition to FIFRA, the State of Hawaiʻi also requires management and registration of pesticides. These requirements (in HRS Chapter 149A, HAR 4-66, 2006), are administered by the Hawaiʻi Department of Agriculture. The law requires licensing and labeling for pesticides, certification for applicators, and licensing for sales.

State labeling requirements say that any pesticide intended for outdoor use that contains an active ingredient with: 1) A mammalian acute oral LD_{50} of 100 mg/kg or less must state: "this pesticide is toxic to wildlife."; 2) A fish acute LC_{50} of 1 ppm or less must state: "This pesticide is toxic to fish."; and 3) An avian acute oral LD_{50} of 500 ppm or less must state: "This pesticide is toxic to wildlife."

Commercial pesticide applicators for the proposed program must be:

- Category 2 for persons using or supervising the use of pesticides in forests, forest nurseries, and forest seed producing areas,
- Category 4, for persons using or supervising the use of pesticides using aircraft for aerial broadcast (4-66-56)
- Category 9, for state, federal or other government employees using or supervising the use of restricted use pesticides in the control of regulated pests.

Although widely used by the general public, both diphacinone and brodifacoum are considered "restricted use" pesticides when used for conservation purposes.

No person shall apply a restricted use pesticide by aircraft except by special permit under the following conditions and limitations (4-66-64):

- A written application including information on that applicant and applicator, purpose of aerial treatment, pesticide formulation, dosage, method of aerial treatment and proposed number of treatments to be made, and proposed sites and conditions.
- The request for special permit may be refused in writing, with rationale, if it is determined that the proposed aerial treatment may cause unreasonable adverse effects to humans or the environment (meaning any unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of use of the pesticide (4-66-2)) or will create a hazard.
- A special permit specifies the time period and may specify and limit the number of treatments, or continuous treatments when conditions are not expected to change or vary during subsequent treatments conducted in the same designated area or areas.
- The Hawaiʻi Department of Agriculture shall be notified 24 hours in advance of the treatment.
- The special permit does not relieve the permittee from the penalty provisions or the law or any liability for any damage or contamination of crops or plants, animals, man and the environment resulting from the aerial treatment.

All equipment for application of restricted use pesticides must be in good working order with no leakage and for liquid pesticides a pressure control device and pressure gauge are required (4-66-64(b)).

The USFWS and DOFAW will obtain the necessary permit for aerial application of the rodenticide and all rodenticide application will be under the direct supervision of a certified applicator.

1.6.3 The Endangered Species Act

The Endangered Species Act (ESA) provides the means to conserve ecosystems upon which threatened and endangered species depend as well as the conservation of endangered and threatened species, and provides for taking steps as may be appropriate for meeting US obligations in treaties and conventions such as migratory bird treaties with Mexico, Japan, Canada and Russia. It prohibits the "take" of listed threatened and endangered animal species without meeting certain procedural requirements. "Take" includes harassment which is defined as an “intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering”(50 CFR 17.3).

Hawai‘i state law HRS 195D-4 and associated regulations at HAR 13-124 govern the state regulation of endangered and threatened species. It provides for all federally listed species to also be listed by the state, although the state retains the right to uplist species listed as threatened by the Endangered Species Act to endangered status. It also provides a list of endangered species at HAR 13-124.

The analysis of this issue and the results of the informal Section 7 consultation are located in Section 3.9.2.2 and the associated conservation actions in Section 2.4.11.1.

1.6.4 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) protects marine mammals and their habitats from any action that might cause a "take" as described below. It also provides a mechanism for permitting, upon request, the incidental but not intentional taking of marine mammals by US citizens, including the Federal government, during implementation of actions unrelated to marine mammals. The agency with which the USFWS would consult in reference to the proposed rodent eradication project is NOAA Fisheries National Marine Fisheries Service. All terms and conditions identified in any incidental take authorization are mandatory. Any incidental take permit must comply with NEPA and the Administrative Procedures Act (publishing a proposed and final rule with public comment). The MMPA regulations identify two levels of harassment “take” of marine mammals:

- Level A harassment includes any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild"; and
- Level B harassment, which includes "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

However, since only an extremely limited amount of bait would enter the marine environment (Section 3.2.1) and no marine mammals are known to be located on or near Mokapu Island (see Chapter 2.3.2.7), no adverse impacts are anticipated to any marine mammals with the proposed action and therefore no compliance with MMPA is required.

1.6.5 The Migratory Bird Treaty Act (MBTA) and Executive Order Guidance for Protection of Migratory Birds

The Migratory Bird Treaty Act, originally passed in 1918, implements the Unites States' commitment to four bilateral treaties with Mexico, Japan, Russia and Canada for the protection of migratory bird resources. The Canadian treaty was amended in 1995 to allow traditional subsistence hunting of migratory birds. Each of the treaties protects selected species of birds and provides for closed and open seasons for hunting identified migratory game birds. Although the

MBTA applies to the Federal government, based on the D.C. Circuit Court of Appeals decision (*The Humane Society of the United States v. Glickman*, Case No. 99-5309, decided 18 July 2000), other case law has found that the MBTA does not apply to actions, Federal or non-Federal, in which incidental (indirect) take of migratory birds occurs incidental to some other activity conducted for some other purpose. Subsequent to the *Humane Society* decision, the U.S Fish and Wildlife Service issued a Director's Order (now superseded and reinforced by USFWS Manual 724 FW 2, *Migratory Bird Permits*) that clearly applies the MBTA to the Federal government. Federal agencies must obtain permits for the same activities for which permits are required for other entities, including permits for bird banding, scientific collecting permits, and depredation.

The USFWS regulations do not provide for permits for any other type of activity, including the application of pesticides. However, the USFWS decided to prepare an environmental impact statement (EIS) for an initial incidental take permit and a subsequent environmental assessment (EA) for renewal of that permit under MBTA per a California District Court action (civil action number 01-2288) for aerial application of brodifacoum on Anacapa Island, California (National Park Service 2000), even though the Court did not require application of NEPA to such a permit. Therefore, the precedent is set for the application of MBTA permits for aerial application of rodenticides for the purpose of rodent eradication for ecological objectives on land under Federal jurisdiction. However, the USFWS has no formal policy in place regarding the requirement for a permit for pest eradication projects. Therefore, although this document will provide sufficient NEPA analysis for a permit application for adoption (40 CFR 1506.3) by the USFWS should one be needed, the USFWS authority per the MBTA will not require that the Federal government nor anyone else request a permit for any rodent control or eradication projects conducted within the scope.

The USFWS published a list of species not regulated under the MBTA in 2005 (Federal Register 70(49): 12710-12716). Although many avian species found in Hawai‘i are native to North America but not to the Hawaiian archipelago, the MBTA does not exempt a species covered by one or more of the four conventions that is nonnative to Hawai‘i but native within the contiguous United States or its territories (same Federal Register notice). Of the species found on Mokapu, neither the Japanese white-eye (*Zosterops japonicus*) nor the nutmeg mannikin (*Lonchura punctulata*) are protected under the MBTA.

The potential impact to migratory birds protected under the MBTA is included in Chapter 3.

On January 10, 2001, President Clinton issued Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, requiring that Federal agencies not only support the conservation intent of the migratory bird conventions, but also identify where unintentional take that is reasonably attributable to agency actions is likely to have measurable negative effects on migratory bird populations. This analysis will be included in Sections 3.6 and 3.7 for impacts to nontarget species of migratory birds protected under the MBTA.

1.6.6 State of Hawai‘i State Wildlife Sanctuaries

Mokapu Island is a legally designated state seabird sanctuary. Per 13 HAR Chapter 125, the State of Hawai‘i, under the authority of the DLNR, can establish wildlife sanctuaries for the purpose of conserving, managing and protecting indigenous wildlife in sanctuaries. It is prohibited to remove, disturb, injure, kill or possess any form of plant or wildlife or to introduce any form of plant or animal life without a permit. Permits may be issued to enter or land upon identified sanctuaries only for scientific, educational, or conservation purposes and shall specify any terms and conditions deemed necessary for the conservation, management, and protection of indigenous wildlife and wildlife habitats. Therefore, a permit will be required from DLNR in order to conduct rat eradication projects on Mokapu.

The island is located in a Conservation District per HRS 183C and associated regulations at HAR 13-5. Because eradication of alien species is a standard management activity and no construction or other alterations are proposed, there is no need for a Conservation District Use permit.

1.6.7 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires that every Federal agency take into account how each of its undertakings could affect historic properties, and provide the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the proposed project. Any property that is listed on or eligible for listing on the National Register of Historic Places, including archaeological resources, is considered historic. The protections of Section 106 extend to properties that possess significance but have not yet been listed or formally determined eligible for listing, as well as properties that have not yet been discovered but possess significance.

The Federal action agency is responsible for initiating and completing the Section 106 review, generally coordinating with the State Historic Preservation Officer (SHPO). The process includes:

- Identifying and evaluating the significance of historic and archaeological properties;
- Assessing the effects based on criteria in 36 CFR 800 ("No Effect", "No Adverse Effect", "Adverse Effect");
- Consulting with the SHPO or ACHP if the agency determines that adverse effects would occur.

HRS Chapter 6E, Historic Preservation, implements the NHPA in Hawaiʻi, under the jurisdiction of the DLNR, State Historic Preservation Division. Section 6E-1 states that: "the Legislature declares that the historic and cultural heritage of the State is among its important assets and that the rapid social and economic developments of contemporary society threaten to destroy the remaining vestiges of this heritage…It shall be the public policy of this state to provide leadership in preserving, restoring, and maintaining historic and cultural property, to ensure the administration of such historic and cultural property in a spirit of stewardship and trusteeship for future generations, and to conduct activities, plans and programs in a manner consistent with the preservation and enhancement of historic and cultural property."

The state law requires that before any agency or officer of the State or its political subdivisions commences any project which may affect historic property, aviation artifacts or a burial site, the agency or officer shall advise the department and allow the department an opportunity for review of the effect of the proposed project, consistent with Section 6E-43 [prehistoric and historic burial sites], especially those on the Hawaiʻi register of historic places. The proposed project shall not be commenced, or in the event that it has already begun, continued until the department shall have given its written concurrence (Section 6E-8). Section 6E-43.6 also regulates the inadvertent discovery of burial sites.

1.6.8 Magnusen-Stevens Fishery Conservation and Management Act and Essential Fish Habitat

The Magnusen-Stevens Act provides for protecting certain fish stocks that have declined to the point where their survival is threatened and other stocks that have been so substantially reduced in number that they could become threatened from fisheries and direct and indirect marine, estuarine, and other aquatic habitat losses. Essential Fish Habitat (EFH) identified in Fishery Management Plans required by law includes those waters and substrate necessary to identified stocks of fish for spawning, breeding, feeding, and/or growth to maturity, considering the species full life cycle. An "adverse effect" on EFH means any impact that reduces the quality and/or quantity of EFH, including direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH, and may include site-specific or habitat-wide impacts, including cumulative impacts. The Federal action agency retains the discretion to make their own determinations as to what actions may fall within NMFS' definition of "adverse effect."

The analysis of potential impacts to EFH is included in Section 3.2.2.

1.6.9 Federal Clean Water Act and HRS 342D and HAR 11-54

The US Environmental Protection Agency (USEPA) has issued a final rulemaking pursuant to the Clean Water Act regarding whether a National Pollution Discharge Elimination System (NPDES) permit is required for application of pesticides that are applied over or near water (71 FR 227:68483-68492, November 27, 2006). The final rule, at 40 CFR 122.3, states that the "application of pesticides consistent with all relevant requirements under FIFRA (i.e., those relevant to protecting water quality), [is excluded from the requirements to obtain a National Pollutant Discharge Elimination System permit] in the following two circumstances:

"(1) The application of pesticides directly to waters of the United States in order to control pests…

"(2) The application of pesticides to control pests that are present over the waters of the United States, including near such waters, where a portion of the pesticides will unavoidably be deposited to waters of the United States in order to target the pests effectively; for example, when pesticides are aerially applied to a forest canopy or when pesticides are applied over or near water for control of adult mosquitoes or other pests."

Based on the final rule, this proposed action does not require a NPDES permit because the second of these criteria apply.

The State of Hawai'i also has a law and associated regulations for managing and protecting freshwater and marine water quality, located at HRS 342-D and Chapter 11-54.

Analysis regarding the potential for water quality degradation under HRS 342-D is included in Section 3.9.2.4 under consistency with Hawai'i enforceable policies per the CZMA (Section 1.6.1).

1.6.10 Subsistence Uses Under ESA and MBTA, and E.O. 12899 "Environmental Justice"

ESA and MBTA allow for subsistence take of species protected pursuant to their authority. Analysis of potential impacts to subsistence users in the Hawaiian Islands is incorporated into Chapter 3.

Executive Order 12898 *Federal Actions to Address Environmental Justice in Minority and Low Income Populations* (1994) requires every Federal agency to collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin or income. To the extent practical and appropriate, the Federal agency shall use this information to determine whether its actions and programs have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations.

The Executive Order also states that, in order to assist in identifying the need for ensuring protection of communities with differential patterns of subsistence consumption of fish and wildlife, Federal agencies, whenever practicable and appropriate, shall collect, maintain and analyze information on the consumption patterns of populations that rely principally on fish and/or wildlife for subsistence. Federal agencies shall communicate to the public the risks of those consumption patterns.

The Executive Order also recommends that crucial public documents, notices and hearings relating to human health or the environment be translated for limited English-speaking populations.

No subsistence use of terrestrial resources is known to occur on Mokapu (F. Duvall, DOFAW, pers. comm.) but people do fish along many areas of the Moloka‘i north shore. However, based on field and laboratory tests and experiences with past broadcasts, toxicants are not expected to accumulate in fish or marine invertebrates (see Section 3.2). Therefore, no impact would occur regarding either subsistence use of resources or disproportionate impacts to minorities or low income communities and therefore the analysis is not included in Chapter 3.

1.6.11 Consistency with the Hawai‘i State Comprehensive Wildlife Conservation Plan

The Hawai‘i Comprehensive Wildlife Conservation Plan (Mitchell et al. 2005) was prepared by the Hawai‘i Department of Land and Natural Resources (DLNR) participating in the State Wildlife Grant program administered by the USFWS. It presents strategies for long-term conservation of Hawai‘i’s native terrestrial and aquatic species and their habitats. The Plan built upon Hawai‘i’s strong history of conservation and involved working with resource managers, biologists, and concerned individuals statewide.

The mission of Hawai‘i’s Comprehensive Conservation Strategy is to guide conservation efforts across the state to ensure protection of Hawai‘i's wide range of native wildlife and the diverse habitats that support them.

The Grant program requires that the plan include the following eight elements:

1) Information on the distribution and abundance of species of wildlife identified as “species of greatest conservation need,” including low and declining populations, as the State fish

and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife;

2) Descriptions of the locations and relative condition of key habitats and community types essential to the conservation of species identified in (1);
3) Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats;
4) Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions;
5) Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions;
6) Descriptions of procedures to review the plan at an interval not to exceed ten years;
7) Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats;
8) Provisions to ensure public participation in the development, revision, and implementation of projects and programs.

The Plan identifies and analyzes threats to Hawaiʻi's Species of Greatest Conservation Need (SGCN), including all native terrestrial animals, all endemic aquatic animals, additional indigenous aquatic animals identifies as in need of conservation attention, a range of native plants identified as in need of conservation attention, and all identified endemic algae. All the species evaluated in this EA except two nonnative passerine birds are all identified as SGCN in this Plan.

Consistency of the proposed action with the Plan is integrated into the EA wherever it is appropriate. Therefore, this proposed action is fully consistent with and contributes to implementing the Hawaiʻi Comprehensive Wildlife Conservation Plan.

1.6.12 Consistency with the County of Maui 1990 General Plan Objectives and Policies

The County of Maui revised their General Plan in 1990, and the subsequent revision has not been completed. The stated objectives applicable to the proposed action, with associated policies, include:

C. Environment

Objective: To preserve and protect the County's unique and fragile environmental resources.

Policies:

a. Preserve for present and future generations the opportunity to experience the natural beauty of the islands.

b. Preserve scenic vistas and natural features.

d. Support programs to protect rare and endangered species and programs which will enhance their habitat.

e. Discourage the introduction of foreign species into Maui County's unique island ecosystems.

The proposed program is fully consistent with and contributes to implementing the applicable objective and associated policies.

1.7 Response to Comments Received on the Draft EA

Four written comments were received in response to public notification in the State of Hawaii OEQC *Bulletin*, published on November 8, 2007. These letters are published in Appendix A. Only two of the letters made comments requiring a response. Written responses are included in Appendix B.

A letter from the State of Hawaiʻi Office of Planning stated that the proposed action is consistent with the State Enforceable Policies identified under the Coastal Zone Management Act (letter dated 27 Nov 07). This includes consistency with HRS 149A, the Hawaiʻi Pesticides Law (Section 3.10.2.1), HRS 195D and HAR 13-124, Conservation of Aquatic Life, Wildlife, and Land Plants (Section 3.10.2.2), HRS Chapter 6E, Historic Preservation (Section 3.10.2.3), and HRS 342D and HAR 11-54 , Water Pollution and Water Quality Standards (Section 3.10.2.4). No response letter was sent to the Office of Planning since their letter did not raise any questions or problems with the draft EA.

The Hawaiʻi Department of Health, Clean Water Branch, requested analysis of project compliance with state clean water standards, FIFRA, the Clean Water Act requirements for NPDES permits, and U.S. Army Corps of Engineers requirements (letter dated 30 Nov 07). These analyses of full and appropriate compliance are included in Sections 1.5.3 (FIFRA), 1.6.2 and 3.10.2.1 (state pesticide requirements), and 3.10.2.4 and 1.6.9 (Clean Water Act and no requirement for NPDES permit). As no dredge or fill actions would be part of the proposed action, a permit under Section 404 of the Clean Water Act is not required and no consultation with the U.S. Army Corps of Engineers is necessary. A response letter with this information, included in Appendix B, was sent to the Department of Health.

The State Historic Preservation Officer sent a letter concurring with the determination in the draft EA that the project would have no adverse effects on historic properties because there will be no ground-disturbing activities. No response letter was sent since the letter did not raise any questions or problems with the draft EA.

A letter from the Office of Hawaiian Affairs requested the following: 1) assurances that access to the islands for traditional gathering and other practices would be protected during the course of the project; 2) information on tax map key numbers and whether the islands are Ceded Lands; and 3) a copy of the State Historic Preservation Officer's response to the determination in the Draft EA that the project would have no adverse effects on historic properties. A response letter, included in Appendix B, included the following: 1) An explanation that no actions proposed for the project will prohibit access for ongoing cultural or traditional practices – but that no such uses are known to occur on Mokapu Island now, primarily due to steep slopes that effectively limit access to helicopter landings on the ridge; 2) Information that although there is apparently no tax map key number assigned to Mokapu, the island is Section 5(b) Ceded Land; and 3) A copy of the December 31, 2007, letter from the State Historic Preservation Officer, concurring with the determination that the project will have no adverse effect on historic properties.

Verbal comments received during the January 3 and 4, 2008, public meetings on Moloka`i and during December 2007 informal discussions with Moloka`i residents were supportive of the concept of conserving native species through rat eradication. However, concerns about the project were reflected in the three following questions that were often asked: 1) is there any other option besides aerial broadcast for eradicating rats on Mokapu?; 2) will rodenticide pellets falling into the water harm marine life?; and 3) will people who eat marine life from the area be at risk as a result of the aerial broadcast? These questions were answered in detail with the information already contained within the draft and final EAs. Specifically, question 1 is addressed in Section 2.5.2 and questions 2 and 3 are addressed in Section 3.2. Documentation of low risk to marine organisms and humans is based largely on over 10 years of laboratory and field data collected for EPA. Minimal amounts of rodenticide are expected to be available to marine organisms and for any organisms that were exposed to rodenticide, the risk to the marine organisms and human consumers is small due to the low toxicity of the compound and its relatively rapid excretion by animals that ingest or absorb it. Rough winter ocean conditions are also expected to break pellets down quickly, making them unavailable for fish to eat.

2.0 DESCRIPTION OF AFFECTED ENVIRONMENT, PROPOSED ACTION, AND MITIGATION

2.1 Introduction

2.1.1 Contents and Format of the Environmental Assessment

In addition to an introduction, this chapter includes:

- Analysis of the requirements and challenges of conducting rodent eradication projects on isolated oceanic islands based on the experiences of researchers and practitioners worldwide (Section 2.2)
- No Action Alternative and detailed descriptions of the existing ecosystem components of Mokapu Island (Section 2.3);
- Proposed Action Alternative and detailed description of the proposed eradication project using rodenticides (Section 2.4), and
- Other project alternatives not considered in detail, with a rationale (Section 2.5).

This EA will not have an encyclopedic Affected Environment chapter, as the baseline information is already incorporated analytically into the evaluation of the need for action in Chapter 1, into the description of the No Action alternative (Section 2.3), and in the description of each resource issue in Chapter 3. This approach is consistent with the CEQ NEPA implementing regulations at 40 CFR 1508.9(b), 1501.7(a)(2-3), 1500.1(b), and 1502.15, 1502.10 (and others), and the Department of Interior NEPA guidance at 516 DM Chapter 3.4, which reinforces the flexibility of formats for EAs allowed by 40 CFR 1508.9(b) and even encouraged for EISs by 40 CFR 1502.10.

2.1.2 Basis for Consideration of Only the No Action and the Proposed Action Alternatives in this EA

This proposed action is based on lessons learned through more than 250 successful invasive rodent eradication projects conducted worldwide and incorporates successful, effective and appropriate actions and recommendations used in international projects, especially in New Zealand. Of these, 57 eradications were achieved through aerial broadcast of rodenticides. The decision process leading to the Proposed Action Alternative is, therefore, based on extensive experience with island rodent eradications and aerial broadcast in particular.

The regulations implementing NEPA state that an environmental assessment must include, in addition to the need for action and environmental impacts (40 CFR 1508.9), alternative ways of meeting the need only if the project would involve "unresolved conflicts regarding alternative uses of resources of concern" (section 102(2)(E) of NEPA).

These proposed rodent eradication projects are based on the studies, findings, and experience of rodent eradication experts world-wide and evaluates the impacts associated with the use of two rodenticides that have been successfully used in international projects on oceanic islands. Diphacinone has already been granted a label by EPA for use in the United States for conservation purposes; brodifacoum is still under consideration. Other methods have been evaluated and found to be less effective under the conditions associated with eradicating invasive rodents on isolated oceanic islands. Analyses of potential impacts on various nontarget resources associated with the use of these two rodenticides under the project descriptions indicate that long-term impacts would be sufficiently low or absent and therefore no "unresolved conflicts" exist (See Chapter 3). Other alternatives have been eliminated from detailed evaluation in this EA because, based on worldwide experience and consensus, these approaches have not been effective and/or have high nontarget impacts. No additional effective means of meeting the project objectives under the conditions characteristic of Hawaiian Islands are known at this time. Therefore, no additional alternatives except for the "No Action" alternative will be considered in this EA.

2.2 Analysis of Requirements and Challenges for Island Rodent Eradication Projects

2.2.1 Requirements for Success

Decades of research have shown that, although extremely difficult at best, a rodent eradication project is feasible if six fundamental criteria can be met. The essential elements of successful eradication are summarized from Myers et al. 2000:

- Resources must be sufficient and sufficiently long-term to fund the project from pre-project monitoring (baseline) through post-project monitoring.
- Lines of authority must be clear and must allow an individual or agency to take all necessary actions when needed. An extensive project is only feasible if the lead agency has a clear mandate to carry out the required procedures while establishing and maintaining managerial and public support for a costly project.
- The biology of the target species must be vulnerable to the eradication procedure(s), considering dispersal capability, reproductive biology, life history, and susceptibility.
- Reinvasion must be prevented and incorporated into the analysis of costs and benefits.
- The invasive species must be detectable at relatively low densities leading to early detection after invasion before it becomes widespread and more difficult to eradicate.
- Environmentally-sensitive eradication might require the restoration or management of the community or ecosystem following eradication of the invasive species, requiring a sophisticated understanding of the ecological relationships with and without the target species.

In addition, appropriate technology must be legally available for use under the desired conditions.

To optimize the chance of success for an eradication project, it must include the following components prior to the project as summarized by Courchamp et al. 2002:

- A detailed investigation of the historical, ecological, social, and economic conditions of the proposed island;
- A detailed definition of the management goals in order to identify the available management options and evaluate their respective likelihood of success;

- A thorough study of the proposed island and all factors pertinent to a particular eradication, with careful planning of the proposed protocol and its implementation;
- A careful selection of the method or suite of methods, including timing, budget, and costs.

2.2.2 Challenges and Factors for Success Inherent in Invasive Rodent Eradication Projects

Thomas and Taylor (2002) suggest that the primary reasons for failure of rodent eradication projects involve the following factors:

- Not using the best available formulations of rodenticides for the conditions;
- Conducting the eradication project at a time when an abundance of natural alternative food for the target species exists, decreasing rodenticide uptake;
- Complications with and impacts to nontarget species;
- Lack of sufficient organization or maintenance of the overall effort through the completion of eradication; and/or
- Reinvasion of the treated island with rodents from nearby rodent-infested islands with or without human assistance.

The underlying principle of all of these factors, with the exception of reinvasion, is the exposure of all rodents to lethal dosages. All active ingredients registered and proposed for registration in the United States and the State of Hawaiʻi (diphacinone and brodifacoum) are 100% lethal to rodents when ingested at the proper dosage. The key to a successful rodenticide formulation, given it is made available to all rodents in sufficient quantities to ensure 100% lethal exposure, is its acceptance by rodents as the most desirable food within their territory until a lethal dosage has been ingested. Conducting operations at less than optimal periods, such as when abundant natural foods which rodents are already accustomed to are prevalent, drastically reduces the probability of achieving this fundamental objective. Likewise, interference with bait by nontarget species, besides exposing animals not intended as targets, reduces the availability of the rodenticide formulation to the target species. Finally, insufficient operational procedures, maintenance or effort will greatly reduce the likelihood that all rodents will receive the necessary lethal dose.

2.3 Description and Impacts of the No Action Alternative (and Affected Environment)

2.3.1 Introduction

The No Action Alternative is to not conduct a rat eradication project on Mokapu Island. Under this alternative, rats would remain on Mokapu and continue to damage native species. In order to understand the impacts of the No Action Alternative, the rest of this section describes present and future conditions on Mokapu, assuming nothing is done to eradicate the rats.

The description of the plants and seabirds on Mokapu that are potentially impacted by rodents is located in Sections 1.1.1 and 1.2.4. If rats are not eradicated from this island, these impacts will continue, including restricting the ability of rare native species to colonize the island on their own and the ability of people to restore protected plant species to Mokapu in the future.

Analysis of potential impacts to wildlife species from the proposed rodent eradication project is located in Chapter 3, Environmental Consequences.

2.3.2 Description of Mokapu Island

The Hawaiian Islands, located in the subtropical central Pacific Ocean, are among the most isolated island chains in the world. The archipelago is composed of 137 islands stretching almost 1,553 miles between 16 and 23° north latitude. Eleven islands are permanently inhabited and eight – Hawai‘i, Maui, Lana‘i, Moloka‘i, O‘ahu, Kaua‘i, Kaho‘olawe, and Ni‘ihau – are part of the main Hawaiian islands and support more than 99.9% of the archipelago's human population (State of Hawai‘i Data Book 2002).

2.3.2.1 Physical Description and Climate of Mokapu

The Hawaiian island chain was formed by volcanic activity. As the Pacific Plate drifted roughly northwestward, magma periodically perforated the plate and formed each of the islands in the Hawaiian chain in turn (Carson and Clague 1995). Mokapu is of volcanic origin and was likely formed by erosion of the land that once connected it to the rest of Moloka‘i. Mokapu is one of seven relatively large islands off the coast. The others are: Okala, Mokapu, Huelo, Pauonuakea, Mokumanu, Mokuhooniki, and Kahana. All seven islands are owned by the state of Hawai‘i and all but Pauonuakea are managed by DOFAW as State Seabird Sanctuaries. Mokapu is section 5(b) ceded land.

The north shore of Moloka‘i, including its offshore islands, supports some of the most diverse and intact coastal plant communities remaining in Hawai‘i (K.R. Wood and M. LeGrande 2003, unpubl.report). Mokapu is located about 3, 445 feet north of Leinapapio point and 1.5 miles east of Kalaupapa peninsula on Moloka‘i's north shore (21˚ 11′ N – 157˚ 55′ W) (Figure 1). Mokapu is 10 acres in size, excluding the vertical surface area of the cliffs, and about 360 feet above sea level, with precipitous slopes ranging from 45 degrees to vertical (Fig. 2). Only the narrow summit ridgeline is sufficiently level for safe transit on foot. The island is approximately 1, 280 feet north to south by 475 feet east to west (K.R. Wood and M. LeGrande 2003, unpubl. report).

The Hawaiian Islands experience a warm, tropical climate. In general, daytime temperatures at sea level remain between 75°F and 85°F throughout the islands, similar to the consistent average temperature of the air above the surrounding ocean. The most influential element of Hawai‘i's climate is the persistent flow of the trade winds that blow from the east throughout the Pacific's subtropical latitudes (Giambelluca et al. 1986).

Hawai‘i's weather can be divided roughly into two seasons. The season from May through October, called Kau by the native Hawaiians, is somewhat hotter and drier, with nearly constant trade winds. The wet season from November through April, called Ho'oilo by the native Hawaiians, typically has more rainfall, cooler temperatures and trade winds that are more frequently interrupted by atypical wind patterns (Giambelluca et al. 1986). However, the tropical latitude ensures climate fluctuations are minor compared with those of the continental United States. Below an elevation of 1,000 feet, the inter-seasonal fluctuation in average temperature rarely exceeds 9°F.

Mainland Moloka‘i rainfall varies from one-quarter to one-half inch in the wet season (November through April), decreasing to approximately 0.1 inch in the dry season (Giambelluca et al. 1986).

2.3.2.2 Vegetation

Like the adjacent islands of Okala and Huelo, Mokapu has some of the best native coastal plant habitat in the state. Mokapu has a remarkable 29 native plant species, several of which are rare and vulnerable. The island is dominated by native shrubs but also retains small groves of native *Diospyros* (lama) trees. *Pritchardia hillebrandi*, a native palm (luolu) species that dominates Huelo, is present on Mokapu but only in moderate numbers. *Peucedanum sandwicense* (makou), a threatened species and *Lepidium bidentatum* (‘anaunau) a species of concern, are also present. Eleven of the last 14 remaining wild individuals of *Pittosporum halophilum* (ho‘awa) are found on Mokapu (K.R. Wood and M. LeGrande 2003, unpubl. report). In 2003, the USFWS designated critical habitat on Mokapu for *Peucedanum sandwicense*, *Tetramalopium rockii* and *Brighamia rockii* (pua‘ala). Although *Brighamia rockii* and *Tetramalopium rockii* are not currently found on the island, establishing populations on Mokapu would be an important step towards species recovery.

However, the presence of rats and invasive weeds on Mokapu is reducing native plant numbers and may eventually result in some species being lost from the island. If the *Pittosporum halophilum* were lost from Mokapu, only 3 plants would be left in the wild. Rats living on Mokapu are thought to be preventing the regeneration of *Pritchardia*, *Pittosporum* and *Diospyros* by eating seeds and young plants. Several invasive weeds are also present on the island, including the tall shrub *Lantana camara*, the crabgrass *Digitaria insularis*, the succulent *Bryophyllum pinnatum*, the bush *Pluchea carolinensis*, and the Brazilian peppertree (*Schinus terebrinthifolius*). The invasive *Lantana* shrublands, as well as the other invasive species, could outcompete native vegetation (K.R. Wood and M. LeGrande 2003, unpubl.report).

2.3.2.3 Bird Communities

Hawaiian seabirds have undergone a series of historical events that have had varying degrees of impact on their populations, including hunting, loss of coastal habitat, and the introduction of several alien species that eat seabirds, including three species of rats. Current statewide seabird populations are likely significantly reduced from historical numbers. Offshore islets are one of the few places where significant seabird colonies are still found. The presence of rats on Mokapu and other offshore islets keeps seabird populations lower than they would otherwise be and likely prevents other seabird species from establishing new colonies. If rats remain on the island, some of the species present now could be eliminated from Mokapu. The State of Hawai‘i, in the Hawai‘i Comprehensive Wildlife Conservation Plan, identifies predation by invasive rats to be a threat to the native species of seabirds, including those found on Mokapu (Mitchell et al. 2005).

Mokapu currently supports the following species of birds (Wood and LeGrande 2003, unpubl. report; F. Duvall, DOFAW pers. comm., based on survey conducted March 2000):

- Wedge-tailed shearwater (ua‘u): native seabird confirmed nesting on the island
- White-tailed tropicbird (koa‘e): native seabird confirmed nesting on the island
- Red-tailed tropicbird (koa‘e ‘ula): native seabird confirmed nesting on the island

- Bulwer's petrel ('ou): native seabird possibly nesting on the island
- Black noddy (noio): native seabird possibly nesting on the island
- Brown booby ('a): native seabird seen flying near the island
- Great frigatebird ('iwa): native seabird roosting on the island
- Barn owl (*Tyto alba*; owl native to North America but not to Hawai'i)
- Northern cardinal (*Cardinalis cardinalis*; passerine native to North America but not to Hawai'i)
- House finch (*Carpodacus mexicanus*; passerine native to North America but not to Hawai'i)
- Japanese white-eye (*Zosterops japonicus*; non-native passerine)
- Nutmeg mannikin (*Lonchura punctulata*; nonnative passerine)

2.3.2.4 Land Mammals

The only native land mammal known to Hawai'i is the hoary bat (Tomich 1986); however, there are no records of the hoary bat on Mokapu. Other than invasive rats on Mokapu, no other land mammals are known (F. Duvall, DOFAW, pers. comm. based on survey conducted March 2000).

2.3.2.5 Reptiles

Nonnative lizards of two families are known on Mokapu, but, in general, densities are lower than on nearby islands possibly due to the presence of rats on Mokapu. The island supports three species of nonnative reptiles: the snake-eyed skink (*Cryptoblepharus poecilopleurus*), the azure-tailed skink (*Emoia cyanura*) and the mourning gecko (*Lepidodactylus lugubris*). The gecko is a Polynesian introduction to Hawai'i and was found on the ground, trunks and stems of trees and shrubs, and under rocks and in leaf axils. The skinks were commonly seen in open or sparsely vegetated areas, and most common in rocky areas (F. Duvall, DOFAW, pers. comm. based on survey conducted March 2000). It is likely that rats occasionally eat lizards or their eggs and would continue to do so if left on the island.

2.3.2.6 Insects

No in-depth insect surveys have been conducted on Mokapu Island, although some notable species were observed, such as the alien white-lined hawk moth (*Hyles lineata*) and endemic *Nysius* spp. seedbugs (K. Wood, pers. comm., www.hawaiioirc.org). Rats are known to eat many insect species and leaving rats on the island would reduce abundance and diversity of insects. Some of these insect species may also be important pollinators of native plants.

2.3.2.7 Marine Species

Mokapu's slopes continue steeply to the ocean floor, about 100' below the surface, which is a combination of sand and hard substrate (G. Hughes, pers. comm. 2007). Corals are present on the slopes but not extensive, due to the extremely rough winter surf conditions.

The only species of marine mammal that could possibly be found in or near shore would be the endangered monk seal (*Monachus schauinslandi;* īlio-holo-i-ka-uaua), which cannot haul out on Mokapu because of steep slopes (F. Duvall, DOFAW, pers. comm. 2007).

Threatened green sea turtles (*Chelonia mydas;* honu) are sometimes seen in waters around Mokapu but there is no suitable turtle nesting or basking habitat on Mokapu because of steep and rocky shores (G. Hughes, National Park Service, pers. comm.).

Whales and dolphins are not known to frequent waters adjacent to the edges of Mokapu.

A 2004 National Park Service survey along a 60' deep transect at Mokapu recorded 20 fish species (see Table 1). Hinalea lauwili (saddle wrasse, *Thalassoma duperrey*) was the most common species observed.

Table 1. Fish Species Recorded at Mokapu Island

Hawaiian name	Common English name	Scientific name
ma'i'i'i	Brown surgeonfish	*Acanthurus nigrofuscus*
maiko	Bluelined surgeonfish	*A. nigrorus*
na'ena'e	Orangeband surgeonfish	*A. olivaceous*
wahanui	Smalltooth jobfish	*Aphareus furca*
'a'awa	Hawaiian hogfish	*Bodianus bilunulatus*
kikakapu	Teardrop butterflyfish	*Chaetodon unimaculatus*
------	Blackfin chromis	*Chromis vanderbilti*
piliko'a	Redbarred hawkfish	*Cirrhitops fasciatus*
'alo'ilo'i	Hawaiian dascyllus	*Dascyllus albisella*
------	Bandit angelfish	*Desmoholocanthus arcuatus*
humuhumu'el'ele	Black durgon	*Melichthys niger*
'opelu kala	Sleek unicornfish	*Naso hexacanthus*
umaumalei	Orangespine unicornfish	*N. lituratus*
piliko'a	Arc-eye hawkfish	*Paracirrhites arcatus*
moano	Manybar goatfish	*Parupeneus multifasciatus*
------	Eightstripe wrasse	*Pseudocheilinus octotaenia*
------	Fourstripe wrasse	*P. tetrataenia*
uhu	Palenose parrotfish	*Scarus psittacus*
humuhumu lei	Lei triggerfish	*Sufflamen bursa*
hinalea lauwili	Saddle wrasse	*Thalassoma duperrey*

Intertidal invertebrates include crabs (a‘ama) and limpets (opihi). Rats do eat some intertidal species so allowing them to stay on the island will likely allow continued predation on some invertebrates.

2.3.2.8 Human History and Cultural Use

The Hawaiian name for Mokapu is believed to be a contraction of Moku kapu, or ‘sacred island.’ Historical uses of the island are unknown although rock mound structures are present on the ridgeline of Mokapu. However, the nature and source of these rock structures are unknown. The difficulty of accessing Mokapu by water and the steepness of its slopes make it unlikely that it was visited often in the past and there are no known human uses of terrestrial areas today.

However, there is fishing along the north shore of Moloka`i, including areas near Mokapu. Fishing is primarily during the summer since winter seas are often very rough. Interviews with several Moloka`i subsistence users in December 2007 indicated that fishing near Mokapu is primarily for non-resident, pelagic species, such as mahimahi (*Coryphaena lippurus*), ono (*Acanthocybium solandri*), and kawakawa (*Euthynnus affinis*).

Choosing not to eradicate rats from Mokapu would reduce the native species and degrade habitats on Mokapu, both of which have been and still are an important part of the culture of Hawaiian people.

2.3.3 Characteristics and Food Habits of Invasive Polynesian Rats

2.3.3.1 Polynesian, Brown and Black Rat Characteristics and Food Habits

Three rat species have been introduced to Hawaiian Islands. Brown rats, also known as Norway or cellar rats are the largest of these rat species, with an adult total length of up to 12 inches long and exceeding 12 to 16 ounces in weight. Brown rats are excellent swimmers (Jackson 1982). Black rats, also known as ship or roof rats, are smaller than brown rats, averaging between 6.5 to 8 inches and measuring from 5 to 9 ounces in weight. Black rats are able to swim, but are not the excellent swimmers that brown rats are, but they are more agile and better climbers than brown rats (Jackson 1982). Polynesian rats, also known as Pacific rats or kiore are the smallest of these three rats and is the species known to occur on Mokapu Island. Adult body weights are usually between 35 and 120 grams in Hawai‘i, but occasionally heavier. The abundance of rats on an island is primarily dependent on available food resources and presence of other rodent competitors. Polynesian rats can live in a wide range of habitats including grassland, scrub and forest. They are able to climb trees easily where at least some of their feeding is done, but are not good swimmers (Atkinson and Atkinson 2000). Rats in general are nocturnal, highly predictable in their behavior, and constantly seeking cover in vegetation and crevices and under logs, rocks and rubbish (Pye and Bonner 1980). In Hawai‘i, the Polynesian rat was either an accidental or an intended introduced species by the early Polynesians (Tomich 1986). *R. exulans* is found on many offshore islands including Mokapu and Lehua Islands and is likely the species present on Ka‘ula Rock.

Polynesian rats eat a wide variety of foods, including fleshy fruit, seeds, flowers, stems, leaves, roots and other plant parts (Atkinson and Atkinson 2000). They also eat earthworms, centipedes, the larvae of butterflies and moths, ants, beetles, cicadas, snails and spiders. Rats in general scavenge and may also kill vertebrate prey, including small mammals, birds and reptiles as well as eating eggs (Drummond 1960, Norman 1970, Fall et al. 1971, Jackson 1982, Atkinson 1985, King 1990, Navarette and Castilla 1993, Sugihara 1997, Drever and Harestad 1998, Hobsen et al. 1999, Cole et al. 2000, Innes 2001, Stapp 2002, Dunlevy and Scharf 2007).

Though rats are omnivorous, they are also highly selective feeders, exhibiting distinct patterns in their diet selection and often favoring specific combinations of foods found within their home range. Within a given population, the same two to four specific foods typically occur in all individuals foraging within a particular area, demonstrating a very high uniformity in foraging strategies. Rats also exhibit a very strong sampling component in their foraging, as indicated by the universal consumption of trace amounts of novel food items (Clark 1981, Clark 1982). Food preferences are affected by the availability of alternative foods, and each food is selected either as it becomes available or when more favored food items becomes scarce (Campbell 1978). Many factors enter into the foraging strategies used by rats, including social status, reproductive behavior, odors of rodent predators, and the dual problem of maximizing the rate of energy gain while selecting a balanced diet, which is especially a concern for generalist feeders such as rats (Berdoy and MacDonald 1991). An individual's status within the social hierarchy most likely influences access to preferred foods and feeding sites; subordinates in the hierarchy may test novel foods to a greater degree than rats of higher status (Dubcock 1984, Nott and Sibly 1993). More risky behavior most likely depends on physiological factors such as health and fat stores (McNamara and Houston 1990). In addition, young rats learn foraging habits from their mothers or other "demonstrator" rats (Jackson 1982, Innes 2001), so populations of rats tend to continue feeding on the same types of foods and prey over time.

Rats isolated on islands for many generations may be less fearful of new objects present in their home range (neophobic) and more opportunistic than rodents from areas where toxicants and traps have been used for years. Island rats are the descendants of animals that were able to colonize areas in part by adapting to new food sources and have persisted to some degree by exploring new items that wash up in coastal areas. Thus, neophobia might be less of an issue at least during the initial eradication attempts of an isolated population. Interest in abundant, newly available foods may have been a factor in the many successful eradication projects conducted to date. If the initial eradication attempts are not successful, there likely would be some selection for increased neophobia, trap shyness, or even behavioral and/ or physiological resistance, thereby making subsequent operations more challenging (Jackson 1982, King 1990, Moors et al. 1992, Innes 2001).

As reported in Tomich (1986), Polynesian rats may prey upon Bulwer's petrel, Laysan albatross (*Phoebastria immutabilis;* mōlī) and burrow-nesting species such as the wedge-tailed shearwater and Bonin petrel. Atkinson and Atkinson (2000) also reported detrimental effects on burrowing petrels in Hawai‘i and New Zealand and on red-tailed tropicbirds. The author also postulated that predation on seabirds may become significant after storms have reduced fruiting of food plants. Rat eradication on Midway Atoll resulted in dramatic increases of Bonin petrels (Seto and Conant 1996). In the two years immediately following the control of black rats on Mokoli`i near O‘ahu, nesting success in wedge-tailed shearwaters increased rapidly, from only one chick fledging in the three years prior to rat eradication to 185 chicks fledging the second year after eradication (D. Smith, Hawai'i DOFAW, pers. comm.). Rats also contribute to the decline of *Achatinella mustelina*, a tree-snail endemic to a mountain range on O‘ahu (Hadfield et al. 1993). Rats have also been documented to feed on endemic crickets and weevils (F. Howarth unpublished data, pers. comm.).

Rats eat the seeds, bark, fruits, leaves and shoots of Hawaiian plants. Rats strip the bark of koa saplings, girdling and killing the young trees (Scowcroft and Sakai 1984). The endemic vetch (*Vicia menziessii*) has also been girdled by rats (Clarke et al. 1982, L. Pratt, pers. comm.). Rat herbivory has been shown to prevent reproduction in the wild of *Hibiscadelphus* spp. (Baker and Allen 1978) and *Pittosporum* sp. (L. Pratt, pers. comm.). Seed depredation by rats has affected populations of *Pritchardia* sp. (Beccari and Rock 1921; Male and Loeffler 1997). It is most likely the presence of rats that have terminated the regeneration of native *Pritchardia*, *Pittosporum* and *Diospyros* along with other native plant taxa on Mokapu (K. R. Wood and M. LeGrande 2003, unpubl. report).

2.4 Description of the Proposed Action Alternative - Invasive Rodent Eradication Project on Mokapu

2.4.1 Integrated Pest Management Strategy for Mokapu

The proposed invasive rodent eradication project for Mokapu Island involves an Integrated Pest Management strategy (IPM) that includes aerial broadcast of bait pellets containing rodenticide. The principal proposed management action within the IPM project focuses on the use of rodenticides with various application methods to eradicate invasive rodents, with and prevention of invasion and re-invasion by rats and other invasive species as an integral component of the strategy. The rodenticide bait formulation proposed for use focuses on diphacinone (50 ppm), with brodifacoum (25 ppm) as a backup the following year only if it can be determined that any failure is due to the rodenticide and not other factors. Application methods will be comprised of aerial broadcast on Mokapu, with the potential for bait stations and/or burrow application for mopup in accessible areas of the island, used according to the currently approved label for diphacinone pursuant to FIFRA and the State of Hawaiʻi and any future approved label for brodifacoum. The pre- and post- operation monitoring plan components are identified based on the characteristics of Mokapu. The appropriate mitigation measures and conservation actions are selected based on the size and extent of the proposed project, as well as the types and levels of risk of adversely impacting nontarget species specific to the particular site.

The proposed action was developed cooperatively by WS, USFWS, and DOFAW staff in collaboration with members of the Offshore Islet Restoration Committee (OIRC). OIRC is a multi-agency group that plans and coordinates statewide island surveys and restoration projects in Hawaiʻi. Operational requirements, monitoring plan, and project planning were also reviewed by the New Zealand Island Eradication Advisory Group, integrating methodologies that have been successful in New Zealand and other locations into this proposed project.

2.4.2 Selection of Timing for Application of Rodenticides

Since the operational objective is to eradicate rats, a key consideration when evaluating potential timing is the biology of the target rat population, including:

- Periods when rat reproduction is low or nonexistent, rat abundance is lowest, and dependent juveniles are in burrows avoiding exposure to the rodenticide; and
- Periods of lowest seasonal abundance and diversity of alternative foods available for rats, such as seeds, leaves, and other nutritious components of the vegetation, invertebrates,

and eggs and chicks of vulnerable ground- or burrow-nesting bird species (Orueta and Ramos 2001).

Subsequent to the consideration of rat biology, the presence of nontarget species that could be vulnerable to rodenticide toxicity, either directly by eating bait or indirectly by eating prey that has rodenticide residues in tissues, must be evaluated. Selecting the season when most nontarget species are not present is the most important (Orueta and Ramos 2001).

In addition, possible weather regimes and their potential impacts are considered.

Knowledge of rat populations in other parts of the state and other islands was used to predict Mokapu rat breeding cycles. This is because very little study of the rat populations on Mokapu has been conducted, primarily due to the problem of accessing and working on the island. A review of relevant literature suggests rat breeding is strongly associated with the annual light cycle. Breeding slows and/or ceases for some period during the shorter daylight period of the year. In the northern hemisphere this occurs sometime from fall through spring. In Hawai‘i, no published studies have detected breeding in rats from late December through March. The literature is less clear regarding annual rat population abundance cycles in Hawai‘i.

Besides breeding, abundance is influenced by resource availability; which is highly variable both seasonally and annually. Large scale weather patterns such as El Niño and La Niña events may contribute significantly to the abundance cycle in any given year or season via rainfall and its subsequent effects on vegetation and invertebrates, which are the primary foods of rats. In the Hawaiian Islands, studies document rat population lows both in the summer and in the winter, however, in general there is much less difference between the annual highs and lows in abundance than is found in highly seasonal temperate environments (Wirtz 1968, Tamarin and Malecha 1971, Tamarin and Malecha 1972, Clark 1980, trapping records from various agencies in Hawai‘i). This somewhat reduces the importance of abundance in the assessment of timing; placing more emphasis on the breeding cycle of rats.

The timing of operations to avoid the presence of desired avian species, especially the vulnerable eggs and chicks, also resolves many concerns with the exposure of desired nontarget species to rodenticide. Applying rodenticide when nontarget species are absent is the primary and most assured method of reducing the exposure of these species to the toxicant or disturbance (Orueta and Ramos 2001). Low numbers of birds in the air also reduces safety concerns associated with helicopters being struck by birds. On Mokapu, the greatest diversity and abundance of avian species is from April through September (Sections 3.6 and 3.7).

For the Mokapu operations, the primary weather -related logistical constraints are wind and rain. Rodenticide application may not be made in winds higher than 35 mph and five days without significant rainfall after the broadcast is considered necessary. At Kalaupapa, mean monthly wind (predominately from the north) speed ranges from about 10 to 15 mph and maximum wind gusts from 44 to 54 mph. The windiest months are April through September, while winds decline from October through February. In general it rains more from September through April, although the weather-related logistical considerations overall are minimal (Giambelluca et al. 1986). Rat numbers are attenuated and breeding ceases in the winter and the low in the diversity and abundance of rats' natural foods occurs from fall to early spring.

Therefore, the ideal period to conduct rodent eradication projects on Mokapu Island would be at the time of year that ensures the highest probability of successfully distributing rodenticide and eradicating rats while having the lowest potential impact on nontarget species. Between December and March, alternative foods, such as native and nonnative plants, are at their lowest. Also between December and March, most species of native birds that also provide foods for rats and would be evaluated for nontarget impacts, are absent from Mokapu or only present in low numbers (Sections 3.6 and 3.7). Nonnative passerine birds such as the Japanese white-eye and nutmeg mannikin may remain year-round, but, as nonnative species not protected by the Migratory Bird Treaty Act, effects to these species are not considered for impact analysis.

Therefore, the optimum timing of the operation is based primarily on the lack of rat reproduction, the absence of avian seabird species, and the most favorable weather possible—in that order—which are the winter months from December through March

2.4.3 Rodenticide Selection and Use

Selection and use of the most appropriate rodenticide for the specific conditions of a project is one of the primary decisions for any rodent eradication project. Rodenticides must be used wisely and in the lowest quantity and toxicity which ensures that every rodent is exposed to a lethal dose while minimizing adverse environmental effects, especially impacts to nontarget species. Prudent use is also critical to ensure that regulators will allow effective rodenticides to continue to be made available for future use (Marsh 1985, Cromarty et al. 2002).

Marsh (1985) advised selecting the rodenticide for which the target rodent has a high susceptibility and nontarget wildlife species have a low susceptibility, thereby maximizing effectiveness and minimizing adverse effects, especially to nontarget species. Maximizing effectiveness of the selected rodenticide involves combining the critical factors of the concentration of the active ingredient in the bait formulation, the bait application rate, the method of application, and the seasonal timing of bait application (when rodent populations, reproduction, and alternative foods are lowest) to ensure that all target rodents are exposed to a lethal dose. Both the selection of the appropriate rodenticide and the technical considerations must also judge the complexity of the physical terrain and the size of the island to be treated.

The technical considerations of efficacy are more straightforward, however, than considerations involving minimizing adverse effects to nontarget species and other environmental resources. Minimizing overall adverse effects is possible in a variety of ways; however most mitigation methods for reducing hazards to nontarget species involve (Kalmbach 1943, Marsh 1985):

- Applying bait when nontarget species are not present, present in seasonally low numbers, or not breeding or raising young;
- reducing bait toxicity to nontarget species;
- reducing palatability or attractiveness of bait to nontarget species;
- minimizing or avoiding exposure of nontarget individuals to the bait via protective stations;
- minimizing rodenticide residues in the tissues of target species.

In summary, selection of the appropriate rodenticide in an effective bait formulation for a specific project must ensure a high potential for efficacy in eliminating invasive rodents when conducted according to the description of the proposed action during the optimum seasonal time frame, while having the lowest potential for adverse impacts to nontarget species.

The New Zealand Department of Conservation (DoC) implemented a policy in October 2000 that placed restrictions on the use of brodifacoum for conservation purposes on the New Zealand mainland because of documented levels of direct and indirect poisoning of nontarget species. New Zealand DoC conducted a study using diphacinone 0.005% formulations using pellets and blocks in mainland control situations that adequately demonstrated the efficacy of diphacinone in the field (Gillies et al. 2006). Studies in Hawai‘i have also documented diphacinone efficacy with lower nontarget impacts in field and laboratory studies (Dunlevy and Campbell 2000, Nelson et al. 2002, Eisemann and Swift 2006).

For the rodent eradication project on Mokapu, the rodenticide with the lower risk to nontarget species, diphacinone, has been selected for use. Brodifacoum would be used only if it is approved by EPA and then only if failure can be determined to be caused by the rodenticide diphacinone itself and not improper or inadequate application methods, timing, bait life, bait competition with nontarget species, or other operational issues.

2.4.4 Operational and Ecological Monitoring

2.4.4.1 Introduction

Monitoring the efficacy of meeting rodent eradication and ecosystem restoration objectives as well as the mortality of nontarget species and the associated effects on their populations is critical to rodent eradication projects (Atkinson 1994, Courchamp et al. 2002, Smit 2003). Smit (2003) focuses on the importance of monitoring not only to determine if goals are achieved, but also to add to existing knowledge on how to better manage ecosystems, including learning from experience and adjusting actions when necessary to better meet objectives. He states that it is critical to define indicators that characterize the state of the resource, define the intensity of monitoring, and use thresholds to determine whether to increase or decrease the intensity of monitoring or stop it altogether, based on the results of monitoring. Monitoring also assists in determining how long an ecological resource adversely impacted by rodenticides can persist before it either recovers or disappears. Courchamp et al. (2002) also emphasize the importance of learning from “unwitting mistakes made in the past, since all results contribute to an understanding of island ecology and can be used in future conservation actions on other islands.”

The informal consultation under Section 7 the Endangered Species Act conducted for Mokapu required that all monitoring transects identified in the following sections will be located on or near the ridgeline to avoid trampling *Peucedanum sandwicense* plants on the steep northeast slope of the island (Section 3.9.2.2). Human safety considerations also dictate that transects be along the more accessible ridgeline area.

2.4.4.2 Monitoring for Bait Application, Uptake, and Potency

Evaluating rodenticide take by target rodents must also be evaluated to ensure that sufficient bait is applied to ensure lethal exposure to 100% of the rats (Sterner and Ramey 2002). Monitoring for bait uptake using hand or aerial broadcast application methods require refined monitoring techniques. Careful testing and calibration of equipment and methods prior to broadcast and detailed records of the amounts of rodenticide applied and the areas (using Differential GPS systems) over which it is distributed are the first steps in the monitoring of bait application, while providing for the computation of bait application rate. Monitoring the appropriate density of bait is also necessary. These monitoring transects would also be along the ridgeline.

In addition, broadcast applications require monitoring of bait degradation, which will also be outlined in detail within the specific project operation plan. In general, this entails closely monitoring weather conditions in representative habitats and areas of possibly variable exposure and observing how rapidly the bait deteriorates.

The level of toxicant in the bait must also be monitored, both before application and once on the ground, to ensure that all rats are exposed to the appropriate dosage of active ingredient for meeting eradication objectives (Spurr and Powlesland 2000).

Evaluating rodenticide take by target rodents must also be evaluated to ensure that sufficient bait is placed to ensure exposure to 100% of the rats (Sterner and Ramey 2002).

On-the-ground application monitoring methods will be outlined in detail in the specific project operation plan and include methods such as those outlined by Sterner and Ramey (2002) and McClellan (2001). However, it is planned that rodenticide application will be assessed by measuring and recording the total amount of bait applied and evaluating the actual bait distributed on the ground in the treatment area using ground surveys. The number of pellets found along census transects along the ridgeline will be recorded immediately after bait application, while recording substrate and slope. For determining bait uptake, marked pellets will be examined daily until they disappear or biodegrade. If bait is still available and in appropriate condition, bait monitoring will cease after 14 days.

2.4.4.3 Eradication Efficacy Monitoring

Rat abundance and distribution will be monitored using rodent traps. On Mokapu, traps will be placed only on the ridgeline to ensure personnel safety and minimize habitat disturbance. An appropriate number of transects with snap-traps will be laid out and baited daily for several days after pre-baiting to avoid neophobia. The trap lines will be located on the ridge on Mokapu for safety reasons. Genetic material will be collected from rats prior to initiation of the operations.

Accepted practice to confirm the success of rodent eradication on large islands is to wait two years before carrying out intensive on-the-ground efficacy monitoring (Taylor and Thomas 1989). Waiting two years ensures that, if the treatment operation did not eradicate all the rats in a population, the remnant populations will have increased sufficiently to easily determine if rats are still present, or if the original population was successfully eradicated. However, since the island is so small, follow-up monitoring for success in meeting the eradication objective will be conducted in April 2008, fall 2008, and fall 2009 using snap-traps and tracking tunnels.

If rats are still found after up to 4 applications of diphacinone, then bait stations and/or burrow treatments may be used to continue to target these areas in accessible areas of the island. If it can be shown that the reason for failure is due to the choice of using diphacinone, then brodifacoum may be used the following winter.

2.4.4.4 Ecological Response Monitoring

On Mokapu, a plant species checklist has been created and the abundance of rare native plants has been documented, as well as presence of reptilian, avian, and some insect species (www.hawaiioirc.org, K. Wood and M. LeGrande 2003, unpubl. report, F. Duvall, DOFAW, pers. comm.). DOFAW and OIRC will continue to monitor improvements in protected plant species status, as well as general vegetation composition and abundance, following the operations. Increased numbers of nesting seabird species will also be key indicators of meeting ecological objectives.

Monitoring for primary and secondary adverse impacts on nontarget species is one of the foremost concerns for rodent eradication projects. Sometimes the primary factor in determining whether to conduct an eradication project is the evaluation of the ecological cost of killing individuals of nontarget species, and potentially adversely impacting populations, as compared to the benefits associated with meeting ecosystem restoration objectives. As evaluated in Chapter 3, primary poisoning (through direct ingestion of bait) and secondary poisoning (through eating prey with rodenticide residues in their tissues) of individuals of nontarget species, even outside of the treatment area, may occur. The evaluation and determination of killing a proportion of a nontarget population and whether it would cause adverse impacts at a population level must be considered in terms of species' biology and population dynamics. Highly mobile species with density-dependent characteristics (rates of increase of a population are dependent on the density of individuals in an area, with decreasing densities resulting in increased rates of increase) and high reproductive rates can more readily overcome some level of population losses (Armstrong and Ewen 2000, Courchamps et al. 2002).

Populations of desired nontarget species, including nesting seabirds and protected plants, will be actively monitored for a sufficient period to produce reliable estimates before and after operations. At a minimum, personnel will collect all carcasses found incidentally for necropsy and laboratory analysis of tissue rodenticide residues.

2.4.4.5 Monitoring Water and Tissues for Rodenticide Residue

Weather conditions permitting, several water and intertidal invertebrate tissue samples will be collected 24 hours and one week after the broadcast and sent to multiple laboratories to test for the presence of any pesticide residues. This is to address potential human health concerns.

2.4.5 Rodenticide Label Requirements for Invasive Rats

All applications of rodenticides must follow label requirements as approved by the US Environmental Protection Agency (USEPA) pursuant to FIFRA. Any application methods may be more stringent than the label, but cannot be less stringent. Brodifacoum can only be used for conservation purposes for these projects if and when a nationwide and state registration is approved. The proposed brodifacoum label described below may be different from any label approved in the future.

2.4.5.1 EPA-Approved Diphacinone Label (see label copy in Appendix D)

The FIFRA Section 3 label for the use of Ramik® Green, a rodenticide containing diphacinone (0.005% or 50 ppm concentration of active ingredient), has the following requirements for field application for rat eradication for conservation purposes:

- Bait stations: Tamper-resistant bait stations must be used when applying this product on grounded vessels or vessels in peril of grounding or when used in areas of human habitation. Bait must be applied in locations out of reach of children, non-target wildlife or domestic animals, or in tamper-resistant bait stations. Apply 113 to 454 grams (4 to 16 oz) of bait per placement. Placement should be made in a grid over the area for which rodent control is desired. Maintain an uninterrupted supply of fresh bait for at least 15 days or until signs of rodent activity cease.

- Burrow-baiting: Place bait in burrows only if this can be done in a way that minimizes potential for ejection of bait and exposure of bait to seed-eating birds and other non-target species. Place 84 to 112 g (3 to 4 oz) of bait in a cloth or reseal able plastic bag. The bags should be knotted or otherwise sealed to avoid spillage and holes should be made in plastic bags to allow the bait odor to escape. Place one such bag or placement in each active burrow opening, and push bag into burrow far enough so that its presence can barely be seen. Do not plug burrows. Flag treated burrows and inspect them frequently, daily if possible. Maintain an uninterrupted supply of bait for at least 15 days or until rodent activity ceases. Remove bait from burrows if there is evidence that bags are ejected.
- Aerial and ground-based broadcast: Broadcast applications are prohibited on vessels or in areas of human habitation. Broadcast bait pellets by helicopter or manually at a rate of 11.1 to 13.8 kg/ha (10 to 12.5 lbs/ac) of bait per treatment. Depending upon local weather conditions, make a second broadcast application (typically 5 to 7 days after the first application), at a rate no higher than 13.8 kg/ha (12.5 lbs/ac). In situations where weather or logistics only allow one bait application, a single application may be made at a rate no higher than 22.5 kg/ha (20 lbs/ac). Aerial (helicopter) applications may not be made in winds higher than 35 mph. If rodent activity persists after aerial application, set up and maintain tamper-resistant bait stations or apply bait directly to rodent burrows in areas where rodents remain active. If terrain does not permit the use of bait stations or burrow treatment, continue with broadcast baiting, limiting such treatment to areas where active signs of rodents are seen. Maintain treatments for as long as rodent activity is evident in the area and rodents appear to be accepting bait.
- For all methods of baiting, monitor the baited area periodically and collect and dispose of any dead animals found. Dead animals and spilled bait may be buried on site if the depth of burial makes excavation by nontarget animals extremely unlikely.

Broadcast applications of diphacinone bait by helicopter at the maximum rate of 22.5 kg/ha (20 lb/ac) result in approximately one 2.25-gram pellet distributed about every square meter.

2.4.5.2 Label Submitted to EPA for Brodifacoum

The draft label submitted to the EPA under Section 3 of FIFRA for PI-25, a rodenticide containing brodifacoum (0.0025% or 25 ppm concentration of active ingredient) has the following requirements for field application for conservation purposes (any approved label may be different from these draft requirements):

- Bait Stations: Tamper-resistant bait stations must be used when applying this product to grounded vessels or vessels in peril of grounding or when used in areas of human habitation. Bait must be applied in locations out of reach of children, non-target wildlife or domestic animals, or in tamper-resistant bait stations. Apply 113 g to 454 g (4 to 16 ounces) of bait per placement. Space placements at intervals of 5 to 50 meters (16 to 164 feet). Placements should be made in a grid over the area for which rodent control is desired. Maintain an uninterrupted supply of fresh bait for at least 15 days or until signs of rodent activity cease. Where a continuous source of infestation is present, permanent bait stations may be established and bait replenished as needed.

- Burrow-baiting: Place bait in burrows only if this can be done in a way that minimizes potential for ejection of bait and exposure of bait to non-target species. Place 3 to 4 ounces (84 to 112 g) of bait in a cloth or resealable plastic bag in each active burrow and push bag into burrow far enough so that its presence can barely be seen. Do not plug burrows. Flag treated burrows and inspect them frequently, daily if possible. Maintain an uninterrupted supply of bait for at least 15 days or until rodent activity ceases. Remove bait from burrow if there is evidence that bags are ejected.
- Broadcast Application: Broadcast applications are prohibited on vessels or in areas of human habitation. Broadcast bait using aircraft, ground-based mechanical equipment, or by gloved hand at a rate no greater than 18 kg bait/ha (16 lbs/acre) per application. Aerial (helicopter) applications may not be made in winds higher than 22 knots (25 mph). Set the application rate according to the extent of the infestation and apparent population density. For eradication operations, treat entire land masses.
- Assess baited areas for signs of residual rodent activity (typically 7 to 10 days post-treatment). If rodent activity persists, set up and maintain tamper-resistant bait stations or apply bait directly to rodent burrows in areas where rodent remain active. If terrain does not permit use of bait stations or burrow baiting, continue with broadcast baiting, limiting such treatments to areas where active signs of rodents are seen. Maintain treatments for as long as rodent activity is evident in the area and rodents appear to be accepting bait.
- For all methods of baiting, monitor the baited area periodically and collect and dispose of any dead animals found. Dead animals and spilled bait may be buried on site if the depth of burial makes excavation by nontarget animals extremely unlikely.

The maximum proposed application rate of brodifacoum bait is 19.3 kg/ha (17 lbs/ac), resulting in a density of approximately one six-gram pellet per 3 square meters.

2.4.6 Necessary Permits for Eradication Projects on Mokapu

For conducting any actions on Mokapu, which is designated as a State Wildlife Sanctuary, DOFAW will issue a permit (HAR 13-125-6).

For aerial application of rodenticide on Mokapu, a permit from the Hawai‘i Department of Agriculture per HRS 149A and HAR 4-66 must be acquired prior to beginning the operation.

2.4.7 Aerial Broadcast of Rodenticides

2.4.7.1 Overall Application Operational Plan

Rats will be removed using toxic bait containing the active ingredient diphacinone at 50 ppm. The bait is dyed green by the manufacturer to reduce exposure to birds. The rodenticide will be uniformly broadcast across the emergent land area of the island at the approved application rate allowing all rats to be exposed to a lethal dosage. Rodenticide bait will be applied once all necessary personnel and equipment are in place and a suitable weather forecast is received.

Application on Mokapu will be completed by aerial broadcast across 100% of the land area of the island. All rodenticide application would be carried out under the direct supervision of licensed pesticide applicators. Aerial broadcast will be carried out utilizing an agricultural spreader suspended from a helicopter. Bait will be applied at a nominal rate of 10 lbs/acre (11.25 kg/ha) in at least two separate broadcast applications to be carried out approximately five to seven days apart. To ensure as uniform an application rate as possible, onboard Differential Geographic Positioning System (DGPS) in the helicopter and computerized GIS mapping would document the application area. This allows real time and after-the-fact monitoring and assessment of rodenticide application, as well as printouts showing the actual path covered by the helicopter. Immediately prior to the actual application, all equipment will be tested and calibrated in a location allowing for repairs or adjustments and ensuring accurate application results.

The aerial broadcast application operation will start as early in the day as possible to provide as much time as possible to finish the entire application, check GPS printouts and re-apply any gaps and conclude bait application monitoring before dark.

Weather forecasts will again be consulted before deciding on the appropriate day for the second application of bait five to seven days after the first application, using the same application methods as for the first application. The five-to-seven day interim for the second application can be extended if sufficient bait is still on the ground (greater than 5 lb/acre bait (5.63 kg/ha) remains). The second application will also be at the 10 lbs/acre rate. Application lines for the second application will be treated in reverse and/or perpendicular to the first application. Coastlines and steep areas may again be treated twice for each application.

An additional two applications of diphacinone may be conducted if evidence of rats persists, using the same application methods described for the first two applications. All aerial broadcast applications should be completed by the end of March or when rat breeding begins.

If bait density monitoring is favorable (greater than 5 lb/acre (5.63 kg/ha) remains) and no sign is observed, no further bait applications will be made. However, if there are known survivors, observed rat activity and/or bait density monitoring is not favorable (less than 5 lb/acre (5.63 kg/ha) remains), additional hand or aerial broadcasts (up to a total of four broadcasts) may be made as described above. Follow-up will continue in this manner through up to four aerial broadcast treatments if necessary. If known survivors or observed rat activity persists, bait stations and/or burrow treatments per the label may be used to continue to target problem areas, if possible.

If rats persist post-operation and it is shown that the active ingredient diphacinone is responsible for the failure (as opposed to application methodology or formulation acceptance, for examples), bait containing 25 ppm brodifacoum could be used the following winter per the label, if approved by EPA. The process would be the same as that described in this section for diphacinone. However, this is not expected to be needed.

Water and marine tissue samples will be collected 24 hours and 7 days after application, weather permitting. Test results will be made public.

2.4.8 Bait Handling, Storage and Staff Safety Measures

- All possible measures to transport and store the rodenticide in a manner which maintains its integrity and quality will be followed. Optimum storage conditions are a cool, dry and dark environment.

- The rodenticide will be inspected regularly, and the relative humidity within the storage shed measured daily. Any bait with evidence of decay will be immediately removed and disposed of according to the label, and the remaining bait dried. Anti-moisture techniques will be used for stored bait, including use of moisture absorbents, opening doors during dry windy conditions, elevating and maintaining drainage around storage facility.
- Staff will follow all approved label handling and disposal instructions, per 242 FW 7, 241 FW 3, such as:
  - Storing bait in original containers tightly sealed in a dry secure place away from food or feed;
  - Wearing rubber gloves at all times when handling bait (US Environmental Protection Agency 1998);
  - Wearing dust mask and protective eyewear when handling loose bait (US Environmental Protection Agency 1998);
  - Washing hands and all exposed skin before eating and after work;
  - Not reusing empty bait containers for any reason, and disposing of empty bait containers according to label;
  - Not using or disposing of bait or empty containers where it might come in contact with water or the water supply;
  - Preventing access to stored bait by all unauthorized persons and by animals.
- All spilled bait will be cleaned up and disposed of properly according to the label from each loading site during operations and at the completion of the site's use.
- Helicopters, bait stations, robber gloves, and bait buckets, storage containers, and facilities will be cleaned on-site before returning to the mainland or logistics headquarters.
- Effective and reliable office and communications facilities will be provided for daily communication with managers and off-site advisors, including equipment for computer mapping and data storage, compilation and evaluation, main and backup printers, laminated and paper maps, satellite telephone and fax machine, and SSB radio.

2.4.9 Prevention of Rat Reinvasion after Eradication and Rapid Response to Reinvasion

After a successful eradication operation, it is critical to reduce the potential of rodents reinvading the island. DOFAW will work to insure that during and after the operation, anyone going on to the island under a DOFAW permit will inspect all gear and equipment to make sure that rodents are not present (or weed seeds or alien insects). Staff and visitors will be briefed before going to the island on rodent quarantine concerns and measures.

The ability to respond to an accidental introduction of any non-native species requires a rapid response to reduce the risk that a species becomes established on the island. In the event that a nonnative species is detected on the island, the USFWS and DOFAW have the authority to respond appropriately to the introduction under Hawai‘i Revised Statutes 195D-5, Hawai‘i

Revised Statutes 183D-4, Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j, not including 742 d-l; 70 Stat. 1119), as amended, Endangered Species Act of 1973 (16 U.S.C. 1531-1544; 87 Stat. 884), as amended, and Executive Order 13112 on Invasive Species (February 3, 1999). The response if rats are found on the island would follow the description of the proposed action (Section 2.4) and would involve application of rodenticides again, using the same techniques.

2.4.10 Reporting, Project Debriefing and Adaptive Management

Upon completion of each project, at the minimum an internal report detailing all aspects of the project will be completed. In addition, a project debriefing will be conducted for the purpose of evaluating and modifying rodent eradication policy and procedures. Lessons learned from these small projects will be applied to subsequent rodent eradication projects in Hawai‘i.

2.4.11 Resource-Specific Mitigation Measures

Many mitigation measures for project-level actions are already incorporated directly into the description of the proposed action, including the use of diphacinone, conducting the operation in the winter when most seabirds are not present and rodent populations are vulnerable, safe bait handling procedures, not flying in high winds or when heavy rains are predicted, public notification prior to application, and pre- and post-project monitoring. The following mitigation actions are in addition to those already incorporated into the proposed action and are based on analyses documented in Chapter 3. These mitigation measures will be implemented as part of the operation and included in the operation plan.

2.4.11.1 Species Protected under the Endangered Species Act on Mokapu

Per the results of the informal Section 7 consultation for Mokapu (September 12, 2007) the following actions are necessary to avoid impacts to protected species and will be incorporated into the operational plan (Sections 1.6.3 and 3.9.2.2):

- All rodent and plant monitoring transects will be sited on or near the ridgeline of the island, away from the population of *Peucedanum sandwicense* plants which are located on the steep northeast slope of the island. Worker safety considerations also dictate that no survey work will be done in the steep area where listed plants are located.
- Cleaning procedures to reduce the introduction of noxious plant seeds and propagules will be required. All biologists will be informed of this necessity and the requirement to clean their clothes and gear before going on Mokapu will be included in standard operating procedures.

2.4.11.2 Archaeology Sites Protected under the National Historic Preservation Act

The rock mounds on Mokapu would not be disturbed by either aerial bait application or pre- and post-application monitoring. As no ground-disturbing activities are involved, no adverse impacts are expected to these structures. Placing pre-operational rat and bait monitoring gear, as well as conducting post-operational monitoring, will require limited foot traffic, focused on the ridgeline. However, the structures will be identified and foot traffic will avoid the structures (Sections 1.6.7 and 3.10.2.3). No known cultural practices occur on terrestrial areas of Mokapu. The USFWS and DOFAW sent a copy of the draft EA for this project (published by OEQC on November 8, 2007) to the State Historic Preservation Division (SHPD), with a request to concur with the determination that the project would cause no adverse effects to historic properties, based on the fact that no ground disturbing activities will take place. SHPD sent a letter on December 31, 2007, included in Appendix A, concurring with this determination.

2.4.11.3 Coastal Zone Management Act and Enforceable and Administrative Policies

The proposed projects must be consistent, to the maximum extent practicable with the enforceable policies. The Hawai‘i State Office of Planning has determined that the proposed rodenticide projects must go through the consistency process and this review was initiated on October 1, 2007. The Office of Planning sent a letter, dated November 30, 2007, confirming that the project is consistent with the Hawaii CZM Program (see appendix A).

2.4.11.4 Human Health

Public notices will be posted and published in local newspapers informing people before the bait is dropped. Weather permitting, water and marine invertebrate tissues samples will be collected 24 hours and 7 days after bait is applied to test for rodenticide residues. Lab test results will be made public. Use of Mokapu is by DOFAW permit only, and the island is inaccessible due to lack of suitable and safe boat landing areas and steep slopes. Access permits for landing on the island, for other than project personnel, will not be issued during pre-operational monitoring, during distribution of bait (up to 4 times through March), and during post-operational monitoring.

2.5 Alternatives (Not Considered in Detail)

2.5.1 Use of Other Toxicants

Labeling for a product with active ingredient brodifacoum has been submitted but not yet approved by the US Environmental Protection Agency pursuant to FIFRA for the broadcast use pattern for conservation purposes in the United States. However, Ramik® Green (50 ppm diphacinone) is currently approved; a registration application for brodifacoum 25 ppm has been submitted and is under consideration by US EPA. Therefore, as no other toxicants have yet been under consideration for conservation purposes in the United States, no other toxicants are considered in detail in this EA.

Registrations for chlorophacinone and cholecalciferol are not under consideration at this time, but, at a minimum, should also be sought in the future as well as other materials as appropriate. Each of these tools has its own suite of benefits and detriments and any one could be more appropriate for a particular project.

In the future, if chlorophacinone has an approved label, diphacinone and chlorophacinone products could be relied on for the bulk of projects, because they offer a very favorable combination of target species efficacy and relative nontarget safety, while brodifacoum was specifically developed to overcome extreme circumstances such as resistance. Second-generation anticoagulants were specifically developed to overcome resistance to earlier anticoagulant compounds. Anticoagulant-resistance is a genetically-mediated phenomenon in which several alleles have been implicated. Use of a first-generation anticoagulant against a population which includes individuals possessing these resistance factors may select for those individuals and their offspring. Typically, this is not an issue in properly conducted eradication operations; however it must be considered in a long-term program as unsuccessful projects could ensue and new introductions of resistant population are not out of the question.

2.5.2 Use of Only One Individual Eradication Technique Instead of an IPM Approach

2.5.2.1 Bait Stations Only

When rats were first found on Mokapu, a field visit was conducted to determine if using bait stations was feasible. Technical climbers used ropes to inspect the steep slopes of the island. However, the steep slopes and crumbly rock characteristic of Mokapu makes the placement and necessary regular servicing of bait stations extremely hazardous to project personnel, who would need to access the areas using ropes and technical climbing equipment. These factors preclude the safe use of bait boxes, which must be be placed into every potential rodent territory and foraging area (placed at most every 50 m (164 feet) apart) and re-filled periodically for several months. In addition, personnel using climbing ropes to perform these activities would disturb or scrape off native plants and nesting seabirds. Lastly, the increased number of visits to the island required to service bait boxes would increase the chances of accidentally introducing new alien species that could harm native organisms.

2.5.2.2 Trapping

Procedures for trapping different species of rodents vary widely, and considerable behavioral information on the species of concern in a particular habitat is often required. Assessment of the selectivity of particular traps is useful, since capture of other animals reduces trap efficiency and may affect nontarget populations. Jackson (1982) outlines procedures for capturing rats and mice with snaptraps or "breakback" traps, cage traps, and glue boards. Trap densities must be adjusted to rodent population levels and the home range size of the species involved; and traps must be placed where animals are active, such as edges or under the shelter of logs or grass tussocks. Traps may be baited to attract animals to the triggering mechanisms or may be set to capture animals in the course of their normal movements by carefully choosing the set locations.

Trapping generally is not practical for managing large rodent populations or removing entire populations over extensive rugged areas. However, traps can be used effectively in limited areas or where substantial resources are available and more efficient techniques cannot be used or developed. Gosling and Baker (1989, as cited by Tobin and Fall 2005 describe successful, sustained efforts over many years by British government biologists using leghold and cage traps to eradicate populations of muskrats and nutria. Typically, with most equipment presently available, kill-trapping is used primarily for monitoring rodent presence, abundance, and density, not as an eradication method, due to inherent disadvantages, such as:

- The method is labor and equipment intensive;
- Individual traps are inoperable once sprung, requiring continuous maintenance and perhaps several traps per placement location to ensure optimum effectiveness;
- Traps are difficult to place and continuously maintain in rugged, remote areas and extreme weather; and
- Traps have the potential to catch nontarget animals, especially passerine birds.

2.5.2.3 Biological Control

The following discussion is paraphrased from Tobin and Fall (2005). The concept of using predators, parasites, or disease organisms to eradicate invasive rodent populations is appealing in many respects. Biological control of invasive rodents is a promising area for research, but many challenges remain before this is able to achieve eradication of invasive rodent populations. There are no examples of the successful introduction of predators or diseases that have been effective in eradicating a rodent population. On the contrary, attempts have not only been ineffective, but have resulted in serious environmental problems themselves.

The relationship between predators and rodents is an interesting, but frequently misunderstood, concept. Natural predation pressure is rarely effective in reducing rodent populations (Howard 1967, Hygnstrom et al. 1994, cited in Tobin and Fall 2005). Many studies have shown that rodents are important in the diet of some predators and have encouraged the establishment of predator populations in areas where population control is desired (Lenton 1980, Hall et al. 1981, Duckett 1982, cited in Tobin and Fall 2005), but few have systematically measured the value of predation for reducing rodent populations. Interest in fostering barn owl populations as a potential way to reduce rodenticide use continues, although the introduction of barn owls to Hawaiʻi for rodent control in the 1960s was ineffective and resulted in adverse impacts to native species.

The introduction of predators for rodent population control has never been demonstrated to be successful and, in some cases, has resulted in apparently unanticipated, disastrous ecological effects. In the late 1800s, the small Indian mongoose (*Herpestes auropunctatus*) was introduced into both the West Indies and Hawaiʻi to control rat populations in sugarcane fields. Although in some areas mongoose diet can include rats (Baldwin et al. 1952, Kami 1964, cited in Tobin and Fall 2005), these introductions failed to reduce rat populations, primarily because mongoose are diurnal and rats are nocturnal. In both the West Indies and Hawaiʻi, mongooses have had devastating negative impacts on ground-nesting bird populations (Ebenhard 1988, cited in Tobin and Fall 2005). Nearly all studies that have investigated predator-prey relationships have concluded that predators exert a controlling influence on their prey populations only under rare circumstances, such as when prey populations are already at very low densities and alternative prey are scarce or absent. More commonly, the presence of high rodent or other prey populations attracts and sustains predators which relocate when those prey animals become more difficult to find and capture. Thus, except under extremely rare conditions, predators do not hunt their prey to the low levels required for effective population management of rodent species and do not result in population eradication.

Where rodent populations present ecological problems, they must be completely removed or at least reduced to very low levels. Under these circumstances, disease organisms or parasites can not sustain their populations or infection rates unless an alternative host population exists (Davis et al. 1976, cited in Tobin and Fall 2005). Davis and Jensen (1952, as cited in Tobin and Fall 2005) released *Salmonella enteriditis* into a population of brown rats and documented very limited spread of the infection and a likely development of resistance among the rodents. The conclusion was that the introduced disease was not effective in reducing the rat population. Another investigation released the nematode parasite *Capillaria hepatica* into wild populations of house mice and concluded that the parasite could not limit low-density mouse populations (Singleton et al. 1995, cited in Tobin and Fall 2005). Many of the diseases and parasites to which rodents are susceptible are readily transmitted to humans and domestic animals, indicating the need to exercise extreme caution when considering such techniques for rodent control. Ensuring that nontarget species are not susceptible to biological control agents is just as important as with the use of toxicants. The only practical delivery system for such agents would be via baiting. The same nontarget organisms that may eat toxic bait could eat bait formulated with other agents. Disease agents could infect organisms that eat bait, organisms that eat primary consumers, and perhaps any other organism exposed in any way to diseased organisms or their waste products, including expired air.

2.5.2.4 Fertility Control

The following is paraphrased from Tobin and Fall (2005). Reproductive inhibition, in theory, would seem to be a useful method of reducing rodent populations. The rapid reproductive potential of most rodent species often enables them to rapidly overcome other population reduction measures. Reproductive inhibition is a non-lethal alternative that has the potential to provide long-lasting control. During the 1960s and 1970s, researchers explored the potential of various chemosterilants such as synthetic steroids, estrogens, and progestins as reproductive inhibitors (McIvor and Schmidt 1996, cited in Tobin and Fall 2005). More recent research has focused on immunocontraception as a means of inducing self-sterilization in pest populations (Miller et al. 1998, cited in Tobin and Fall 2005). However, to date the only successful use of wildlife reproductive inhibitors has been in laboratories, pens, and limited field situations, where animals are either captured, treated, and released, or are injected with darts at close range (obviously impractical for small, nocturnal mammals). The effective control of free-ranging wildlife populations would require oral delivery systems or species-specific, infectious carriers that could deliver reproductive inhibitors to a sufficiently high proportion of animals to affect population control. The technologies for achieving such delivery systems are still being researched and are therefore not currently available for applied use. The ultimate development of reproductive inhibitors for controlling free-ranging wildlife populations will require the resolution of many complex legal, biological, economic, and ethical issues (Guynn 1997), and may be practical only for long-lived animals with lower reproductive capacities (Tobin and Fall 2005). Ensuring that nontarget species are not susceptible to fertility control agents is just as important as with the use of toxicants. The only practical delivery system for such agents would be via baiting. The same nontarget organisms that may eat toxic bait could eat bait formulated with other agents. Fertility control agents could sterilize organisms that eat bait and possibly organisms that eat primary consumers, depending upon the nature and specificity of the reproductive inhibitor.

In summary, sterilants have not been used much in the field and they do not appear to be sufficiently effective. They are only useful to obtain partial population reduction, but they can be included as part of integrated control in combination with poisons. Effort and expenses are similar, so toxicants are generally preferred (Orueta and Ramos 2001).

3.0 ENVIRONMENTAL CONSEQUENCES

This chapter includes the technical background/affected environment information for each issue considered in detail, and documents the impact analysis for each issue immediately following the background discussion. This chapter also includes consistency analyses with the Hawaiʻi Enforceable and Administrative Policies under the Coastal Zone Management (CZMA), Endangered Species Act, National Historic Preservation Act and potential impacts to Essential Fish Habitat under the Magnusen-Stevens Act and state equivalent laws. Since the analyses required for the impacts under the identified laws are functionally equivalent to those required for NEPA, these analyses are incorporated into this chapter and are identified as such to facilitate understanding the impacts and resultant determinations and to avoid unnecessary paperwork, consistent with NEPA (40 CFR 1501.7, 1502.25, 1506.4).

In order to understand the analyses of impacts caused by rodenticides on each issue, the chapter begins with a summary of the scientific literature regarding the rodenticides diphacinone and brodifacoum and compares their characteristics and their relative toxicity to invertebrates, reptiles, fish, birds and mammals. It also summarizes the methodologies used in this EA for evaluating the impacts of proposed actions on the resources of Mokapu. The actual impact analyses follow these summary sections. This approach is intended to help the reader better understand the logic of the impact analyses and how the differing characteristics of the rodenticides apply to those impacts with minimal redundancy in the text.

3.1 Introduction to Rodenticides

Eason and Wickstrom (2001) clarified the fundamental terms used in the scientific field of eradication of invasive species on oceanic islands:

> *Toxic substances of natural biological origin, principally derived from microbes, plants and animals are usually described as toxins (e.g., cholecalciferol or vitamin D_3, cyanide and 1080). Toxicants are considered to be substances that are toxic in relatively small doses and do not originate from microbes, plants and animals (e.g., brodifacoum, phosphorus and pindone). The term 'poison' or 'vertebrate pesticide' can be used to cover both toxins and toxicants. In the context of this manual, compounds such as cholecalciferol and warfarin are considered as vertebrate pesticides, whereas the former is commonly regarded as a vitamin and the latter as a drug commonly used to treat blood clotting disorders in humans. This should not be surprising since "All substances are poison and it is only the dose that makes a distinction between one which is a poison and one which is a remedy." (Paracelsus c. 1500) Vertebrate pesticides (sometimes referred to as rodenticides) are distinguished from insecticides (toxic to insects), herbicides (toxic to plants), and fungicides (toxic to fungi).*

Rodenticides are divided into two categories of compounds:

- Acute rodenticides: The onset of symptoms following ingestion is relatively rapid (a short latent period), and if the dosage eaten is lethal, death also follows relatively quickly. However, rats characteristically test minute amounts of new food items before accepting them as a routine part of their diet. In this way, they are able to avoid toxins found naturally in new foods that they encounter while foraging. If a rat experiences symptoms quickly after ingestion of a rodenticide bait but survives, it will most likely avoid the bait in the future and may train other rats to do the same, substantially decreasing the effectiveness of the toxicant.

- Chronic rodenticides: The onset of symptoms only begins after the rodent eats the rodenticide bait over a period of time, sometime after the lethal dosage has been ingested (referred to as the latent period). Death of the animal is usually significantly delayed after ingestion of the lethal level of rodenticide. If a rat does not experience symptoms after it has ingested a sublethal dose, or until long after ingesting a lethal dose of the rodenticide, it can not associate the symptoms with the new food item, causing the rats to continue eating the bait until or even long after a lethal dose has been ingested.

Both diphacinone and brodifacoum are chronic anticoagulant rodenticides that act by disrupting the normal blood-clotting mechanisms of vertebrates by competing with vitamin-K, a chemical necessary for clotting of blood, for receptor sites in the liver. Death in animals receiving a lethal dose of an anticoagulant rodenticide typically occurs from shock due to excessive blood loss through internal and sometimes external hemorrhaging eventually causing severe anemia. Prior to dying, between the time of ingestion and actual death (latent period), poisoned animals may exhibit increasing weakness and behavioral changes such as acting sluggish, changes in activity time, and reduced predator avoidance ability. This behavior can make target rodents more susceptible to predation (Cox and Smith 1990, Newton et al. 1990, Innes and Barker 1999).

Anticoagulant rodenticides are divided into two chemical groups, the indandiones, such as diphacinone and the coumarins; which includes brodifacoum. More informally, anticoagulant rodenticides are also described either as “first generation” or “second generation” rodenticides, simply referring to the time period during which they were developed. Second generation compounds were specifically designed to overcome resistance to warfarin (an early “first generation” compound) and are therefore generally more toxic than the first generation rodenticides. The coumarins in general, but especially brodifacoum, are characterized by their greatly increased potential for accumulation and persistence in body tissues. This is due primarily to their greater affinity to bind to receptors in the liver, the much higher toxicity of brodifacoum and the long latent period during which rodents continue to feed on the toxicant (Eason and Wickstrom 2001, Fisher et al. 2003).

3.1.1 Comparison of Brodifacoum and Diphacinone Characteristics

Brodifacoum is far more toxic than diphacinone and is retained much longer in the body tissue of exposed animals, especially the liver, than diphacinone. Animals may ingest a lethal dose of brodifacoum more quickly than with diphacinone; however, death is still typically delayed from 4 days to about 2 weeks for both rodenticides. During this extended latent period between ingestion of the lethal dose and death, the animals continue to feed on the brodifacoum bait and build up ever higher levels of toxic residues in their tissues. In contrast, diphacinone, because it is less toxic and more rapidly metabolized and excreted, accumulates in body tissues less readily and in lower concentrations (Erickson and Urban 2004).

Products containing diphacinone were first registered for rodent control in 1960 at active ingredient concentrations of 0.005% to 0.01 % (50 to 100 ppm). Diphacinone (0.005% active ingredient) is currently registered for use for conservation purposes in the United States. Brodifacoum was first registered for rodent control in and around buildings in 1979 and is still not registered for use for conservation purposes in the United States, although it has been used on an experimental basis per FIFRA on Anacapa Island off the coast of California. However, applications for registration of two brodifacoum products were submitted to EPA in 2006 and are under consideration.

3.1.2 Efficacy Studies of Brodifacoum and Diphacinone

The following information is compiled from Erickson and Urban (2004) and the New Zealand Pesticide Toxicology Manual (New Zealand Department of Conservation 2001).

Brodifacoum has been used for most rat eradication projects worldwide because its far greater toxicity is perceived to impart a greater probability of success. However, it is important to remember that toxicity and efficacy are not synonymous terms. Efficacy is a complex interaction of many factors, including bait acceptance, application rate, application method, toxicity, and timing of application when rodent populations, reproduction and alternate foods are lowest to ensure eradication. The eradication of rodents on islands has been successfully implemented using the generally less toxic anticoagulant rodenticides warfarin, pindone, diphacinone and bromadiolone (Witmer et al. 2001, Donlan et al. 2002, Dunlevy and Scharf 2007) and some eradication efforts have failed during operations using brodifacoum (Tyrell et al. 2000, Clout and Russell 2006, Howald et al. 2006).

Recently, however, an increasing number of experts in island rodent eradication and control have recommended using less toxic rodenticides such as diphacinone, and decreasing the use of more persistent and toxic rodenticides such as brodifacoum on future projects because of the greater risk to nontarget species associated with brodifacoum, including both primary hazards (when nontarget species feed directly on the bait) and secondary hazards (when nontarget species feed on rodenticide-exposed animals with high levels of toxic residues in their tissues) (Tobin 1994, Eason et al. 1999, Fisher et al. 2003). New Zealand has a policy of not using brodifacoum on mainland sites, but still primarily uses brodifacoum in offshore island eradication strategies (Hoare and Hare 2006). Fisher et al. (2004), recommend conducting additional field studies using diphacinone to further determine efficacy and validate estimates of lower risk of secondary poisoning of nontarget species.

A number of laboratory and field studies in the United States have evaluated the effectiveness of various application methods and the efficacy of diphacinone for eradication of rats, especially in Hawai‘i:

- Laboratory trials using Sprague-Dawley strain laboratory rats found that 100% of 20 laboratory-bred brown rats died after consuming an average of 42 grams of bait (0.21 g of the a.i. diphacinone), 7 g per day per animal over an average of six days (Svircev 1992).
- Laboratory trials found that 100% of 20 Hawaiian wild-caught Polynesian rats died over two to ten days after consuming an average of 19.7 grams of bait (0.099 g of 0.005% diphacinone) per animal and 95% of 20 wild-caught black rats died over four to 17 days after consuming an average of 21.2 grams of bait (0.106 g of diphacinone) per animal. These trials indicated that a minimum exposure time of 7 days with 37.5 g of bait is needed for effective control of black rats, and 6 days and 30 g are needed for effective control of Polynesian rats (Swift 1998).

- A broadcast application rate study using a nontoxic formulation of Ramik® Green (0.005%) and a biomarker determined the optimal application rate, 22.5 kg/ha or 20 lb/ac, which exposed 100% of Polynesian rats and 94.4% of black rats over a 14-day period (Dunlevy et al. 2000), even though immigration could not be eliminated. Bait disappearance was most rapid at the 22.5 kg/ha application rate with 50% of the bait disappearing by day 6 and 80% disappearing by day 12.
- An exposure study using remote cameras found that 98.98% of vertebrates photographed at broadcast rodenticide pellets were the target species, rats and mice (Dunlevy and Campbell 2002).
- A broadcast trial, also using Ramik® Green bait containing 0.005% (50 ppm) diphacinone, resulted in 100% control of radio-collared Polynesian, black, and brown rats in two 4-ha study areas in Hawaiʻi (Lindsey and Forbes 2000). Follow-up broadcasts in the same study areas were also highly effective in controlling subsequent rat immigration.
- A trial of Ramik® Green broadcast into a 45.5 ha forested area in Hawaiʻi also achieved 100% mortality of 21 radio-collared rats within one week of application. Three weeks after bait application, based on trapping and chew blocks, rat abundance was still reduced by 99% relative to reference areas (Spurr et al. 2003a and Spurr et al. 2003b) despite the immigration issues of this main island study site.
- In the Bay of Islands, Adak, Alaska, a three-year study evaluated Ramik® Green and various application methods on several small islands (Dunlevy and Scharf 2007).

These successful laboratory trials and field studies strongly suggest that well planned rat eradication projects utilizing diphacinone have a very high probability of eradicating rats on islands if used appropriately. The proposed Mokapu rat eradication project would be the first island eradication project using the aerial broadcast application of a rodenticide containing the less toxic active ingredient diphacinone (0.005%, 50 ppm) in Hawaiʻi.

3.2 Potential Impacts to Invertebrates and Fish

3.2.1 Environmental Fate of Brodifacoum and Diphacinone in Soil and Water

Both diphacinone and brodifacoum have extremely low solubility in water and bind tightly to organic matter, so the rodenticide would be released slowly from bait pellets. Both diphacinone and brodifacoum are tightly bound in soil, where the rodenticide is degraded by soil micro-organisms and exposure to oxygen and sunlight. The half-life in soil is 84 to 175 days for brodifacoum and 30 to 60 days for diphacinone, depending on the soil type. Microbial degradation is dependent on climatic factors such as temperature and the presence of microbes enabling degradation. Therefore, length of time for the active ingredient to degrade would tend toward the higher end of the range in colder climates and the lower end of the range in warmer climates (Eason and Wickstrom 2001). Given the non-polarity of brodifacoum molecules and the ionic strength of seawater the solubility of brodifacoum is likely in the low parts per billion range (Primus et al. 2005).

Therefore, potential for contamination of surface water, groundwater, or seawater is extremely low for both brodifacoum and diphacinone. The mechanism for either rodenticide to reach surface water or seawater is either via soil erosion rather than in runoff water (US Environmental

Protection Agency 1998), which is not expected under the proposed action, or bait could land directly into water or could bounce there after hitting rocks, soil or vegetation on steep slopes. Mokapu does not have any surface water or significant groundwater. Experience in New Zealand indicates that bait pellets break up quickly in the dynamic intertidal and nearshore environment (Empson and Miskelley 1999). Additionally, New Zealand scientists estimated that, during a normal helicopter aerial application of brodifacoum pellets using experienced pilots and DGPS as described in Chapter 2, incidental bait discharge into the nearshore marine waters resulted in 0.0000006 mg/l, or about seven orders of magnitude below the level known to be lethal to bluegill sunfish (New Zealand Department of Conservation 1996, cited in New Zealand Department of Conservation 2000). Diphacinone is far less toxic than brodifacoum and will be used on Mokapu Island in such as way as to minimize bait entering the water. Bait will also not be broadcast when winds exceed 35 miles per hour or when significant rain is forecast within 5 days and could potentially wash bait into the water before rats eat it.

Therefore, this issue will not be considered further in this EA.

3.2.2 Comparison of Brodifacoum and Diphacinone Effects on Nontarget Invertebrate and Fish Species, including Essential Fish Habitat

3.2.2.1 Terrestrial Invertebrates

Because anticoagulants were developed to control small mammals, these compounds are far less toxic to invertebrates, which have hemolymph instead of blood. Terrestrial invertebrates are not as well understood regarding the effects these compounds have on them or the role they may play as primary consumers in the secondary exposure of animals that might eat them (Hoare and Hare 2006). However, there is some indication that some mollusks may be susceptible to brodifacoum.

Many terrestrial invertebrates are known to ingest rodenticides during operations (Ogilvie et al. 1997, Spurr and Drew 1999, Pain et al. 2000, Dunlevy et al. 2000, Booth et al. 2003), including an assortment of worms, slugs, snails, insects, and land crabs. Studies show that they do accumulate rodenticide residues when exposed, although residue retention times are variable by species.

The following studies describe rodenticide exposure and accumulation in tissues of invertebrates:

- Johnston et al. (2005) conducted an assessment of diphacinone residues in three species of slugs and snails exposed to Ramik® Green bait (0.005%) in the laboratory and the field. In the laboratory portion of the study, slugs and snails were fed only the bait formulation for seven days to determine maximum potential accumulation, with no mortality of slugs or snails. Residue levels from the laboratory feeding trial ranged from below the method limit of detection (0.01 mg/kg) to 5.01 mg/kg, while mean residues were 0.806 mg/kg, 1.77 mg/kg, and 2.64 mg/kg for the three species, respectively. No slugs or snails died. For the field portion of the study, the same species were collected from a diphacinone aerial broadcast site. The field samples collected ranged from 0.21 mg/kg to 0.79 mg/kg while mean residues were 0.23 mg/kg, 0.62 mg/kg and 0.69 mg/kg for the three species, approximately one-half the residue levels found in the laboratory study. The maximum documented diphacinone residue level of 5.01 mg/kg for slugs is used for secondary impact analyses for animals eating invertebrates.

- Ogilvie et al. (1997) detected brodifacoum in weta (*Gymnoplectron* spp., a large terrestrial New Zealand insect) after aerial broadcast of 20 ppm brodifacoum on Lady Alice Island. The maximum documented brodifacoum residue level of 4.3 ppm for weta is used for secondary impact analyses for insectivores.
- Tanner et al. (2004) exposed coconut land crabs (*Birgus latro*) to 0.005% diphacinone bait and rodent carcasses in a no-choice laboratory trial. No crabs died. Most crabs contained diphacinone residues in tissues, with a maximum of 0.35 ppm in the hepatopancreas from direct exposure and a maximum of 0.09 ppm from indirect exposure.
- Spurr and Drew (1999) found that only a very small fraction of invertebrates present were found to feed on bait in the study forests, making the probability that they would provide a secondary hazard to insectivores that may feed on them very low.
- Pain et al. (2000) examined the effects of brodifacoum on the land crab of Ascension Island. In this study, crabs were fed bait containing 0.002% brodifacoum to simulate maximum exposure. Crabs readily consumed bait but documented mortality was not thought to be related to brodifacoum exposure. Residue concentrations of brodifacoum ranging from 0.076 mg/kg to 0.129 mg/kg were found after exposure, but were not detected one month later.

A laboratory study showing 100% mortality of a species of Seychelles Island land snail that had consumed brodifacoum bait (Gerlach and Florens 2000, cited in Booth et al. 2003) and Booth et al. (2003) reported from their own study that brodifacoum was toxic to earthworms at 500 mg/kg and 1000 mg/kg in the soil. However, this would be highly unlikely to occur in the field as this would require roughly 25 kg to 50 kg of bait per kg of soil to reach these contamination levels of brodifacoum. No studies indicate toxicity of diphacinone to invertebrates, which presumably would be substantially less toxic to terrestrial invertebrates than brodifacoum.

Therefore, no direct adverse impact is foreseen for terrestrial invertebrates from ingesting rodenticides.

3.2.2.2 Marine Invertebrates

In 2001, an accident involving a semi-trailer truck that rolled off the road into the ocean on the east coast of the South Island of New Zealand prior to an eradication project using 0.002% (20 ppm) brodifacoum bait resulted in 20 tons of bait being spilled into the near shore environment at a point source (Primus et al. 2005). Estimates indicated that a maximum of 360 g of brodifacoum (Primus et al. 2005), the active ingredient in the pelletized 20 ppm bait formulation, was spilled into the tidal environment. Samples of marine invertebrates and fish were taken immediately after the spill, then monthly for four months, then at three and six month intervals for the following 21 months (Primus et al. 2005). Tissues from any dead animals observed in the area were also analyzed. Bait spilled into the water began to soften and disintegrate quickly, but the plume of green water from the bait dye lasted approximately 24 hours (Primus et al. 2005). The disintegrated bait 'sediment' layer which settled on the seabed in the area contained 7.6 ppm brodifacoum 36 hours after the spill, compared with 19.3 ppm in a sample of dry bait collected from the road (Primus et al. 2005). Dry weight concentrations from the seabed sample could have been much higher, although this was not sampled. Approximately one week post-spill, the congealed grain bait material on the ocean floor was diluted and dissipated by wave action

(Primus et al 2005). Between 36 hours post-spill and day 9, brodifacoum concentrations in the water column were below the method detection limit of <0.02 ppb (Primus et al. 2005). Most exposure of marine invertebrates occurred within approximately 300 feet of the spill site; minor exposure was detected from 300 to 900 feet from the spill site, and none was detected beyond 900 feet (Primus et al. 2005).

The following residues were found during sampling (Primus et al. 2005):

- Mean brodifacoum concentrations in mussels peaked at 0.41 ppm one day after the spill and were just above detection limits after 29 days. Five mussel samples collected 353 days after the spill still averaged 0.002 ppm, which is over the maximum New Zealand residue limit for human consumption (0.001 ppm). Concentrations in mussels were initially higher than in other invertebrates, but decreased more rapidly over time. Potential explanations for the tissue residue concentrations in soft-bodied mollusks includes a relatively long-half-life of brodifacoum and re-exposure to brodifacoum via filter feeding of low concentrations remaining in the sediment disturbed over time by tidal action.
- Abalone gut and muscle tissue residues were highest on day 29 with 0.07 ppm for gut tissue and 0.03 ppm for muscle tissue. At day 191, residues averaged 0.003 ppm for gut and 0.0015 ppm for muscle. At day 353, abalone gut and muscle tissues were 0.0017 ppm and 0.0014 ppm, respectively.
- Limpet tissue maintained detectable brodifacoum residues for about 80 days. Limpets may also have extended exposure through bait fragments settling in rock crevices and being disturbed over time by tidal action.
- A starfish, 13 crayfish and a crab collected between eight and sixteen days after the spill had residues <0.02 ppm.

Therefore, sampling indicated that brodifacoum residues in shellfish, including edible mussels, took up to 31 months to decline to concentrations below the method limit of detection and therefore to acceptable levels for human consumption. The persistence of brodifacoum was thought to be due to a combination of the high volume of brodifacoum introduced into the shallow marine environmental from a point source, a prolonged half-life of the brodifacoum in the invertebrates, and re-exposure in the highly active tidal marine environment to the high volume of bait.

Calculations for a theoretical main island use of diphacinone in Hawaiʻi found that none of the risk quotients for fish, crustaceans, or other aquatic invertebrates exceed 0.05 (see Section 3.3.1 for the definition of "risk quotient"), so no risk from the use of aerial or hand broadcast of diphacinone is predicted for any aquatic organism, including fish (Eisemann and Swift 2006).

In summary, it is highly unlikely that any marine invertebrate populations would be affected at Mokapu. Diphacinone will be used for all broadcasts unless the eradication fails the first year, and diphacinone has been determined to have no impact on crustaceans or other invertebrates (Eisemann and Swift 2006). Also, these conditions resulting from an accident are highly unlikely during any operation conducted in the Hawaiian Islands. In New Zealand during a rat eradication operation using the aerial application of a 20 ppm brodifacoum rodenticide, researchers estimated the concentration of brodifacoum in nearshore waters to be 0.0000006 mg/l (New Zealand Department of Conservation 1996, cited New Zealand Department of

Conservation 2000) which is about seven orders of magnitude below the level known to be lethal for bluegill sunfish (EPA 1998) and many orders of magnitude lower than that found at the spill site in the New Zealand accident.

Although the effects of rodenticides on native corals have not been evaluated, as the analysis above indicates no adverse impact on marine invertebrates, it is assumed that this extends to corals.

Therefore, while analyzed for the worst case scenario for the more highly toxic rodenticide, this scenario is highly unlikely for either rodenticide, including the substantially less toxic diphacinone. Therefore, no direct adverse impacts are predicted for marine invertebrates with the use of diphacinone or brodifacoum.

3.2.2.3 Marine Fish Communities

The benthos of the undersea cliff closely resembles basalt pavement covered with turf algae. Six species of coral are commonly seen with the most abundant coral species being cauliflower coral (*Pocillopora meandrina*). Algae were limited in abundance and appeared to be well grazed by marine herbivores. No alien algae were observed (Beets et al. 2006).

One marine survey transect at Mokapu was established in 60 feet of water on the sheltered, western shore of the islet (Beets et al. 2006). Twenty fish species were recorded with humuhumu'el'ele (black durgon, *Melichthys niger*), 'opelu kala (sleek unicornfish, *Naso hexacanthus*), hinalea lauwili (saddle wrasse, *Thalassoma duperrey*) and the bandit angelfish (*Desmoholacanthus arcuatus*) representing the most fish biomass. Table 1 in Section 2.3.2.7 lists all the fish species observed at Mokapu.

Field trials were conducted on Lehua Island in 2004, using placebo bait pellets (C. Swenson, USFWS, unpublished data), to determine if nearshore reef fish were attracted to bait and were likely to consume it. Results indicated that although certain species routinely inspected bait pellets in the water, none of the fish species present consumed the bait (Table 2). Bait pellets are also expected to break up quickly in the rough ocean conditions and be unavailable to fish.

Table 2. Attraction of nearshore marine fishes to placebo Ramik Green rat bait pellets (2 - 3 gram size) at Lehua Island, Hawai`i, September 18-19, 2004 (USFWS unpublished data)

Common English Name	Scientific Name	Total Number of Fish	Number of bait interactions observed (some individuals interacted multiple times)			Number of bait interactions per species
			Inspected Bait	Touched Bait	Consumed bait	
Orangespine Unicornfish	*Naso literatus*	13	10	8	0	18
Convict Tang	*Acanthurus triostegus*	8	0	0	0	0
Whitebar Surgeonfish	*Acanthurus leucopareius*	85	19	0	0	19

Orangeband Surgeonfish	*Acanthurus olivaceous*	7	3	5	0	8
Achilles Tang	*Acanthurus achilles*	2	0	0	0	0
Ringtail Surgeonfish	*Acanthurus blochii*	1	0	0	0	0
Eyestripe Surgeonfish	*Acanthurus dussumieri*	1	0	0	0	0
Lagoon Triggerfish	*Rhinecanthus aculeatus*	1	1	0	0	1
Black Durgon	*Melichthys niger*	6	21	13	0	34
Pinktail Durgon	*Melichthys vidua*	5	13	9	0	22
Moorish Idol	*Zanclus cornutus*	1	0	0	0	0
Ornate Butterflyfish	*Chaetodon ornatissimus*	1	0	0	0	0
Longnose Butterflyfish	*Forcipiger longirostris*	1	0	0	0	0
Cornetfish	*Fistularia commersonnii*	1	0	0	0	0
Gray Reef Shark (juv)	*Carcharhinus amblyrynchos*	1	1	0	0	1
Blackspot Sergeant	*Abudefduf sordidus*	1	3	0	0	3
Manybar Goatfish	*Parupeneus multifasciatus*	2	0	0	0	0
Blue Goatfish	*Parupeneus cyclostomus*	3	0	0	0	0
Yellowstripe Goatfish	*Mulloidichthys flavolineatus*	1	0	0	0	0
Hawaiian Hogfish	*Bodianus bilunulatus*	1	1	1	0	2
Parrotfish spp.	Family *Scaridae*	2	0	0	0	0

3.2.2.4 Conclusion on Impacts to Marine Invertebrates and Marine Fish, including Essential Fish Habitat

Bait pellets break up quickly in the dynamic intertidal and nearshore environment (Empson and Miskelley 1999). Additionally, New Zealand scientists estimated that, during a normal helicopter aerial application of brodifacoum pellets using experienced pilots, and DGPS as described in Section 2.4.7, incidental bait discharge into the nearshore marine waters resulted in 0.0000006 mg/l, or about seven orders of magnitude below the level known to be lethal to bluegill sunfish (New Zealand Department of Conservation 1996, cited in New Zealand Department of Conservation 2000). A butterfish sampled 9 days after the major spill in New Zealand had 0.040 ppm in the liver, 0.02 ppm in the gut, and below method limit of detection (<0.02 ppm) in muscle tissue. Residues in four other fish samples collected between day 14 and 16 were all below method limit of detection of 0.02 ppm) (Primus et al. 2005).

Hawaiian reef fish at Lehua Island did not ingest placebo bait pellets (Table 2) of the same size, color and bait type that would be used at Mokapu so it is assumed that fish at Mokapu would not be exposed to either rodenticide. Studies have shown that, even with substantial spills of the more toxic rodenticide, brodifacoum, and assuming incorrectly that fish did ingest pellets, rodenticide would not accumulate in tissues nor would the fish be adversely affected by diphacinone if they were exposed (Eisemann and Swift 2006, Primus et al. 2005). Therefore, no adverse impact is foreseen for marine fish communities for either diphacinone or brodifacoum.

No physical changes would occur to any Essential Fish Habitat (EFH) at Mokapu and no impact would occur to any of the species from direct or indirect ingestion of either diphacinone or brodifacoum.

Therefore, no impacts to marine invertebrates or marine fish from ingesting either diphacinone or brodifacoum are anticipated. The proposed project is not anticipated to adversely affect Essential Fish Habitat; therefore an EFH assessment per the Magnusen-Stevens Act is not required.

3.2.2.5 Impacts to Humans

Harvest or consumption of terrestrial resources, such as plants or seabirds living on the island is illegal and is not known to occur. In addition, access to Mokapu, other than by helicopter, is hazardous if not impossible during the winter months. Field data supports the assumption that Hawai‘i nearshore fish do not ingest the type of bait pellets planned for use and therefore would not have any rodenticide residues in their tissues (Section 3.2.2.3, Table 1). Bait pellets are also not expected to persist for more than 2-3 days in the rough winter ocean conditions, and so would not be available for fish consumption. Exposure levels of marine invertebrates to toxins in the bait would be at such low levels and for such a short time that no tissue accumulation is anticipated and no effects to humans. For these reasons, the risks of public exposure to rodenticides are minimal to non-existent. Nonetheless, public notices will be issued prior to bait application and sampling of water and invertebrate tissues is planned after application, as soon as ocean conditions permit safe collection. Lab test results would be made public. Workers applying rodenticide will follow proper safety procedures and wear protective clothing to minimize their exposure to the rodenticide (Section 2.4.8).

3.3 Introduction to Rodenticide Hazard Analyses

3.3.1 Definitions

The US Environmental Protection Agency (EPA) evaluates the hazards associated with the use of rodenticides. Standard evaluation tests of hazard include a toxicity assessment of rodenticides from a single ingestion (acute toxicity) as well as with repeat ingestion over time (chronic toxicity), mortality of nontarget species, retention time of rodenticide residues in primary consumers (animals that eat the bait directly) and indirect exposure of predators and scavengers that eat exposed primary consumers. Because of these concerns, EPA requires standardized studies for determining the toxicity of and impacts on fish, birds and mammals from rodenticides prior to registration of a particular rodenticide under FIFRA. EPA has two recent documents outlining study methodologies, overall results of studies, and resultant hazards of various rodenticides, including brodifacoum and diphacinone (US Environmental Protection Agency 1998 and Erickson and Urban 2004). The following summary of study approaches and terms is primarily from Erickson and Urban (2004), which summarizes the findings of studies regarding diphacinone and brodifacoum, as well as other rodenticides.

The EPA limits their definition of nontarget hazard to a product of toxicity and exposure. The level of exposure is determined by the amount of active ingredient (a.i.) ingested.

Hazard can be characterized and assessed by many measures, including:

- Acute oral toxicity or LD_{50}– A single dose that is lethal to 50% of the test subjects in the population or study group under consideration, expressed as milligram(s) of active ingredient per kilogram of test subject body weight;
- Dietary toxicity or LC_{50}– The concentration of rodenticide in the diet (multiple feedings) that is lethal to 50% of test subjects in the population or study group under consideration, expressed as parts per million of the daily diet.
- Lowest observable effects level or LOEL– The lowest dosage at which measurable effects, such as increased prothrombin times, are documented. This is not a mortality threshold and no negative impacts are necessarily derived at this hazard level.
- The dietary risk quotient (RQ) was developed by the EPA to compare hazards among different rodenticides. The ratio of the concentration of any rodenticide (ppm of active ingredient) to the dietary toxicity (LC_{50}) of the rodenticide provides a relative index of hazard. This allows for the comparison of the hazards among various rodenticides. The Level of Concern (LOC) is an RQ threshold used by the EPA to determine if unacceptable risk exists for a particular species. The index allows for comparisons among risks for different species. Risk is presumed for non-endangered species if the RQ is $\geq$0.5 and for an endangered species if the RQ >0.1.
- Half life - The length of time that rodenticide residues persist in tissues is calculated in terms of the time that half the original concentration of residue still persists in tissue or blood.
- Total daily food intake for a particular species compared to the animals weight can be used to gauge the possibility that an animal is physically capable of eating the amount of

rodenticide (at any particular concentration of the active ingredient) required to deliver an LD_{50} dosage.

To describe the range of potential hazard to nontarget species from rodenticide application, this analysis discusses the acute oral toxicity of both diphacinone and brodifacoum for the species of concern. From the LD_{50} we can determine the amounts of bait and/or rodenticide residue in tissues of prey that an individual of a nontarget species would be required to eat to obtain this dosage. Using this information we can assess the potential for this level of exposure based on knowledge of the biology of the nontarget species, such as behavior and daily food intake. Another very useful way of evaluating the potential hazards associated with rodenticide use is to describe the lowest dosage level which results in any measurable adverse effects and assess the potential for this level of exposure. Using laboratory and field data accepted by the EPA, quantitative characterizations of rodenticide nontarget hazards can be made and assessed in conjunction with the known biology of the species of concern.

Standardized laboratory studies are used to determine the acute oral and dietary toxicity of vertebrate pesticides for some standard test subjects, such as brown rats, and sometimes for other species. These studies produce a range of values, sometimes with considerable variation. The details and assessments by the US EPA of these studies are discussed in the Reregistration Eligibility Decision (US Environmental Protection Agency 1998) and Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: A Comparative Approach (Erickson and Urban 2004).

The determinations of the EPA in these documents are utilized in the analyses presented here. For untested mammals, a theoretical LD_{50} can be calculated, based on the size of the animal, using the laboratory documented LD_{50}, accepted by the US EPA, for a brown rat for any particular compound. For a brown rat, the LD_{50} of diphacinone is 2.3 mg/kg; for brodifacoum it is 0.4 mg/kg, indicating the substantially greater relative toxicity for brodifacoum. A 100 kg mammal would, therefore, require 230 mg of diphacinone, or 40 mg of brodifacoum to ingest the projected LD_{50} dosage.

EPA calculates hazards for nontarget birds the same way, using a known laboratory-derived LD_{50} from representative birds: the northern bobwhite quail (*Colinus virginianus*) and mallard duck (*Anas platyrhynchos*). Some studies have also documented, in the laboratory, LD_{50} and LC_{50} values for some other species besides the standard species consistently used by EPA in toxicity studies.

Table 2 outlines the acute oral (LD_{50}) and dietary toxicity (LC_{50}) for birds and primary and secondary hazards for birds and mammals as well as known tissue residues for brodifacoum and diphacinone (from Erickson and Urban 2004). Although information is provided for mammals in Table 2, analysis of impacts to nontarget mammals are not included in this EA because no nontarget mammals are present on or near Mokapu, including the endangered monk seal (F. Duvall, DOFAW, pers. comm.).

Table 2. Nontarget Hazards to Birds and Mammals from Brodifacoum and Diphacinone (both at 50 mg a.i./kg bait)[1]

		Brodifacoum	Diphacinone
Acute Oral Toxicity (LD_{50}) to Birds[2]	Mallard	0.26 mg ai/kg	3,158 mg ai/kg
	Northern bobwhite	Not reported	>400, <2,000 mg ai/kg
Acute Dietary Toxicity (LC_{50}) to Birds[2]	Mallard	2.0 ppm	906 ppm
	Northern bobwhite	0.8 ppm	>5,000 ppm
Bird: Primary Hazard[3]	LD_{50} (amount of ai per kg body weight to kill 50% of population)	0.26 mg ai/kg	>400 mg ai/kg
	25-g bird: grams of bait LD_{50} / % of daily food intake	0.13 g / 2.1%	200 g / >100%
	100-g bird: grams of bait LD_{50} / % of daily food intake	0.52 g / 5.4%	800 g / >100%
	1000-g bird: grams of bait LD_{50} / % of daily food intake	5.2 g / 9.6%	8000 g / >100%
Bird: Secondary Hazard[5]	Mean mortality (%)	42%	9%
	Blood retention time (half life)	7.3 days	17.5days
	Liver retention time (half life)	217 days	90 days
Bird: Secondary Hazard[9]	# nontarget incidents reported	252 incidents	6 incidents
Bird: Primary Hazard Risk[10]		High	Low
Bird: Secondary Hazard Risk[10]		High	Moderate
Mammal: Primary Hazard[4]	LD_{50} (amount of ai per kg body weight to kill 50% of population)	0.4 mg ai/kg	2.3 mg ai/kg
	25-g rodent: grams of bait LD_{50} / % of daily food intake	0.2 g / 5.2%	1.2 g / 32%
	100-g rodent: grams of bait LD_{50} / % of daily food intake	0.8 g / 9.6%	4.6 g / 55.4%
	1000-g mammal: grams of bait LD_{50} / % of daily food intake	8.0 g / 11.6%	46.0 g / 67%
Mammal: Secondary Hazard[6]	Mean mortality (%)	42%	58%
	Blood retention time (half life)	7.3 days	0.82 days
	Liver retention time (half life)	217 days	90 days
Avg. Number of LD_{50} Doses Consumed by Rats by Time of Death[7]	Choice test	40	Not reported
	No choice test	80	
Anticoagulant Residue Levels in Primary Consumers exposed to 50 mg ai/kg bait[8]	Range of whole-carcass residues (ppm)	2.07-25.97	0.48-3.4
Mammal: Secondary Hazard[9]	# nontarget incidents reported	157 incidents	29 incidents
Mammal: Primary Hazard Risk[10]		High	High
Mammal: Secondary Hazard Risk[10]		High	High

1 All data and information from Erickson and Urban (2004).
2 Table 3. Acute Oral and Dietary Toxicity of Second-generation Anticoagulants to Birds and Table 4. Acute Oral and Dietary Toxicity of First-generation Anticoagulants to Birds
3 Table 28. Comparative Risk to Birds From a Single Feeding of Rodenticide, Based on the Amount of Bait Needed to Ingest an LD_{50} Dose (i.e., a dose lethal to 50% of the individuals in a population.
4 Table 31. Comparative Risk to Mammals From a Single Feeding of Rodenticide, Based on the Amount of Bait Needed to Ingest an LD_{50} Dose (i.e., a dose lethal to 50% of the individuals in a population.
5 Table 41. Comparative Analysis Model Results for Secondary Risk to Birds.
6 Table 42. Comparative Analysis Model Results for Secondary Risk to Mammals.

[7] Figure 1. Average number of LD_{50} doses consumed by captive wild Brown rats offered 50 ppm brodifacoum bait in no-choice (bait only) or choice (bait and untreated food) feeding tests (after ICI Americas, Inc. 1987b)
[8] Table 13. Second-generation Anticoagulant Residue Levels in Primary Consumers.
and Table 17. First-generation Anticoagulant Residue Levels in Primary Consumers.
[9] Table 43. Comparative Number of Reported Rodenticide Nontarget Incidents (based on confirmed exposure).
[10] Table 49. Primary and Secondary Risk Presumptions for Birds and Nontarget Mammals.

3.3.2 Characteristics of Brodifacoum and Diphacinone

The following summary is also primarily from Erickson and Urban (2004).

Many laboratory studies of the LD_{50} for vertebrate species have been conducted on a variety of test species (both target and nontarget species) using a range of methods (Swift 1998, Fisher 2005). In general, the median oral lethal dosage of diphacinone for rats is about 3.0 mg/kg, while for brodifacoum it is roughly 0.3 mg/kg. Brodifacoum is about ten times more toxic on a weight/weight basis to rats than diphacinone. However, as previously mentioned, there is a similar latent period between the time of ingestion and death between the two toxicants. Many factors influence this delay, but in general the latent period is about seven days and ranges from three to 14 days for both of these rodenticides (Eason and Wickstrom 2001, Erickson and Urban 2004).

A rodenticide that is rapidly metabolized and/or excreted from the primary consumer (the animal directly ingesting the rodenticide) poses fewer hazards to nontarget species than one that is readily retained in tissues and therefore accumulates in the bodies of animals over time. Sublethal exposure to anticoagulants can produce significant blood clotting abnormalities and internal and external hemorrhaging. Such chronic hemorrhaging might be especially detrimental if combined with other factors such as adverse weather, food shortages, pregnancy or predation stressors, and could predispose an animal to death from other sources, such as bruising, food stress, and reduced potential for recovery from wounds and accidents.

Most rodents will continue eating for several days or more after ingesting a lethal dose of an anticoagulant rodenticide. In a laboratory study with wild caught brown rats the average number of LD_{50} doses of brodifacoum (50 ppm bait) ingested was 80 if feeding only on bait, and as many as 40 LD_{50} doses were ingested if offered a choice of bait or untreated food prior to dying (after ICI Americas, Inc. 1978b, cited in Erickson and Urban 2004). Another similar laboratory study found that rats (*Rattus norvegicus* Wistar) in an *ad libitum* choice study ate almost 25 LD_{50} doses of a brodifacoum (20 ppm) bait formulation resulting in liver residues of 10.7 mg/g (Fisher et al. 2004). For comparison, the bait formulation to be submitted to EPA for possible registration for conservation uses is to be 0.0025% (25 ppm) brodifacoum or 2.5 mg a.i./g of bait. Therefore, the livers of these rats contained more than four times the active ingredient concentration of the actual brodifacoum bait formulation.

Using the same procedures, the same study found that rats ate over twelve LD_{50} doses of a diphacinone bait formulation resulting in liver residues of 4.7 mg/g. For comparison, the bait formulation submitted to EPA for possible registration is 0.005% diphacinone or 5 mg/g (Fisher et al. 2004). Therefore, the livers of these rats actually contained slightly less than the active ingredient concentration of the actual bait formulation.

Generally, repeated exposure to smaller doses of anticoagulants over several days poses greater hazard than larger single doses. Anticoagulants bind to receptors in the liver and other tissues, including the kidneys, pancreas, lungs, brain, fat and muscles and are eliminated from the liver last. The length of time a rodenticide is retained in tissues or how quickly it is eliminated (half-life) greatly influences accumulation of rodenticides in tissues and, therefore, nontarget hazards.

Elimination of anticoagulant rodenticides from tissues is biphasic, with a proportion of the toxicant excreted within a shorter time and the remainder bound in the tissues and excreted over a much longer period of time (Parmer et al. 1987, cited in Fisher et al. 2003). The first phase of brodifacoum excretion from tissues takes about 60 days, with the second phase lasting almost 300 days. In contrast, 70% of a single dose of diphacinone may be excreted in about 8 days. In a laboratory test, 0.1 mg/kg of brodifacoum was administered to rats, resulting in mean liver residue concentrations of 1.27 mg/kg at one week, 0.59 mg/kg at 18 weeks and 0.49mg/kg at 24 weeks. The study estimated the liver elimination half-life of brodifacoum to be 113.5 days. In the same test, 0.8 mg/kg of diphacinone was administered to rats, resulting in mean liver residue concentrations of 0.08 mg/kg at one week and below the detectable limit at six weeks. Further trials of diphacinone resulted in the estimated liver elimination half-life 3 days (Fisher et al. 2003). In addition, the range of whole carcass residues reported by the EPA in primary consumers was 2.07 to 25.97 ppm for brodifacoum and 0.48 to 3.4 ppm for diphacinone.

Therefore, brodifacoum presents a substantially higher potential for causing secondary exposure to predators and scavengers than diphacinone.

3.3.3 Comparison of the Effects of Brodifacoum and Diphacinone on Birds

3.3.3.1 Effects from Direct Ingestion of Rodenticides in Bait (Direct Effect)

Standard EPA studies of the acute oral toxicity of diphacinone and brodifacoum have been conducted for two avian species. For diphacinone, the LD_{50} for the mallard duck is 3,158 mg/kg and for the northern bobwhite 400 mg/kg $<LD_{50}<$ 2000 mg/kg. For brodifacoum, the LD_{50} for the mallard is 0.26 mg/kg (no documentation for the bobwhite) (Erickson and Urban 2004; Table 2). The dietary (chronic) toxicity studies for mallard and bobwhite quail documented LC_{50} values of 906 ppm diphacinone for the mallard and >5,000 ppm for the bobwhite quail. For brodifacoum, the LC_{50} reported for the mallard is 2.0 ppm and for the northern bobwhite it is 0.8 ppm, many orders of magnitude higher than the LC_{50} for diphacinone (Erickson and Urban 2004; Table 2).

Primary and secondary hazard calculations for diphacinone acute oral toxicity for nongame birds weighing $\leq$0.22 pounds ($\leq$3.5 ounces) were made for the equivalent of Hawaiian passerine birds. In order to consume sufficient bait to reach the dose equivalent to the LD_{50} for the northern bobwhite, a passerine bird would have to eat 0.53 pounds of bait or 5,027 pounds of invertebrates in one day. To reach the lowest dietary dose over several days to cause mortality, the bird would have to consume 0.36 g of bait or 3.59 g of invertebrates. Neither of these amounts is even physically possible. However, hazard calculations for sublethal exposure show that a 30 g bird would only need to eat 0.07 g (a 100th of a bait pellet, or 0.2% of its body weight) or 0.65 g of invertebrates per day for multiple days to ingest a dose that resulted in measurable blood clotting effects in golden eagles. Therefore, small passerine birds could be vulnerable to sublethal or possibly lethal effects through both primary and secondary exposure if they forage on diphacinone bait or contaminated invertebrates over time (Eisemann and Swift 2006).

Birds that are most at risk from feeding directly on rodenticides are those that are naturally inquisitive, which are terrestrial ground-feeders, and that have a diet that includes grains and seeds. The risk of secondary poisoning is greatest for predatory and scavenging birds, especially those that feed directly on the target rodent species, such as owls. Brodifacoum has a far greater potential for primary and secondary poisoning of nontarget bird species than diphacinone because of its much higher toxicity, longer retention time in tissues, and higher rate of bioaccumulation (Erickson and Urban 2004, Eason and Wickstrom 2001, Fisher et al. 2003, Fisher et al. 2004). Combined with an extremely long half-life of residues in tissues, the general characteristic of anticoagulants for delayed symptoms and mortality after exposure results in target animals ingesting many lethal doses before death (Erickson and Urban 2004).

Erickson and Urban (2004) provide this useful discussion of potential effects of brodifacoum and diphacinone on avian nontarget species found during field operations:

> Eason and Spurr (1995) reviewed the impacts of brodifacoum baiting on nontarget birds during baiting programs in New Zealand, where bait is applied in bait stations (50 ppm cereal-based wax blocks) or aerially broadcast (20 ppm pellets). They report mortality of a wide range of bird species, including 33 indigenous species or subspecies and 8 introduced species or subspecies, and presume most resulted from primary exposure. Populations of indigenous rails (weka, *Gallirallus australus*; pukeko, *Porphyrio porphyrio*) monitored during rodenticide baiting operations were severely reduced: "For example, the entire population of western weka on Tawhitinui island were exterminated by consumption of Talon® 50WB intended for ship rats [a brodifacoum formulation], which they obtained by reaching into bait stations, eating bait dropped by rats, and eating dead or dying rats (Taylor 1984)."
>
> On another island, 80% to 90% of the Stewart Island weka population was killed by brodifacoum bait applied for brown rats. Aerial application of 0.002% brodifacoum bait on two other islands reduced a weka population by about 98% and a pukeko population by >90%. Numbers of quail, blackbirds, sparrows and myna were markedly reduced on another island. Some other species suffered no apparent adverse effects. Dowding et al. (1999) and Veitch (2002) found numerous dead birds after an aerial baiting operation to eradicate rats and mice and reduce rabbit numbers on Motuihe Island, New Zealand. Brodifacoum bait (20ppm) was applied twice, with 9 days between applications. Nontarget species were monitored, including pukeka (3 groups of 98 birds), a flock of 52 paradise shelducks (*Tadorna variegata*), 8 New Zealand dotterels (*Charadrius obscurus*), and 14 variable oystercatchers (*Haematopus unicolor*). There was no evidence that dotterels or oystercatchers were adversely affected, but mortality of pukeko and shelducks was 49% and 60%, respectively. Birds of 10 species were found dead. The liver from each of 29 dead birds of 10 species was analyzed. All livers contained brodifacoum residue, with mean levels per species ranging from 0.56 to 1.43 ppm. Chaffinch (*Fringilla coelebs*), North Island robin (*Petroica australis longipes*), North Island weka, and North Island saddleback (*Philesturnus carunculatus rufusater*) also were found dead after a brodifacoum baiting on Mokoia Island, New Zealand (Stephenson et al.1999).
>
> Hegdal (1985) conducted a field study in Washington to examine the risk to game birds from the broadcast application of 0.005% diphacinone bait applied for vole control in orchards. Most orchards were treated twice, with 20 to 30 days between treatments; at an average rate of 12.9 kg/ha (11.5 lb/acre). Telemetry was used to monitor the fate of 52 ring-necked pheasants, 18 California quail, and 30 chukar potentially exposed to the bait. About half of the quail and all chukar

> were pen-raised and had been released into the orchards. Dead game birds and other animals found were necropsied and any available tissue collected for residue analysis. Eight of 30 pheasants, 9 of 15 quail and one of ten chukar collected by the researchers or shot by hunters contained diphacinone residue in the liver. Bait made up as much as 90% of crop contents of some birds. No residue was detected in four passerines collected 31 to 73 days after treatment. The author concluded that risk to game birds in orchards appeared to be low but emphasized that substantial quantities of bait were eaten and longer-term behavioral and physiological effects, such as susceptibility to predation, need to be considered along with direct mortality in order to evaluate potential hazards from exposure.

Several laboratory studies document data assessing the hazards of rodenticides ingested by birds. Chickens (*Gallus gallus*) were fed a rodenticide containing 50 ppm brodifacoum by Lund (1981). This study was a choice test and included offering of the toxic bait as well as untreated chicken food for up to 15 days. The four chickens offered brodifacoum bait died within 6 to 12 days. A similar study with chickens by Christopher et al. (1984) offered brodifacoum bait every other day for one to four feedings and documented 50% mortality. Ten northern bobwhites and 10 ring-necked pheasants were exposed to a 50 ppm brodifacoum rodenticide for 14 days in an *ad libitum* feeding choice including the toxic pellets and untreated food by Ross et al. (1979a) and Ross et al. (1979(b)). Six each of the bobwhites and pheasants died. In addition, several pheasants died when exposed to 50 ppm brodifacoum pellets in a broadcast pen trial conducted by ICI Americas, Inc (1981). Diphacinone was not tested in any of these studies.

During field studies using diphacinone, searches for nontarget carcasses after baiting found one dove and two roadrunners (*Geococcyx californicus*), however there was no evidence that these birds were exposed to the rodenticide (Baroch, 1994; Baroch, 1996). No avian nontarget mortality was observed during rodent eradication operations using diphacinone rodenticides conducted on Buck Island in the Virgin Islands (Witmer et al. 2001) or Canna Island in Scotland (Elizabeth Bell, pers. comm., February 2006). Throughout two years of studies using a diphacinone rodenticide in the Aleutian Islands only one bird carcass was documented, though two ravens shot during this work also contained diphacinone residues and winter wrens, song sparrows and ptarmigan were also documented to eat the bait (Dunlevy and Scharf 2007). Two studies evaluated diphacinone residues in game birds captured from sites in Hawai‘i that had been treated by hand or aerial broadcasting 0.005% diphacinone bait. The first study utilized hand broadcast techniques on a 10-acre treatment area (Spurr et al. 2003a). Five Kalij pheasants (*Lophura leucomelana*) were collected within the treatment area between 2 and 6 weeks after treatment. Of the five, only one contained detectable diphacinone residues. The liver of this bird contained 0.09 ppm diphacinone. The second study was an aerial broadcast trial in support of the proposed aerial broadcast registration of Ramik Green (Spurr et al. 2003b). Two Kalij pheasants were collected within the 112 acre treatment area one month after treatment. Diphacinone residues of 0.12 and 0.18 ppm were found in the livers of these birds. Though extensive carcass searches were conducted during both studies no avian mortality due to diphacinone was found.

3.3.3.2 Effects from Indirect Ingestion by Eating Prey

Incident reports submitted to EPA indicate that nontarget birds and mammals are being secondarily exposed to rodenticides, especially brodifacoum, in the field. Brodifacoum is widely used for control of rodents in orchards and around buildings and human habitation, is highly toxic to birds and mammals, and is persistent in tissues. In 264 reported incidents, 20 animals had diphacinone residues and 244 animals had brodifacoum residues. The birds most commonly exposed to brodifacoum include great horned owls and red-tailed hawks, but multiple incidents are reported for bald and golden eagles, crows, barn owls, screech owls, hawks, falcons, kestrels and vultures.

Erickson and Urban (2004) found eleven laboratory studies which have investigated brodifacoum secondary hazards in eight nontarget avian species. A total of 149 individuals were exposed to brodifacoum-poisoned prey and 63 (42%) birds died, including: 11 of 20 barn owls, 6 of 6 red-tailed hawks (*Buteo jamaicensis*) and red-shouldered hawks (*Buteo lineatus*), 13 of 65 American kestrels (*Falco sparverius*), one of four Eurasian harriers (*Circus pygargus*), and 32 of 50 laughing gulls (*Larus atricilla*). However, no deaths occurred in four golden eagles tested (*Aquila chrysactos*), although three showed external symptoms of anticoagulant toxicosis such as bleeding. Some studies did not report whether sign of toxicosis was observed in surviving birds. Of studies that examined survivors, about one-third exhibited symptoms of toxicosis. Stone et al. (1999) also found brodifacoum residues in wildlife carcasses submitted for testing in New York State.

Three laboratory studies report the secondary toxicity of diphacinone to birds. Test species were barn owls, great horned owls (*Bubo virginianus*), saw-whet owls (*Aegolius acadicus*), golden eagles (*Aquila chrysaetos*), and American crows (*Corvus brachyrhynchos*). A total of 34 individuals were exposed to diphacinone-poisoned prey during these studies and three (9%) birds died, including two of three great horned owls and the only saw-whet owl tested. Symptoms of anticoagulant poisoning were noted in 13 (42%) of the survivors, indicating that raptors can recover from sublethal doses. The highest dosage administered to an eagle was 0.23 mg/kg/day for 10 consecutive days and the LOEL was determined to be 0.11 mg/kg/day. If it is assumed that the great horned owls ate equal quantities of treated mice each day, they would have consumed a maximum dose of 0.78 mg/kg/day for 5 days. Using the same methods, it can be calculated that the saw-whet owl consumed a dose of 11.1 mg/kg/day (Erickson and Urban 2004).

Calculations for the Hawaiian owl (*Asio flammeus*) were conducted for diphacinone for secondary effects from eating contaminated rats, as it is extremely low probability that an owl would feed directly on bait pellets. A 0.77 pound bird would have to consume at least 100.5 pounds of rodents containing 3.07 ppm diphacinone (the highest residue found in pig's liver) in one day to ingest a dose equivalent to the LD_{50} for the northern bobwhite. For a dose equivalent to the lowest dietary dose over several days, the owl would need to consume 20% of its weight in contaminated rats. Hazard calculations for sublethal exposure show that an owl would only need to eat 0.03 pounds of rodent tissue containing 3.07 ppm diphacinone per day (3.6% of its body weight) for multiple days to ingest a dose that caused increased blood clotting times in golden eagles. This amount is less than one rodent per day (Eisemann and Swift 2006). The assessments in Eisemann and Swift (2006) are based on very conservative assumptions and are assumed to overestimate the actual hazard of aerial broadcast of diphacinone.

3.3.3.3 Conclusion

EPA (1998) states that brodifacoum is "very highly toxic" to both bobwhite quail and mallard duck for both acute and dietary exposure. Diphacinone is "moderately toxic" in acute tests of bobwhite quail, “practically nontoxic” to quail in dietary tests, and “moderately toxic” to mallard in dietary tests. Brodifacoum toxicity in birds is two orders of magnitude more toxic than required for the category “very highly toxic.” The EPA declares a potential primary hazard to nontarget birds when their dietary risk quotient equals or exceeds 0.5 for non-endangered species and 0.1 for endangered species. Brodifacoum exceeds this level of concern for non-endangered species by 126-fold using the northern bobwhite LC_{50} and 50-fold using the mallard LC_{50}. For endangered species, the level of concern is exceeded by 630 times and 250 times, respectively. Diphacinone does not exceed these levels of concern for either endangered or non-endangered species using the mallard LC_{50}. Using the northern bobwhite $LC_{50,}$ diphacinone is considered “practically nontoxic” to birds by the EPA. The LOEL of brodifacoum for birds has not been determined; where efforts to establish this have been made, all dosages administered produced measurable effects; therefore a dosage where no observable effects (NOEL) have been measured has not been documented. A dosage of no observable effects is necessary to establish the lowest observable effects level.

Although individuals of avian nontarget species often die during eradication operations, especially associated with the use of brodifacoum, if the nontarget population is not extirpated and is healthy and viable it usually recovers. However, if the population is an endangered species or a small isolated island population, it may be driven too low to recover or experience negative population-level genetic effects. In most cases the long-term ecosystem benefits probably outweigh the initial nontarget mortality caused by rodenticides during eradication operations (Taylor and Thomas 1993, Eason and Spurr 1995, Dowding et al. 1999). Stephenson et al. (1999) found that passerine populations can recover naturally from a 30% decrease in populations within one to two breeding seasons following a rodenticide operation because passerine species typically have several clutches per year and successfully fledge several young per clutch. Populations of owls, because they live longer and typically fledge less than one chick per year, may recover more slowly, taking two to three seasons (also Murphy et al. 1998). The relative resilience of a species to recover after large population declines depends on the species capacity to compensate for density independent perturbations in abundance, such as the broad-scale application of rodenticides. Species with a high intrinsic rate of increase and strong-density dependent links between their demographics and factors that regulate their abundance will typically be more resilient than species without these population dynamics. Species for which there is clear evidence of a high intrinsic capacity for increase and strong density-dependence in their dynamics should be able to sustain higher levels of reduction from poisoning without any undue threat to their long-term viability (Choquenot and Ruscoe 1999).

Erickson and Urban (2004) conclude that potential primary risks are higher for second generation rodenticides, including brodifacoum, than for first generation rodenticides, including diphacinone. A small bird finding and eating just a small pellet or two is likely to ingest a lethal dose, and a few small pellets could provide a lethal dose to larger birds. In contrast, it seems highly unlikely that any small bird could eat 100 to 1000 pellets in a single feeding which would be needed to provide an LD_{50} dose from a first-generation anticoagulant. Eason et al. (1999) and Eason and Wickstrom (2001) state: “the recorded mortality of birds after some control operations, coupled with the detection of brodifacoum residues in a range of wildlife including native birds and feral game animals raises serious concerns about the long-term effects of the targeted field use of brodifacoum…where wildlife might encounter poisoned carcasses.” New Zealand is recommending reducing the field use of brodifacoum because of the high risk of poisoning nontarget species, especially secondary poisoning (Eason and Wickstrom 2001, Eason and Murphy 2001, Hoare and Hare 2006).

Based on laboratory and field studies and monitoring regarding adverse impacts to desired nontarget birds, diphacinone will be used for Mokapu in the winter of 2007 through 2008, and brodifacoum, if registered with a label, will be used only if failure of eradication is shown to be due solely to the rodenticides and not operational or other factors.

3.4 Methodology for Calculation of Potential Impacts

3.4.1 Direct and Indirect Impacts

The analyses of the direct and indirect impacts of brodifacoum and diphacinone on nontarget birds are based on the known laboratory LD_{50} and LC_{50} information documented by the US Environmental Protection Agency (US Environmental Protection Agency 1998, Erickson and Urban 2004). This EA uses sampling data from the 20-ton spill of brodifacoum in New Zealand documented by Primus et al. (2005), which presents the "worst case" most conservative analysis for rodenticide impacts. These data are the most conservative because:

- Brodifacoum is substantially more toxic, persistent and bioacummulative than is diphacinone;
- The likelihood of that volume of any rodenticide being spilled into the environment at a point source is extremely remote. The only circumstance under which such a spill could happen in the Hawaiian Islands would be if a vessel carrying large quantities of bait to an island to be treated would sink in shallow nearshore waters;
- The fraction of applied bait that might incidentally be spread over open water would be extremely small due to DGPS-aided bait application techniques.

Broadcast applications of diphacinone bait by helicopter at the maximum rate of 22.5 kg/ha (20 lb/ac) (see Section 2.4.5.1 for label requirements), result in approximately one 2.25-gram pellet distributed about every square meter. The maximum proposed application rate of brodifacoum bait is 19.3 kg/ha (17 lbs/ac), resulting in a density of approximately one 2-gram pellet per square meter.

The analyses of the primary hazards of brodifacoum and diphacinone use a computed LD_{50}-equivalent dose. This is based on laboratory studies in species such as the rat, a surrogate for other mammals, and bobwhite or mallard for other avian species. The average weight of an adult female animal of concern and the established LD_{50} of the surrogate species studied are used to calculate the amount of each rodenticide that would need to be ingested to reach the LD_{50}-equivalent dosage. This amount of rodenticide bait is compared to the area over which that amount would be distributed during an aerial application and the likelihood of an animal eating every bait pellet within that area. If it is highly unlikely that the animal would directly eat bait pellets based on its dietary habits, the calculated results are evaluated in that context.

The analyses of the secondary impacts of brodifacoum and diphacinone assume that the adult female animal of average weight feeds exclusively in an area massively contaminated to the extent documented at the spill site in New Zealand and exclusively on the most contaminated samples collected during the monitoring of the incident: mussels and fish liver. One day after the accident, mussels contained brodifacoum residues of 0.41 ppm and a butterfish sampled nine days after the spill had brodifacoum liver residues of 0.04 ppm. This is then used to calculate the amounts of these prey items secondary nontarget species would need to eat in order to ingest the computed LD_{50} for the species of concern. This is then compared to either the animal's average daily food intake or body weight to determine if eating such a quantity is probable or even possible.

For the most conservative assessment of secondary hazard, it is assumed that nontarget species of concern would be exposed to prey items that have themselves been exposed to rodenticides and contain residues and that these residues are similar to the maximum residue levels of either potential prey items documented in Primus et al. (2005) during a massive point-source spill of rodenticide, laboratory exposure to a toxicant only, and/or collected from the site of an actual rodenticide operation.

The evaluation and comparison of LD_{50} values and risk quotients provides a good description of the upper end of the hazard spectrum associated with rodenticide use. However, because anticoagulants are far more toxic when administered on multiple days with smaller exposures, to fully characterize the range of possible hazard the lower end of the hazard potential needs to be assessed. To do this we will examine the Lowest Observable Effect Level (LOEL) for all nontarget species that we know are at the highest risk of exposure. Assessing the LOEL will illustrate the minimum amount of exposure necessary to produce a measurable effect, such as increased prothrombin time. This is not a mortality threshold and no negative impacts are necessarily derived at this hazard level.

In a laboratory study using golden eagles fed diphacinone-laced sheep muscle (2.7 ppm) Savarie et al. (1979) established the LOEL for golden eagles at 0.11 mg/kg/day in a 7-day exposure study. The EPA reports the LOEL of diphacinone for rats in a 14-day subchronic lab study as 0.085 mg/kg/day (EPA 1998).

The LOEL of brodifacoum is not as well studied as those for diphacinone. No LOEL of brodifacoum for birds has been established because the lowest dose administered has caused observable effects. The EPA reports the LOEL of brodifacoum for rabbits in a developmental lab study as 0.005 mg/kg/day (EPA 1998). Using these available figures to extrapolate the LOELs for each of the species of concern the lower limit of potential hazard can be assessed.

On Mokapu, the native nontarget species are birds, mostly seabird species. Nonnative passerine birds are also found on the islets, as well as nonnative barn owls on Mokapu. Neither terrestrial nor marine mammals, including the endangered monk seal, are present in or near the island and monk seals forage far out to sea. Three species of nonnative small lizard are present on Mokapu.

3.5 Adverse Impacts to Birds

Both brodifacoum and diphacinone are toxic to birds; however brodifacoum is significantly more so than diphacinone. Most bird species found on Mokapu are present in significant numbers only seasonally and are absent or greatly reduced in the winter. However, some species are year-round residents. For the proposed projects, the primary concerns are the potential nontarget impacts of brodifacoum and, to a much lesser degree, diphacinone, on resident and wintering birds. All species discussed below except the nonnative Japanese white-eye and the nutmeg mannikin are protected under the Migratory Bird Treaty Act.

Mokapu supports the following species of birds (K. Wood and M. LeGrande 2003, unpubl. data; F. Duvall, DOFAW pers. comm., based on survey conducted March 2000):

- Wedge-tailed shearwater (native seabird) nest on the island
- White-tailed tropicbird (native seabird) nest on the island
- Red-tailed tropicbird (native seabird) nest on the island
- Bulwer's petrel (native seabird) possibly nest on the island
- Black (Hawaiian) noddies (native seabird) possibly nest on the island
- Brown boobies (native seabird) present near the island
- Great frigatebird (native seabird) roost on the island
- Barn owl (owl native to North America but not to Hawai'i)
- Japanese white-eye (non-native passerine not protected under the MBTA)
- Northern cardinal (passerine native to North America but not to Hawai'i)
- House finch (passerine native to North America but not to Hawai'i)
- Nutmeg mannikin (non-native passerine not protected under the MBTA)

The comparison of the toxicity of the two rodenticides to birds is described in Section 3.3.3 and the analysis of the impacts to birds in general is found in Section 3.4. This information and analysis is used for the following impact analyses for the specific species identified above that are protected under MBTA.

3.6 Impacts to Native Seabirds Present in the Winter

3.6.1 Biology and Status

Several species of seabirds come to Mokapu during the spring, summer, and fall. Species present include wedge-tailed shearwater, brown booby, black noddy, Bulwer's petrel, white-tailed tropicbird, red-tailed tropicbird, and great frigatebird. However, none of the seabird species are present in significant numbers on Mokapu during the winter operational period. Species that may be present in small numbers during the winter include black noddy, white-tailed and red-tailed tropicbirds, and frigatebirds.

All Mokapu seabird species forage on fish and squid in the open ocean or offshore areas, not along shorelines. All but the black noddy and red-tailed and white-tailed tropicbird breed in the summer season, with the earliest breeders beginning in February or March, but most breed later in the spring. The black noddy, and tropicbirds may breed year-round, but the peak is in the spring through fall (Table 3).

Table 3. Biological Characteristics of Seabirds Present on Mokapu Island

Species[1] (primary/ secondary)	Mass (g)	Energy Dyna-mics	Winter Distribution	Diet	Biological Information	Seasonal Distribution in Mokapu Areas	Citations[2]
Wedge-tailed shearwater ʻuaʻu kani	340	65 g/day	Migrates to the eastern Pacific outside of breeding season	In Hawaiʻi, fish, squid, caught from surface or plunging into water	Age at first breeding 4 years; 1 egg/season; natal site fidelity; excavate burrows or nest in rock crevices; both parents incubate, brood, and feed	Breeding synchronous, with most eggs laid in June, and young fledging in November	Mitchell et al. 2005
Bulwer's petrel ʻou	100	24 g/day	Migrates outside of breeding season, possibly to southeast	Forages on fish from surface of ocean or by dipping on the wing	Age at first breeding is 6 years; 1 egg/season; natal site fidelity; nest in variety of hollows or crevices; both parents incubate, brood, and feed	Eggs laid in mid-May to June, fledging in early October	Mitchell et al. 2005
Brown booby ʻā	1340	141 g/day	Little known about movements outside of breeding season	Forages on fish by diving into the water	Age at first breeding 4 to 5 years; 2 eggs/season; nests on ground; both parents incubate, brood, and feed	Breeding from March through May, with fledging by September	Mitchell et al. 2005
Black noddy noio	108	29 g/day	Typically remain within 50 miles of breeding area year-round	Forages on fish by dipping near surface or shallow dives	Age at first breeding 2 to 3 years; site fidelity; 1 egg/season; nests on cliffs or in trees; both parents incubate, brood, and feed	Breeding variable, and egg-laying occurs year-round	Mitchell et al. 2005, Pratt et al. 1987
White-tailed tropicbird koaʻe	455	60 g/day	Outside the breeding season, adults are solitary and pelagic	Forages on fish by diving into the water	Age at first breeding probably after fourth year; 1 egg/season; nests on steep cliffs, caves, and tree hollows; both parents incubate, brood, and feed	Breeding can occur throughout the year, but most breeding from March through October	Mitchell et al. 2005
Red-tailed tropicbird koaʻe ʻula	660	87 g/day	Outside the breeding season, adults are solitary and pelagic	Forages on fish by diving into the water	Age at first breeding between 2 and 4 years; 1 egg/season; nests on ground; both parents incubate, brood, and feed	Breeding can occur throughout the year, but most nests active between February and June	Mitchell et al. 2005

Species[1] (primary/ secondary)	**Mass (g)**	**Energy Dyna-mics**	**Winter Distribution**	**Diet**	**Biological Information**	**Seasonal Distribution in Mokapu Areas**	**Citations**[2]
Great frigatebird ‘iwa	1350	147 g/day	Outside breeding season, breeding adults remain relatively close to breeding area; young and nonbreeders disperse	Forages for fish and squid by dipping into the water	First breeding at 8 to 10 years; 1 egg/season; platform nests in low bushes; both parents incubate, brood, and feed; females often only breed every 2 to 4 years	Does not breed in the main Hawaiian Islands but can be present and possibly roosting throughout the year	Mitchell et al. 2005

3.6.2 Potential Impact Associated with the Proposed Action

3.6.2.1 Potential Impact from Direct Ingestion of Rodenticide (Primary Nontarget Hazard)

As all the seabird species forage for fish offshore (Table 3), and only the black noddy and great frigatebird might be in the area during the winter operational period (within 50 miles for the black noddy), it is highly unlikely that any of the seabirds could incidentally pick up bait pellets of either diphacinone or brodifacoum for a winter operation. Few pellets would actually fall into the nearshore waters, and any pellets falling into the water would disintegrate rapidly (Section 3.2.1).

Even if a bird were to pick up bait pellets, a Bulwer's petrel, the smallest of the seabirds (which would likely not be present) would have to consume 792 grams (1.7 pounds) of 50 ppm diphacinone bait (based upon the lower reported acute oral LD_{50} of >400 mg/kg body weight for bobwhites) to obtain an LD_{50}-equivalent dosage. It would be impossible for a Bulwer's petrel to consume that much bait in one or even several days. The largest bird, the great frigatebird, which has the highest probability of being present during a winter operation, would have to consume 10,800 g (almost 24 pounds) of 50 ppm diphacinone bait. It is highly unlikely that a great frigatebird could physically consume 24 pounds of bait pellets to cause adverse impacts. However, the projected LOEL (extrapolated from the lowest reported LOEL for diphacinone in birds, 0.11 mg/kg/day, Saverie et al 1977) of diphacinone for Bulwer's petrel is 0.01 mg/day or about 0.22 g of bait per day. For the great frigatebird, the LOEL is 0.15 mg/day or about three grams of bait per day (Table 4). As long as bait is present in a treated area, such a level of exposure would be physically possible, although it is highly improbable that any of the seabirds would forage on bait pellets along the coastline rather than fish in the open ocean.

Based on the acute oral LD_{50} figure reported for mallards (0.26 mg/kg body weight, Table 2), a 100 g (3.5 oz.) Bulwer's petrel, the smallest species of seabird likely to be present during the operational window, would only have to consume one gram of 25 ppm brodifacoum bait, or half of one 2-g pellet, to obtain an LD_{50}–equivalent dosage. The average adult great frigatebird weighs approximately 1,350 g (3 lbs) and would need to ingest 14 g, or about seven small-size (2 g) pellets of a brodifacoum product to obtain the LD_{50}–equivalent dosage of 0.35 mg (Table 4). As stated in Section 3.3.3, LOEL values are not available for brodifacoum.

The toxicity data for wedge-tailed shearwater, brown booby, black noddy, white-tailed tropicbird, and red-tailed tropicbird would fall between these two species for diphacinone and brodifacoum, but proportionally similar based upon body weight (Table 4).

In conclusion, the potential for any adverse impacts to seabirds from consuming either diphacinone or brodifacoum is improbable since most of the species are not present in the winter operational period, and if present, would feed on fish in the open ocean rather than bait in the nearshore area that would disintegrate quickly from the nearshore ocean dynamics.

3.6.2.2 Potential Impacts from Indirect Ingestion of Rodenticide (Secondary Nontarget Hazard)

Another potential route of exposure to rodenticides for seabirds is associated with consuming prey items that have themselves ingested rodenticide, mostly nearshore marine invertebrates (secondary hazard). However, all species of seabirds on Mokapu consume fish or squid offshore during the winter so this scenario is clearly not possible, but it does serve as an example of how difficult it would be for seabirds to obtain a toxic does of rodenticide. Although this scenario is highly improbable, this approach to the analysis of secondary effects is used to describe an absolute worst case scenario. The most conservative (worst case) analysis of this situation will be examined here using data from the massive brodifacoum spill in New Zealand (20 tons (16,329 kg); Primus et al. 2005; Section 3.2.2.2).

This analysis assumes seabirds of average weight (80 to 1,700 g; 0.2 to 3.7 lbs) feed exclusively in an area massively contaminated to the extent documented at the spill site in New Zealand and exclusively on the most contaminated samples collected during the monitoring of that incident (mussels). In reality, New Zealand scientists estimated that, during a normal aerial application of brodifacoum pellets using experienced pilots and DGPS, as described in Section 3.2.1, incidental bait dropped into the nearshore marine waters resulted in 0.0000006 mg/l, or about seven orders of magnitude below the level known to be lethal to bluegill sunfish (New Zealand Department of Conservation 1996, as cited in: New Zealand Department of Conservation 2000).

Although this large-scale accident involved a brodifacoum product, for any of the following diphacinone analysis, we assume similar contamination levels with diphacinone residues despite data that indicate accumulation and persistence of diphacinone in animal tissues to be exponentially less than that of brodifacoum (Section 3.2.2).

One day after the New Zealand spill of 20 tons (16,329 kg) of brodifacoum bait directly into the nearshore marine waters, mussels contained brodifacoum residues of 0.41 ppm. Based on the acute oral LD_{50} value of brodifacoum for the mallard of 0.26 mg/kg body weight, a 100 g (3.5 oz.) Bulwer's petrel would have to consume 0.03 mg of brodifacoum to receive an LD_{50}–equivalent dosage. To obtain that amount, the Bulwer's petrel would have to ingest 62.8 g (2.2 oz) of mussels contaminated at the 0.41 ppm level found in mussels collected one day after the New Zealand spill. That amount of intake would be about 63% of the bird's body weight and approximately three times its average daily food intake (Table 4).

For a diphacinone product, the likelihood that a Bulwer's petrel could consume enough contaminated mussels to approach an LD_{50}–equivalent dosage is substantially lower than with brodifacoum. Based on the lower of the two acute oral LD_{50} values shown in Table 2 for bobwhites (>400 mg/kg body weight), a 100 g (3.5 oz.) Bulwer's petrel would have to ingest 40 mg of diphacinone to receive an LD_{50}-equivalent dosage. To attain this dosage, the Bulwer's petrel would have to consume 96.6 kg (213 lbs) of mussels contaminated with diphacinone at 0.41 ppm. That amount of consumption is nearly 1,000 times the animal's body weight, again clearly impossible (Table 4).

Based on the mallard acute oral LD_{50} value of 0.26 mg/kg body weight, a great frigatebird would have to consume 0.35 mg of brodifacoum to receive an LD_{50}–equivalent dosage. This means a 1,350 g (3 lbs) great frigatebird would need to eat 856 g (1.9 lbs) of the mussels found in the contaminated spill site one day after the accident for brodifacoum (Table 4). That amount of intake would be about 60% of the bird's body weight. For a diphacinone product, the likelihood that a great frigatebird would consume enough contaminated mussels to approach an LD_{50}–equivalent dosage is substantially lower than with brodifacoum. Based on the lower of the two acute oral LD_{50} values shown in Table 2 for bobwhites (>400 mg/kg body weight), a 1,350-g great frigatebird would have to ingest 540 mg of diphacinone to receive an LD_{50}-equivalent dosage. To attain this dosage, the great frigatebird would have to consume 1,317 kg (2,900 lbs) of mussels contaminated with diphacinone at 0.41 ppm, obviously impossible.

The amounts of consumption needed to reach toxic levels for wedge-tailed shearwater, brown booby, black noddy, white-tailed tropicbird, and red-tailed tropicbird would be between the dosages for Bulwer's petrel and great frigatebird, but would be proportionally similar based upon body weight.

In conclusion, even under the extreme circumstances of a similar accident involving a large-scale bait spill and assuming that the seabirds are present in the winter and eat nearshore invertebrates (an unknown behavior for the seabird species on Mokapu) rather than fish and squid in the open ocean, the risk of mortality is essentially zero for either a diphacinone or brodifacoum formulation.

Table 4. Acute Toxicity of Diphacinone and Brodifacoum to Seabirds Wintering in the Mokapu Area.[1]

	Primary				Secondary			
	Diphacinone		Brodifacoum		Diphacinone		Brodifacoum	
	mg a.i.	g Bait (50 ppm)	Mg a.i.	g Bait (25 ppm)	g Mussels	g Fish Liver	g Mussels	g Fish Liver
Wedge-tailed shearwater	136	2,720	0.09	3.6	331,707	3,400,000	215.6	2,210
Bulwer's petrel	40	792	0.03	1.0	96,585	990,000	62.8	644
Brown booby	536	10,720	0.35	13.9	1,307,317	13,400,000	849.8	8,710
Black noddy	43	860	0.03	1.1	105,366	1,080,000	68.5	702
White-tailed tropicbird	182	3,640	0.12	4.73	443,902	4,550,000	288.5	2,958
Red-tailed tropicbird	264	5,280	0.17	6.9	643,902	6,600,000	418.5	4,290
Great frigatebird	540	10,800	0.35	14.0	1,317,073	13,500,000	856.1	8,775

1. Based on the lower of the two acute oral LD_{50} values shown in Table 2 for bobwhites or mallards (>400 mg/kg body weight for diphacinone, 0.26 mg/kg body weight for brodifacoum).

3.7 Impacts to Nonnative Passerines Protected by the MBTA

3.7.1 Biology and Status

Two species of passerine birds that are not native to Hawai‘i but are native to North America and therefore protected by the MBTA that have been recorded on Mokapu are the northern cardinal and house finch. The passerines forage on seeds and berries, with the cardinal also eating insects (Table 5). All the nonnative species probably arrive from the adjacent main islands; however, some of the passerines may be residents.

3.7.2 Potential Impact Associated with the Proposed Action

3.7.2.1 Potential Impact from Direct Ingestion of Rodenticide (Primary Nontarget Hazard)

If a 0.005% diphacinone bait is used, a 9 g passerine bird would have to consume 72 g (2.5 ounces) of pellets to receive an LD_{50}-equivalent dosage (based on an acute oral LD_{50} figure of >400 mg/kg body weight for bobwhites). However, the projected LOEL of diphacinone to passerine birds is 0.001 mg/day or 0.02 g of bait/day, which is possible. It is highly unlikely that a 42 g house finch would pick up enough diphacinone bait pellets to cause adverse impacts, as 336 g (almost 12 ounces) would need to be ingested by a house finch in order to obtain the oral LD_{50} dosage. This would be eight times the full body weight of the bird (Table 6). The projected LOEL of diphacinone to house finches is 0.005 mg/kg/day or 0.09 g/day of bait, which is possible.

There is significant potential for primary nontarget hazards to passerine birds from the use of a 0.0025% brodifacoum bait. Based on the acute oral LD_{50} for the mallard (0.26 mg/kg body weight), a 9-g (0.3-oz) passerine bird would have to eat just 0.1 g of a 25-ppm brodifacoum bait (roughly 0.008% of a large-size pellet) to ingest a LD_{50}–equivalent dosage. For example, a house finch would only need to eat 0.4 g of a 20 ppm brodifacoum product, or about 25% of one pellet to obtain an LD_{50} dosage (Table 6). Although LOEL levels for birds using brodifacoum have not been calculated, it would be significantly lower than that for diphacinone, resulting in an even higher potential for adverse impacts to passerine populations. The relationship would be similar for northern cardinals.

It is possible that small passerine bird populations could be substantially decreased during brodifacoum operations; however it would be highly unlikely if operations utilized the diphacinone product. However, both passerine species are introduced to Hawai‘i, and are most likely associated with populations on the adjacent main islands.

Therefore, no adverse impacts are anticipated to the populations of nonnative passerines and barn owl from the proposed action.

3.7.2.2 Potential Impact from Indirect Ingestion of Rodenticide (Secondary Nontarget Hazard)

It is highly unlikely that either the house finch or the northern cardinal would eat prey, as they are primarily seed and berry feeders. The cardinal, however, does eat insects. The following analysis provides the information regarding secondary poisoning for these passerines.

For a diphacinone product, the LD_{50} for a 90 g cardinal is 36 mg of the active ingredient and, to obtain this dosage, the cardinal would need to eat 7,186 g (15.8 pounds) of diphacinone-loaded invertebrates, which would be impossible. A cardinal could obtain a LOEL dosage of diphacinone by eating 1.98 g of these contaminated invertebrates per day, over several days. Based upon the more conservative >400-mg/kg figure for bobwhites (Table 2), the theoretical diphacinone LD_{50}-equivalent dose for a 42 g house finch is 17 mg of the active ingredient. To obtain this dosage, the house finch would have to eat more than 3 kg (6.6 pounds) of highly contaminated invertebrates. However, for a house finch to reach a LOEL-equivalent dosage would require consuming about a gram of contaminated slugs or 1.07 weta per day over consecutive days. Only if contaminated invertebrates were available for several consecutive days would there be any risk of obtaining an LOEL for passerines through secondary exposure to diphacinone.

The brodifacoum LD_{50}-equivalent for a 90 g (3 ounces) passerine is 0.02 mg of the active ingredient. To obtain this amount, the passerine would need to eat 4.7 g of the most highly brodifacoum-contaminated invertebrates documented (5.01 ppm, Johnston et al. 2005). The brodifacoum LD_{50} for a 42 g (1.5 ounce) house finch is 0.01 mg of the active ingredient. To obtain this amount, the house finch would need to eat about 30 g of the most brodifacoum-contaminated invertebrates documented (5.01 ppm, Johnston et al. 2005). The risks to passerines from secondary exposure to brodifacoum would be greater than with diphacinone. However, only the northern cardinal eats insects, so it is highly unlikely that the house finch would be adversely impacted by either rodenticide. However, it is possible that the northern cardinal could be impacted by brodifacoum.

These species have inherently high variation in annual populations, and are typically territorial, with nonbreeding adults usually available to occupy abandoned breeding territories. It is possible that small passerine bird populations could be significantly decreased during brodifacoum operations; however it would be highly unlikely if operations utilized the diphacinone product. However, both species are introduced to Hawai‘i, and are most likely associated with populations on the adjacent main islands.

Therefore, no adverse impacts are anticipated to the populations of nonnative passerines from the proposed action.

Table 5. Biological Characteristics of Passerine Birds Present in Winter on Mokapu Island (only species protected by the MBTA)

Species	Mass (g)	Energy Dynamics	Winter Habitat	Diet	Biological Information	Seasonal Distribution in Mokapu area	Citations[1]
House finch	42-60	No information	Dry areas with bushes	Seeds, buds, and berries	4-6 eggs/clutch; up to 3 clutches/year; Both parents brood and feed young	Year-round resident, probably flies in from mainland island	Kaufmann 1996
Northern cardinal	90	No information	Variable areas with dense bushes for nesting	Seeds, insects, berries	2-5 eggs/clutch; forages on ground; nests in bushes; 2to 3 clutches/year	Year-round resident, probably flies in from mainland island	Kaufmann 1996

Table 6. Acute Toxicity of Diphacinone and Brodifacoum to Passerine Birds Present in Winter on Mokapu Island (includes only species protected by the MBTA)

	Primary				Secondary			
	Diphacinone (50 ppm)[1]		Brodifacoum (25 ppm)[1]		Diphacinone		Brodifacoum	
	mg a.i.	g Bait	Mg a.i.	g Bait	g Slugs[2]	g Weta[2]	g Slugs[2]	g Weta[2]
House finch (42 g)	17	336	0.011	0.40	3,400	3,900	2.7	2.5
Northern cardinal (90 g)	36	720	0.02	0.9	7,186	8,372	4.7	5.4

1. Based on the lower of the two acute oral LD_{50} values shown in Table 2 for bobwhites or mallards (>400 mg/kg body weight for diphacinone, 0.26 mg/kg body weight for brodifacoum
2. .Based on 5.01 ppm active ingredient in slugs (Primus et al. 2005) and 4.3 ppm active ingredient for weta.

3.8 Impacts to Nonnative Barn Owls

The barn owl, also not native to Hawai‘i but native to North America and therefore protected by the MBTA, is also found on Mokapu. The barn owl eats mostly rodents (Table 7). This nonnative species probably arrives from the adjacent main islands.

3.8.1 Potential Impact Associated with the Proposed Action

3.8.1.1 Potential Impact from Direct Ingestion of Rodenticide (Primary Nontarget Hazard)

Barn owls only capture live prey and therefore would not ingest grain-based pellets (Table 7). Therefore, there is no potential for the barn owl to ingest rodenticide directly.

3.8.1.2 Potential Impact from Indirect Ingestion of Rodenticide (Secondary Nontarget Hazard)

Another potential route of exposure to rodenticides for avian predators is associated with consuming prey items that have themselves ingested rodenticide and have rodenticide residues in their tissues. In this case, the barn owl would primarily eat rats and birds. The most conservative (worst case) analyses of these situations will be examined here using data from the literature. To assess secondary nontarget hazards for the barn owl, the analysis will use documented whole body rodent values using maximum residue levels (Erickson and Urban 2004, Table 2).

Barn owls only hunt live prey, which may carry rodenticide residues in their tissues prior to dying. For this species, secondary hazard is the only potential route of exposure. This hazard is reduced by the tendency of sick and dying rodents tend to hide in areas inaccessible to predators. The LD_{50} for an average sized 315 g (0.7 lbs) owl is 0.1 mg of brodifacoum and 126 mg of diphacinone. To ingest these amounts of rodenticides secondarily via rodents contaminated to the highest level documented, an owl would need to consume 3.15 g (0.1 ounce) of a brodifacoum-loaded rat or 10.5 kg (23 pounds) of a diphacinone-loaded rat. An owl could obtain an LOEL dosage of diphacinone by eating 3 g of these contaminated rodents (Table 8). Even under these extreme situations, the risk of mortality is essentially zero for a diphacinone formulation. Using a brodifacoum product however, there is a substantial risk. However, brodifacoum would only be used if it can be shown that eradication failed due to the diphacinone rodenticide, not other factors. The barn owl is an introduced species to Hawai‘i and is most likely a visitor from the adjacent main islands, where populations would not be affected and could provide additional birds.

Therefore, there is little risk to nonnative barn owls using the island.

Table 7. Biological Characteristics of Barn Owls Present in Winter on Mokapu Island

Species	Mass (g)	Energy Dynamics	Winter Habitat	Diet	Biological Information	Seasonal Distribution in Mokapu area	Citations[1]
Barn owl	378 (female) 315 (male)	41 g to maintain weight for 24 hours (1-2 adult voles/day)	Open or semi-open country	Small rodents, including invasive rats, may also eat birds and lizards in coastal areas	3-8, sometimes 12 or more eggs/clutch, 1-2 broods per year; probably nests on adjacent mainland island	Year-round resident, probably flies in from mainland island	Kaufmann 1996

Table 8. Acute Toxicity of Diphacinone and Brodifacoum to Barn Owls Present in Winter on Mokapu Island

	Primary				Secondary	
	Diphacinone (50 ppm)		Brodifacoum (25 ppm)		Diphacinone	Brodifacoum
	mg a.i.	g Bait	Mg a.i.	g Bait	g Rodents[1]	g Rodents[1]
Barn owl (315 g)	126	2,520	0.08	3.30	10,500	3.15

[1] Maximum whole body residues from Table 1: 12 ppm diphacinone, 25.97 ppm brodifacoum.

3.9 Adverse Impacts to Nonnative Lizards

Three species of nonnative lizard are known from Mokapu (F. Duvall, DOFAW, unpublished data based on survey conducted March 2000), the snake-eyed skink, the azure-tailed skink, and the mourning gecko.

No post-baiting monitoring data on reptiles has been collected (Hoare and Hare 2006a). The only information about interactions between brodifacoum poison and native reptiles is observational, confirming brodifacoum consumption by new species of New Zealand geckos. Common geckos (*Hoplodactylus maculates*) in New Zealand showed evidence of bait consumption where brodifacoum was continuously supplied in bait stations (Hoare and Hare, in press). Similarly, bait consumption by a single Duvaucel's gecko (*Hoplodactylus duvaucelli*) was discovered in New Zealand following rodent eradication (Christmas 1995). Toxic bait consumption has been reported in Telfar's skink (*Leiolopisma telfairi*) from Mauritius, which proved lethal in some individuals (Merton 1987, Merton et al. 2002, cited in Hoare and Hare 2006). It has also been reported in Wright's skink (*Mabuya wrightii*) from the Seychelles (Thorson et al. 2000, cited in Hoare and Hare 2006a). However, the potential risk to reptiles is considered to be low, as reptiles have a distinct blood coagulation chemistry compared to that of mammals (Merton 1987, cited in Hoare and Hare 2006a, Orueta and Ramos 2001).

Conversely, removing rats may cause an increase in lizards on the island. New Zealand has recognized that the three species of rat have had an adverse impact on lizard populations, especially when added to impacts caused by other invasive predators (State of New Zealands Environment 1997, http://www.mfe.govt.nz/publications/ser/ser1997/html/chapter9.7.4.html). Towns and Daugherty (1994) and Hoare et al. (2006b) found that lizard populations on islands where rats have been eradicated have shown rapid increases in numbers and habitat range. New Zealand has incorporated rat control as a major action for recovery of skinks, including those species designated as threatened. Eradication of Polynesian rats is recognized for effectiveness in substantially increasing the abundance of skinks and other resident species of lizard (Towns et al. 2002).

The lethal doses of brodifacoum and diphacinone for reptiles are not known. However, the main concern may be interference with reptiles' abilities to thermoregulate, which could prove fatal under conditions of environmental stress (Merton 1987, cited in Hoare and Hare 2006a, Orueta and Ramos 2001). The potential for lizards to play the role of vector of rodenticide residues through a natural food system is rarely considered. Native species may have a sufficiently high density that they may play such a role, particularly to avian predators (Hoare and Hare 2006a). In this case, only the barn owl might be impacted, although it is improbable, based on the analyses in Section 3.7.2.2.

As all three lizards are not native to Hawai'i and the rodenticide application would involve only up to four applications in one year rather than sustained availability of rodenticide, no adverse impact is expected for the three species of nonnative lizards.

3.10 Consistency with Hawai'i State Enforceable Policies per CZMA, Federal Endangered Species Act, National Historic Preservation Act, and Clean Water Act

3.10.1 Consistency with Applicable State Coastal Management Policies

The following objectives and policies of HRS 205A-2 (Coastal Zone Management) would apply to the proposed projects (J. Nakagawa, Hawai'i Coastal Zone Management Program, Hawai'i Office of State Planning, pers. comm.), with evaluation of consistency:

- (b)(4)(A) Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.
    - Consistency rationale: The native ecosystems on Mokapu have been disrupted by invasive rats. The projects intend to eradicate the rats to allow the plant and seabird components of the ecosystems to recover naturally when possible and to provide the foundation for actively removing invasive weeds for supporting the restoration of native plant communities. These actions are consistent with the purposes of HAR 13-125 regarding State Wildlife Sanctuaries. No adverse impact will occur to any marine vertebrate or invertebrate communities and species, nor to marine plant communities.
- (c)(4)(C) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance.
    - Consistency rationale: Some of the native plant and animal species on Mokapu are assumed to have been adversely affected by invasive rats, based on ecological characteristics of the island. Mokapu has remnant populations of important and protected native plant species that will be preserved with the rat eradication projects. Existing seabird species will have the potential to recover to larger populations if rats are removed, and species that are not found on Mokapu but found on adjacent islands may be able to recolonize available habitat. Again, no adverse impact will occur to any marine vertebrate or invertebrate communities and species, or to marine plant communities.
- (c)(4)(E) Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.
    - Consistency rationale: Water quality will not be adversely impacted because:
        - No surface water is found on Mokapu;
        - Very small amounts of rodenticide will enter the marine environment when applied as described in the proposed action in Chapter 2;

- The rodenticide pellets that do enter the marine environment break up rapidly in the intertidal dynamics;
- Studies made of a huge point source spill of brodifacoum in New Zealand indicate that marine invertebrates are not adversely affected; the minute amounts of diphacinone entering the marine environment would have no adverse impacts to water quality.

3.10.2 Consistency with State Enforceable Policies

The following four state laws and associated regulations, as well as their federal counterparts, are described in detail in Chapter 1. Consistency with these state enforceable policies are evaluated for each law and found consistent.

3.10.2.1 HRS 149A: Hawai'i Pesticides Law and FIFRA

- Consistency rationale: Both diphacinone and brodifacoum are "restricted use" pesticides when used for conservation purposes. As described in Chapter 2, the USFWS and DOFAW will obtain the necessary permits from the state Department of Agriculture for aerial application of the rodenticide and all rodenticide application will be under the direct supervision of a certified applicator. Per both FIFRA and HRS 149A, all application will be according to the label, and no pesticide will be used that does not have an approved label (Sections 1.6.2 and 2.4).

3.10.2.2 HRS 195D and HAR 13-124: Conservation of Aquatic Life, Wildlife, and Land Plants (endangered species) and Federal Endangered Species Act

Like the nearby islands of Okala and Huelo, Mokapu supports some of the best native coastal plant habitat in Hawai'i, with 29 native plant species, several of which are rare and vulnerable. The island is dominated by native shrubs, but retains small groves of native lama trees (*Diospyros* spp.), some native palm trees *Pritchardii hillebrandii*, which dominate nearby Huelo, and eleven of the last fourteen individuals of the shrub *Pittosporum halophilum* (endemic to Moloka'i). *Peucedanum sandwicense*, a large perennial herbaceous plant, listed as threatened per the Endangered Species Act, and *Lepidium bidentatum* var. *o-waihiense*, a succulent herbaceous plant, a species of concern, are also found on Mokapu. In 2003, the USFWS designated critical habitat on Mokapu for *P. sandwicense*, and for *Tetramolopium rockii*, a perennial shrub, and *Brighamia rockii*, a succulent perennial plant growing on adjacent islands. Although *T. rockii* and *B. rockii* are not currently found on Mokapu, establishing populations there would be an important step towards species recovery.

Since the *Peucedanum* spp. plants are apparently doing well on the steep northeast corner of Mokapu, the plants have completed their annual cycle by the end of August, and the steep terrain prohibits safe human access to the area, neither bait nor human trampling during pre- and/or post-operation monitoring will jeopardize these listed plants (K. R. Wood, National Tropical Botanical

Garden, pers. comm.). No Hawaiian monk seals or listed birds are known from Mokapu (F. Duvall, DOFAW, pers. comm. 09/07).

The USFWS conducted informal Section 7 consultation on September 12, 2007 for Mokapu Island. This resulted in a "may effect, but not likely to adversely effect species or critical habitat" determination for *Peucedanum sandwicense*, *Brighamia rockii* and *Tetramalopium rockii*. Mitigation measures from the informal consultation are identified in Section 2.4.11.

No additional species other than the federally listed plant species, including the list found at HAR13-124, are found on or near Mokapu, including the endangered Hawaiian monk seal. Therefore, the informal Section 7 consultation conducted for the three plant species fulfills compliance with both state and federal law and regulations (Section 1.6.3).

3.10.2.3 HRS Chapter 6E: Historic Preservation and Federal National Historic Preservation Act

- Consistency rationale: Mokapu has rock structures of unknown origin on the ridgeline. Since bait will be applied from the air, bait application will not adversely affect these structures. Placing pre-operational rat and bait monitoring gear, as well as conducting post-operational monitoring, will require limited foot traffic, focused on the ridgeline. However, the structures will be identified and foot traffic will avoid the structures (Section 1.6.7). No ground disturbing activities will be conducted during operations or monitoring. No cultural practices are known to occur on Mokapu. Subsistence gathering in waters around Mokapu is not expected to be impacted, for reasons discussed earlier. Therefore, no impact would occur to cultural structures and practices.

3.10.2.4 HRS 342D and HAR 11-54: Water Pollution and Water Quality Standards and Federal Clean Water Act

- Consistency rationale (Section 1.6.9):

  Per HAR 11-54-4(b)(3), no pesticide is identified as a toxic pollutant.

HRS 342D-1 defines water pollution as "such contamination or other alteration of the physical, chemical, or biological properties of any state waters, including change in temperature, taste, color, turbidity, or odor of the water as will or is likely to create a nuisance or render such waters unreasonably harmful, detrimental, or injurious to public health, safety, or welfare, including harm, detriment or injury to public water supplies, fish and aquatic life and wildlife, recreational purposes…" Per the associated regulations at Chapter 11-54, coastal waters include those within 3 miles seaward from the coast, including coastal and marine waters, but not including groundwater.

The state policies stated at 11-54-1.1 are, with consistency rationale:

(a) existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(b) where the quality of the waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the state determines, after public involvement, that lower water quality is necessary for important social or economic development in the area in which the waters are located.

- Consistency rationale: The evaluation at Section 3.9.1 provides the rationale for consistency with this state policy.

The basic water quality criteria applicable to all waters, including marine waters are (11-54-4):

All water shall be free of substances attributable to domestic, industrial or other controllable sources of pollutants, including:

(1) materials that will settle to form objectionable sludge or bottom deposits

(2) floating debris, oil, grease, scum, or other floating materials

(3) substances in amounts sufficient to produce taste in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity, or other conditions in the receiving water

(4) High or low temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, or other deleterious substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water

(5) substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life, and

(6) soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands.

Consistency rationale: Pesticides are not considered toxic pollutants per HAR 11-54-4(b)(3). No disturbance of soil and no construction activities are included in the proposed action.

The minute amount of rodenticide pellets that might enter nearshore marine waters would disintegrate quickly and be dispersed. Therefore, the pellets and the active ingredient would not:

- form either a bottom sludge nor floating materials;
- change any water characteristics;
- be toxic to any native marine life;
- encourage any nonnative marine life.

No NPDES permit is required under the Federal Clean Water Act per 40 CFF 122.3.

3.10.3 Cumulative Impact Analyses

Under the National Environmental Policy Act (NEPA), cumulative effects are defined as:

> "The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508).

Under Endangered Species Act (ESA) regulations cumulative effects are defined as:

> "Those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal Action subject to consultation." (50 CFR 402.2)

The U.S. Fish and Wildlife Service further defines "State or private activities" as including tribal, local, or private actions that are reasonably certain to occur in the action area considered. Future Federal actions that are unrelated to the proposed action are not considered because they require separate evaluation under Section 7 consultation. The past and present impacts of non-Federal actions are part of the environmental baseline (in the case of this EA, the discussion included in the "no action" description in Section 2.1)

Overall, because the proposed rat eradication project is completely under the jurisdiction of DOFAW (the island is a State Wildlife Sanctuary), no further cumulative impacts would occur to the species evaluated below under either NEPA or the ESA beyond those already having occurred or continuing to occur under the baseline (no action alternative), mostly caused by the invasive rats that are targeted by the projects. No other non-Federal action could occur on the island without full approval of DOFAW. No planned actions or even proposed actions other than potential ecological restoration projects, are foreseen at this time and will have no contributory adverse impacts to any resources evaluated in this EA.

Even with four applications of diphacinone in the winter of 2007-2008, no long-term cumulative impacts are expected for any species or resource, as evaluated in this chapter. Again, although the hazards to nontarget birds are substantially higher with brodifacoum than diphacinone, the analyses in this chapter indicate that no long term adverse cumulative effects are foreseen with brodifacoum, even if potentially impacted bird populations are reduced substantially. It is expected that population recovery would take longer with brodifacoum than with diphacinone, but that it would occur, especially with ingress from populations on Moloka'i. If quarantine fails in the future and rats re-invade the island, then the proposed action may be repeated. This is not expected to occur and, even if it does, it would not occur for at least several years. Therefore, any impacted populations would be expected to have recovered and no cumulative impacts would occur to those populations.

3.11 Evaluation of Significance of Impacts per HRS 343

The State of Hawai'i Environmental Council gives 13 criteria (in italics below) for defining significant project impacts (Hawai'i Administrative Rules, Section 11-200-12).

As discussed below, this project does not trigger any of the criteria for significance and thus, under State law, does not require preparation of an environmental impact statement (EIS). A Finding of No Significant Impact (FONSI) document prepared by the USFWS provides the rationale, from the perspective of NEPA regulations (40 CFR 1508.27) and USFWS guidelines, for the decision not to prepare an EIS. Federal criteria at 40 CFR 1508.27(b) for significance and the State criteria for significance listed below are similar but not identical.

The proposed actions do not involve an irrevocable commitment to loss or destruction of any natural or cultural resource. The actions will contribute to the restoration of a healthy native ecosystem on Mokapu by eradicating nonnative rats (Section 1.1.2). These actions are also consistent with the Hawaiʻi Comprehensive Wildlife Conservation Plan (Mitchell et al. 2005) (Section1.6.11)

The proposed actions will not curtail the range of beneficial uses of the environment. The activities proposed are intended to contribute to ecological restoration of the island and improve habitat for the native plants and nesting seabirds that inhabit or historically inhabited the island, prior to its degradation by invasive rats. Restoration of Mokapu will thus improve the range of beneficial uses of the environment (Section 1.1.2).

The proposed actions will not conflict with the State's long-term environmental policies. The proposed actions will not conflict with the environmental policies set forth in HRS Chapter 344 and the state written policies and enforceable policies (Section 3.9) and other statutes and regulations, since the proposed actions will not damage sensitive natural resources. Instead, they will improve the environment of Mokapu (Sections 1.1.2 and 1.2.5).

The proposed actions will not substantially adversely affect the economic and social welfare of the community. The proposed activities utilize the most effective strategies to eradicate invasive rats as well as mitigating potential adverse impacts, thus contributing to the restoration of the ecosystems of Mokapu. With ecosystem restoration, seabird populations will most likely increase as well as additional species will most likely return to Mokapu, increasing its value as a State Seabird Sanctuary. Therefore, the proposed projects will result in an improved environment, thus supporting eco-tourism and enhancing economic and social welfare (sections 1.1.2 and 1.2.5).

The proposed actions will not substantially adversely affect the public health of the community. The rodenticides are fully expected to have no adverse impacts on water quality or on marine life that might be consumed by people. Mokapu is uninhabited and overnight camping is prohibited. Visitation to Mokapu requires helicopter access and a permit from DOAFW (Section 1.6.10 and 3.9.2.4).

The proposed actions will not involve substantial secondary impacts, such as population changes or effects on public facilities. Mokapu is a small island designated as a State Seabird Sanctuary and is uninhabited and undeveloped. The project does not propose construction of public facilities or involve establishing a human population on Mokapu. Thus, the proposed actions will not affect any public recreational facilities and will not induce population growth or decline in the area.

The proposed actions will not involve a substantial degradation of environmental quality. Utilizing best management practices as identified in Chapter 2 will minimize impacts to the environment during the implementation of the proposed actions. Restoration will increase the environmental quality of the ecosystems of Mokapu for its flora fauna (Chapter 3).

The proposed actions will not affect a rare, threatened or endangered species or its habitat. The proposed actions will benefit native plant and animal species and plant species protected under the Federal and state endangered species laws. The limited and temporary human activities associated with the proposed action will have a negligible impact on listed plant species present on the island with conservation actions identified during the informal Section 7 consultation (Sections 1.2.5, 2.4.4, 2.4.7, 3.9.2.2).

The proposed actions will not have cumulative impacts or involve a commitment for larger actions. The analyses show that mitigation measures integrated into the proposed actions, such as the use of diphacinone and conducting operations during the winter when presence of nontarget species is minimal, will result in no cumulative impacts. Populations of two nonnative passerine birds protected under the Migratory Bird Treaty Act may be decreased, but their inherent population characteristics and potential ties to mainland island populations will cause rapid recovery. No other known or potential actions would contribute to or cause any cumulative impacts (Chapter 3, including Section 3.9.3).

The proposed actions will not substantially affect air or water quality or ambient noise levels. The proposed actions are fully consistent with both Federal and state water quality laws and regulations. Helicopters will cause noise for approximately one day up to four times during aerial application of rodenticides on Mokapu, but the effect will be highly temporary (Section 3.9.2.4).

The proposed project is not located in an environmentally sensitive area (e.g. flood plain, tsunami zone and coastal zone). Although the site is located in a State Seabird Sanctuary, the proposed actions are in accordance with both HAR 13-125, as well as Federal and State Coastal Zone Management policies and enforceable policies. All actions will protect sensitive resources, including the coastal zone while meeting ecological management objectives. Project actions are in accord with environmental management goals of USFWS and DOFAW (Section 1.6.6).

The proposed actions will not substantially affect scenic vistas and view planes identified or State plans or studies. The project does not involve construction of any permanent structures or alteration of landscapes. Thus, it will not affect any sites or vistas.

The proposed project will not require substantial energy consumption. The affected area is not on a local power grid. The only energy uses will be for using motorized vehicles for accessing points of departure to the island and for broadcasting bait via helicopters for up to 4 days total over several months. All work will be conducted during daylight hours.

4.0 LIST OF PREPARERS

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Appendix A

Copies of Comment Letters Received

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
MARK K. ANDERSON
DEPUTY DIRECTOR
MARY LOU KOBAYASHI
ACTING DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING
235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-11978

November 27, 2007

Mr. Chris Swenson
U.S. Fish and Wildlife Service
300 Ala Moana Boulevard, #3-122
Honolulu, Hawaii 96850

Dear Mr. Swenson:

Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency Review for Rat Eradication on Mokapu and Alau Islands, County of Maui

The proposal to use rodenticides to eradicate rats from Mokapu Island (off of Molokai) and Alau Island (off of Maui), which are designated State Seabird Sanctuaries, has been reviewed for consistency with the Hawaii CZM Program. We concur with your determination that the activity is consistent to the maximum extent practicable.

CZM consistency concurrence is not an endorsement of the project nor does it convey approval with any other regulations administered by any State or County agency. Thank you for your cooperation in complying with the Hawaii CZM Program. If you have any questions, please call John Nakagawa of our CZM Program at 587-2878.

Sincerely,

Mary Lou Kobayashi

Mary Lou Kobayashi
Acting Director

c: Dr. Wendy Wiltse, U.S. Environmental Protection Agency
Department of Land and Natural Resources,
Division of Forestry and Wildlife
Department of Planning, County of Maui

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to
EMD / CWB

11104PKP.07

November 30, 2007

Mr. Patrick Leonard
Field Supervisor
Pacific Islands Fish and Wildlife Office
Fish and Wildlife Service
United States Department of the Interior
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

Dear Ms. Leonard:

Subject: Request for Public Comments on the Draft Environmental Assessment for Eradication of Rats from Mokapu and Alau Islands

The Department of Health, Clean Water Branch (CWB), has reviewed the subject document and offers these comments on your project. Please note that our review is based solely on the information provided in the subject document and its compliance with Hawaii Administrative Rules (HAR), Chapters 11-54 and 11-55. You may be responsible for fulfilling additional requirements related to our program. We recommend that you also read our standard comments on our website at
http://www.hawaii.gov/health/environmental/env-planning/landuse/CWB-standardcomment.pdf.

1. Any project and its potential impacts to State waters must meet the following criteria:

   a. Antidegradation policy (HAR, Section 11-54-1.1), which requires that the existing uses and the level of water quality necessary to protect the existing uses of the receiving State water be maintained and protected.

   b. Designated uses (HAR, Section 11-54-3), as determined by the classification of the receiving State waters.

   c. Water quality criteria (HAR, Sections 11-54-4 through 11-54-8).

2. Please call the Army Corps of Engineers at 438-9258 to see if this project requires a Department of the Army (DA) permit. Permits may be required for work performed in, over, and under navigable waters of the United States. Projects requiring a DA permit also require a Section 401 Water Quality Certification (WQC) from our office.

3. The application of the pesticides must be consistent will all relevant requirements under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in order for the project to be exempt from National Pollutant Discharge Elimination System (NPDES) requirements.

4. Please note that all discharges related to the project construction or operation activities, whether or not NPDES permit coverage and/or Section 401 WQC are required, must comply with the State's Water Quality Standards. Noncompliance with water quality requirements contained in HAR, Chapter 11-54, and/or permitting requirements, specified in HAR, Chapter 11-55, may be subject to penalties of $25,000 per day per violation.

If you have any questions, please visit our website at http://www.hawaii.gov/health/environmental/water/cleanwater/index.html, or contact the Engineering Section, CWB, at 586-4309.

Sincerely,

ALEC WONG, P.E., CHIEF
Clean Water Branch

KP:np

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

DEC 2 1 2007

HRD07/3349

December 18, 2007

Chris Swenson
Pacific Islands Fish and Wildlife Office
U.S. Fish and Wildlife Service
300 Ala Moana Blvd., Rm. 3-122, Box 50088
Honolulu, HI 96850

RE: Request for comments on Draft Environmental Assessment for proposed rat eradication on 'Ālau and Mōkapu islands, Maui County, TMKs:

Dear Chris Swenson,

The Office of Hawaiian Affairs (OHA) is in receipt of the above-referenced Draft Environmental Assessment (DEA), which outlines plans for hand and aerial broadcast of rodenticide to eradicate rats on 'Ālau and Mōkapu islands, in Maui County. OHA offers the following comments.

OHA generally supports the use of rodenticide in areas where rats are negatively impacting the native ecosystem. However, we will rely on the assurances of the applicant that brodifacoum will only be used for this project if it is approved by the federal Environmental Protection Agency and only as an alternative if it is found that diphacinone failed. In addition, we agree that a supplement to the draft environmental assessment must be conducted for the use of chlorophacinone, zinc phosphide or cholecalciferol for the purpose of rat eradication on 'Ālau or Mōkapu.

We also agree that the proposed rat eradication outlined in this EA should be held off until it is determined that 'Ālau does in fact have a rat problem. In addition, we will rely on the applicant's assurances that consultation with the State Historic Preservation Division will occur prior to the project commencing. Furthermore, OHA requests to be copied on that consultation and response.

We will rely on the assurances of the applicant that they will comply with the procedures listed on the rodenticide's label as well as with all federal and state guidelines for the administration of pesticides.

We ask for the assurances of the applicant that access to the islands for the purposes of Native Hawaiian traditional gathering and other practices will be protected during the entire course of this project.

Finally, we ask the applicant to include in the Final Environmental Assessment for this project the Tax Map Key numbers for ʻĀlau and Mōkapu and whether these lands are Ceded Lands.

Thank you for the opportunity to comment. If you have further questions, please contact Sterling Wong (808) 594-0248 or e-mail him at sterlingw@oha.org.

Sincerely,

Clyde W. Nāmuʻo
Administrator

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
FIRST DEPUTY

KEN C. KAWAHARA
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

December 31, 2007

Mr. Chris Swenson
Pacific Islands Fish and Wildlife Office
US Fish and Wildlife Service
300 Ala Moana Blvd, Rm 3-122, Box , Ste 50088
Honolulu, HI 96850

LOG NO: 2007.4107
DOC NO: 0712NM19
Archaeology

Dear Mr. Swenson:

SUBJECT: **National Historic Preservation Act (NHPA) Section 106 Review – Concurrence Determination - DEA for Proposed rat eradication ʻAlau and Mokapu Islands, Maui County**
ʻAlau and Mokapu Islands, Maui

The Draft Environmental Assessment is for rat eradication on ʻAlau and Mokapu Islands.

We concur with your determination that **"no adverse effect"** by this undertaking because:

- ☐ a) intensive cultivation has altered the land
- ☐ b) residential development/urbanization has altered the land
- ☐ c) previous grubbing/grading has altered the land
- ☐ d) an acceptable archaeological assessment or inventory survey found no historic properties
- ☐ e) this project has gone through the historic review process, and mitigation has been completed
- ☒ f) other: *No ground disturbing activities will take place.*

We recommend that an qualified archaeologist accompany the eradication team to ensure historic properties would not be affected by this project. A brief letter report on their findings can be submitted to our office on the results of this project.

In the event that historic resources, including human skeletal remains, are identified during the construction activities, all work needs to cease in the immediate vicinity of the find, the find needs to be protected from additional disturbance, and the State Historic Preservation Division, needs to be contacted immediately at (808) 692-8015.

If you have any questions, please contact Nancy McMahon, at 808-652-1510.

Aloha,

Laura Thielen,
State Historic Preservation Officer
NM

Appendix B

Responses to Comment Letters

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
CS

DEC 12 2007

Alec Wong, Chief
Clean Water Branch
State of Hawaii Department of Health
P.O. Box 3378
Honolulu, HI 96801-3378

Re: Response to Comments on the Draft Environmental Assessment for the Eradication of Rats from Mokapu and Alau Islands

Dear Mr. Wong:

Thank you for your November 30, 2007, letter commenting on the Draft Environmental Assessment (EA) for the Eradication of Rats from Mokapu and Alau Islands. Your letter requested analysis of project compliance with state clean water standards, FIFRA, the Clean Water Act requirements for NPDES permits, and U.S. Army Corps of Engineers requirements.

After re-checking the Draft EA, we have confirmed that analyses of full and appropriate compliance are included in Sections 1.5.3 (FIFRA), 1.6.2 and 3.10.2.1 (state pesticide requirements), and 3.10.2.4 and 1.6.9 (Clean Water Act and no requirement for NPDES permit). Since no dredging, filling or other activities in the water would be part of the proposed action, a permit under the Clean Water Act is not required and no consultation with the U.S. Army Corps of Engineers is necessary.

Thank you for your interest in the ecological restoration of Hawaii's offshore islands. If you have any questions, please contact Chris Swenson, Coastal Program Coordinator, at (808) 792-9400.

Sincerely,

Karen W Marlowe

for/ Patrick Leonard
Field Supervisor

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
CS

JAN 08 2008

Clyde Namu`o, Administrator
Office of Hawaiian Affairs
711 Kapiolani Boulevard, Suite 500
Honolulu, HI 96813

Re: Response to Comments on the Draft Environmental Assessment for the Eradication of Rats from Mokapu and Alau Islands

Dear Mr. Namu`o:

Thank you for your December 18, 2007, letter commenting on the Draft Environmental Assessment (EA) for the Eradication of Rats from Mokapu and Alau Islands. Your letter requested the following: 1) assurances that access to the islands for traditional gathering and other practices would be protected during the course of the project; 2) information on tax map key numbers and whether the islands are Ceded Lands; and 3) a copy of the State Historic Preservation Officer's response to the determination in the Draft EA that this project would have no adverse effects on historic properties.

Because recent rodent surveys on Alau Island did not detect rats, Alau Island will be deleted from consideration and will not be included in the Final EA. Therefore, our responses to your comments will address only Mokapu Island.

Our responses to your requests are as follows:
1) No actions proposed for this project will specifically prohibit ongoing cultural or traditional practices. However, no such uses are known to occur on Mokpau Island now, primarily due to steep slopes that effectively limit access to helicopter landings on the ridge.

2) There is no tax map key number assigned to Mokapu, as is the case with many of Hawaii's small offshore islands. However, information graciously provided by Mr. Sterling Wong, of your office, did confirm that Mokapu Island is Section 5(b) Ceded Land.

3) We have enclosed a December 31, 2007, letter from the State Historic Preservation Officer, concurring with our determination that this project will have no adverse effect on historic properties.

Thank you for your interest in the ecological restoration of Hawaii's offshore islands. If you have any questions, please contact Chris Swenson, Coastal Program Coordinator, at (808) 792-9400.

Sincerely,

for Patrick Leonard
Field Supervisor

Enclosure

Appendix C

Organizations and Individuals Contacted

The following organizations and individuals were contacted by letter or in person and given an opportunity to provide input to the project:

Organizations Contacted

Office of Hawaiian Affairs

Maui Burial Council

Molokai Burial Council

Kalaupapa Patient Advisory Council

Ka Ohana O Kalaupapa

Hawaii Department of Health, Clean Water Branch

Hawaii Department of Health, Environmental Planning Office

Hawaii Department of Agriculture, Pesticides Branch

Hawaii Office of State Planning

Hawaii Dept. of Land and Natural Resources, Division of Aquatic Resources

University of Hawaii Environmental Center

Hawaii Audubon Society

Kahea

Earth Justice Legal Defense Fund

Hawaii Conservation Alliance

The Nature Conservancy of Hawaii

Kalaupapa National Historical Park

NOAA Fisheries, Pacific Islands Regional Office

U.S. Dept. of Agriculture, Wildlife Services Honolulu Office

U.S. Environmental Protection Agency, Office of Pesticide Programs

Hana Public School and Library

Molokai Public Library

Maui County Department of Planning

Hawaii State Historic Preservation Division

Individuals Contacted

Walter Ritte

Walter Naki

Mac Poepoe

Individuals Contacted (cont.)

Kili Mawae

Joe Mawae

Joyce Kainoa

Yama Kaholoaa

Polipo Solitario

Lori Buchanan

Mervin Dudoit

Jim Stone

Penny Martin

Kalaniua Ritte

Hano Naehu

Ed Misaki

Lawrence Aki

Wade Lee

Shannon Crivello

Kanoho Helm

Kathy Tachibana

Ed Misaki

Wailana Moses

Senator Clayton Hee

Shannon Lopes

Ellie Alcon

Russell Kalstrom

Nancy McPherson

Guy Hughes

Kenneth Wood

Appendix D
Approved Pesticide Label for Diphacinone

RESTRICTED USE PESTICIDE
DUE TO HAZARDS TO NON-TARGET SPECIES

For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators certification

For use by or in cooperation with government conservation agencies.

Department of Agriculture
STATE OF HAWAII
LICENSED
PERIOD 2008-2010 LIC. NO.
8600.1

Diphacinone-50: Pelleted Rodenticide Bait for Conservation Purposes

Fish Flavored, Weather-resistant Rodenticide for Control or Eradication of Invasive Rodents on Islands or Vessels for Conservation Purposes

ACTIVE INGREDIENT:
Diphacinone (2-Diphenylacetyl-1,3-Indandione)........................0.005%
INERT INGREDIENTS:..99.995%
TOTAL...100.000%

KEEP OUT OF REACH OF CHILDREN

CAUTION

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS

Caution: Keep away from humans, domestic animals and pets. If swallowed, this material may reduce the clotting ability of the blood and cause bleeding. Wear protective gloves when applying or loading bait. With a detergent and hot water, wash all implements used for applying bait. Do not use these implements for mixing, holding or transferring food or feed.

FIRST AID Have label with you when obtaining treatment advice.	
If swallowed	• Call a poison control center, doctor, or 1-800-222-1222 immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center or doctor.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center, doctor, or 1-800-222-1222 immediately for treatment advice.
• **Note to Physician**: If ingested, administer Vitamin K_1, intramuscularly or orally as indicated in bishydroxycoumarin overdose. Repeat as necessary based on monitoring of prothrombin times.	

For a medical emergency involving this product, call 1-800-222-1222.

ENVIRONMENTAL HAZARDS

This product is toxic to mammals and birds. Predatory and scavenging mammals and birds might be poisoned if they feed upon animals that have eaten bait.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

STORAGE: Store only in original closed container in a cool, dry place inaccessible to children and pets. Store separately from fertilizer and away from products with strong odors which may contaminate the bait and reduce acceptability. Spillage should be carefully swept up and collected for disposal.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

PLASTIC CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ THIS LABEL: Read this entire label and follow all use directions and use precautions.

IMPORTANT: Do not expose children or pets to this product. Take all appropriate steps to limit exposure to and impacts on nontarget species, especially those for which special conservation efforts are planned or ongoing. To help to prevent accidents:

1) Store product not in use in a location out of reach of children and pets.
2) Apply bait only as specified on this label and in strict accordance with the "**USE RESTRICTIONS:**" and "**APPLICATION DIRECTIONS:**". For applications involving bait stations, the bait stations must be tamper-resistant. The bait stations must deny access to bait compartments by children, pets, and other non-target species larger in body size than the type(s) of rats or mice being targeted by the bait program. Lock and secure bait stations, as necessary, to exclude such nontarget species. In locations where captive or feral livestock occur, either remove and exclude such animals from the application site prior to treatment or make sure that the bait stations used are capable of denying them access to bait compartments, and
3) Dispose of product container, and unused, spoiled and unconsumed bait as specified on this label.

USE RESTRICTIONS: This product may be used only to control or eradicate Norway rats (*Rattus norvegicus)*, roof rats (*Rattus rattus),* Polynesian rats (*Rattus exulans),* house mice (*Mus musculus*) or other types of invasive rodents for conservation purposes on islands, grounded vessels or vessels in peril of grounding. This product may be applied only using bait stations, burrow baiting, canopy baiting or aerial and ground broadcast application techniques.

This product is to be used for the protection of State or Federally-listed Threatened or Endangered Species or other species determined to require special protection.

Do not apply this product to food or feed.

Treated areas must be posted with warning signs appropriate to the current rodent control project.

APPLICATION DIRECTIONS:

Bait Stations: Tamper-resistant bait stations must be used when applying this product on grounded vessels or vessels in peril of grounding or when used in areas of human habitation. See Item 2) under "**IMPORTANT:**" regarding the performance characteristics needed for tamper-resistant bait stations. To bait rats: Apply 4 to 16 ounces (113 to 454 grams) of bait per placement. Space placements at intervals of 5 to 50 meters. Placements should be made in a grid over the area for which rodent control is desired. To bait mice: Apply 0.25 to 0.5 ounces (7 to 14 grams) of bait per placement. Space placements at intervals of 2 to 4 meters. Placements should be made in a grid over the area for which rodent control is desired. Larger placements (up to 2 ounces) may be needed at points of very high mouse activity. For both rat and mouse baiting: Maintain an uninterrupted supply of fresh bait for at least 15 days or until signs of rodent activity cease. Where a continuous source of infestation is present, permanent bait stations may be established and bait replenished as needed.

Burrow-baiting: Place bait in burrows only if this can be done in a way that minimizes potential for ejection of bait and exposure of bait to seed-eating birds and other non-target species. To bait rats: place 3 to 4 ounces (85 to 113 g) of bait inside each burrow entrance. Baits used in burrows may be applied in piles or in cloth or reasealable plastic bags. The bags should be knotted or otherwise sealed to avoid spillage and holes should be made in plastic bags to allow the bait odor to escape. To bait mice: place approximately 0.25 ounces (7 grams) of bait in each active burrow. For both rat and mouse baiting: place one such bag or placement in each active burrow opening and push bag into burrow far enough so that its presence can barely be seen. Do not plug burrows. Flag treated burrows and inspect them frequently, daily if possible. Maintain an uninterrupted supply of bait for at least 15 days or until rodent activity ceases. Remove bait from burrows if there is evidence that bags are ejected.

Canopy Baiting (bait placement in the canopy of trees and shrubs): In areas where sufficient food and cover are available to harbor populations of rodents in canopies of trees and shrubs, canopy baiting should be included in the baiting strategy. Approximately 4 to 7 ounces (113 g to 200 g) of bait should be placed in a cloth or resealable plastic bag. The bags should be knotted or otherwise sealed to avoid spillage and holes should be made in plastic bags to allow the bait odor to escape. Using long poles (or other devices) or by hand, bait filled bags should be placed in the canopy of trees or shrubs. Baits should be placed in the canopy at intervals of 50 meters or less, depending upon the level of rodent infestation in these habitats. In some vegetation types, bait stations may need to be used to ensure bait will stay in the canopy.

Aerial and Ground Broadcast: Broadcast applications are prohibited on vessels or in areas of human habitation. Broadcast bait pellets by helicopter or manually at a rate of 10 to 12.5 lbs. of bait per acre (11.1 to 13.8 kg/ha) per treatment. Make a second broadcast application typically 5 to 7 days after the first application, depending upon local weather conditions, at a rate no higher than 12.5 lbs. (13.8 g/ha) of bait per acre. In situations where weather or logistics only allow one bait application, a single application may be made at a rate no higher than 20.0 lbs. bait per acre (22.5 kg/ha).

Aerial (helicopter) applications may not be made in winds higher than 35 mph (30 knots). Pilot in command has final authority for determining safe flying conditions. However, aerial applications will be terminated when the following conditions are met:

- Windspeed in excess of 25 knots with an evaluation of the terrain and impact of the wind conditions and not to exceed a steady wind velocity of 30 knots.

If rat activity persists after broadcast application, set up and maintain tamper-resistant bait stations or apply bait directly to rodent burrows in areas where rodents remain active. If terrain does not permit use of bait station or burrow baiting, continue with broadcast baiting, limiting such treatments to areas where active signs of rats are seen. Maintain treatments for as long as rodent activity is evident in the area and rodents appear to be accepting bait.

For all methods of baiting, monitor the baited area periodically and, using gloves, collect and dispose of any dead animals and spilled bait properly. Dead animals and spilled bait may be buried on site if the depth of burial makes excavation by nontarget animals extremely unlikely.

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
4700 River Road, Unit 149
Riverdale, MD 20737-1237
EPA Reg. No 56228-35
EPA Est. No. 61282-WI-1

Net Contents: 20 lbs. (9.07 Kg)

Label Revised: 12/07/2007