Draft

Alternatives Selection Process Report
For the Farallon Mouse Eradication DEIS

Executive Summary

The Alternatives Selection Process Report describes the quantitative decision-making tool that was developed to assist the USFWS in deciding which mouse removal methods might become Action Alternatives that will be developed and fully analyzed in the *Draft EIS: Invasive House Mouse Eradication from the South Farallon Islands of the Farallon National Wildlife Refuge.* The Alternative Selection Process utilized available data and the expertise of eradication specialists and island resource specialists to systematically analyze and objectively compare potential mouse removal methods.

The methods analyzed with this tool were scored and ranked if they were consistent with meeting the purpose of the project. The project purpose states that the proposed action must meet the Service's management goal of protecting and restoring the ecosystem of the Farallones, particularly seabirds and other native biological resources, by eradicating non-native house mice. The potential mouse removal methods that were analyzed were selected based on public and agency comments received during the NEPA scoping processes from 2006 and 2011, as well as from a thorough review of past mouse and rodent eradication efforts world-wide.

Fifty-five potential mouse removal methods were analyzed in the model, including sixteen rodenticides with various application methods, mechanical removal methods such as trapping, and several theoretical methods such as sterilization. This selection tool is intended to allow decision makers to compare the potential impacts of each method to island resources and determine which methods have the greatest potential to effectively eradicate mice from the Farallon Islands, as well as to achieve the purpose of the project with the least impact on the environment.

Thirteen products were developed as input parameters to the decision-making tool or to provide additional support for decision-makers when using this tool to determine which methods should be developed into action alternatives for the Draft EIS. The products developed include:

1. **List of Minimum Operational Criteria**
2. **List of Operational Tools and Methods**
3. **List of Important Operational Considerations, Environmental Concerns, and Potential Mitigation Measures** to evaluate in Matrices
4. **An Analysis of Mouse Control vs. Eradication**
5. **Comparison of Mouse and Rat Ecology**
6. **Conceptual Model of the Alternative Selection Process**

7. **Matrices evaluating the Methods for Environmental Concerns**
   a. *Biological Resources Worksheet* (Short Term Negative Impacts)
   b. *Overall Environmental Concerns Matrix*
8. **Operational Considerations Matrix** evaluating all potential alternatives
9. **Combined Matrix** that combines scores from the *Overall Environmental Concerns Matrix* and the *Operational Considerations Matrix*
10. **Minimum Operational Criteria Matrix** comparing each potential alternative
11. **Mitigation Matrix** that includes a subset of potential alternatives that meet the Minimum Operational Criteria and are evaluated for mitigation potential
12. **Potential Alternatives List** with a described outcome from the Alternatives Selection Process based on the Total Score from the above ranked matrices.
13. **Report Summary** on how the Potential Action Alternatives were assessed and scored

Each potential alternative was analyzed for its potential impact to island resources (biological, physical, and social), as well as its availability for use and its potential for successfully eradicating mice from the Farallon Islands. The scores allowed for easy comparison of the potential alternatives to better understand the relationship between various operational and environmental concerns. The fifty-five methods resulted in scores ranging from a low (best) of 24 to a high (worst) of 96.

Every method was filtered through a checklist to establish a subset of potential alternatives that meet the Minimum Operational Criteria. The Minimum Operational Criteria is a coarse filter that provided a framework for eliminating methods that were logistically or technically unfeasible (not available), unacceptably unsafe, or whose use might violate Refuge's guidelines or Department of Interior policies. Of the 55 potential alternatives, eight satisfied all of the Minimum Operational Criteria, and all eight methods had scores that ranked among the top ten scores for combined environmental concerns and operational considerations. All eight potential action alternatives involved an aerial application of rodenticide as the primary eradication method. The eight methods were then rescored under a mitigated scenario based on a selected suite of potential mitigation measures and best practices that could be employed during a mouse eradication operation.

Of these eight possible methods, diphacinone and brodifacoum are the only two compounds that have products that are currently registered with the EPA for conservation use for island rodent eradications, and thus are the only two legally available for island eradication use in the United States. The available products are diphacinone-D50, brodifacoum-25D (designed for dry environments like the Farallones) and brodifacoum-25W (designed to last longer in wet tropical environments). The two potential alternatives that are currently available for conservation/eradication use, and are best designed for the Farallon Island's climate are **Diphacinone-D50** and **Brodifacoum-25D**.

Five methods met the Minimum Operational Criteria but were not considered as suitable as Action Alternatives due to current unavailability: they are not registered with USDA for conservation use, and they appear to have no greater efficacy for eradicating mice nor any less of an impact on the environment than the two available registered rodenticides. The five toxicants dismissed are either first generation anticoagulants toxicologically similar to diphacinone, second generation anticoagulants toxicologically similar to brodifacoum, or a subacute toxicant that has similar impacts as brodifacoum.

Of the five toxicants that were not selected as Action Alternatives, none are projected to have a higher potential to eradicate mice from the Farallon Islands than brodifacoum or diphacinone.

Based on all of the information reviewed and assessed in this process, the two alternatives that scored among the top for full development and analysis as Action Alternatives in the Draft EIS are the two products that are currently legally available and registered for island eradication and conservation use in the United States: **aerial diphacinone D50 and aerial brodifacoum 25D.**

Of the 60 island mouse eradications attempted worldwide, over 82% have utilized one of these two compounds (n=1 for diphacinone, n=48 for brodifacoum). Of the 41 successful mouse eradications world-wide, 98% (all but one) used brodifacoum or a closely related second generation anticoagulant.

The following table illustrates the outcome of each of the eight potential Action Alternatives and a brief justification for dismissal from further consideration or inclusion in the EIS as an Action Alternative.

Potential DEIS Action Alternatives Meeting the Minimum Operational Criteria

Alternative	Total Score (Unmitigated)	Suggested Outcome	Justification
Aerial Warfarin	24	Dismissed	Not registered, similar to D50, history of resistance
Aerial Diphacinone D50	27	**Action Alternative in EIS**	**Registered, history of use**
Aerial Brodifacoum 25D	30	**Action Alternative in EIS**	**Registered, history of use**
Aerial Chlorophacinone	30	Dismissed	Not registered, similar to D50
Aerial Cholecalciferol	31	Dismissed	Not registered, similar impacts to 25D, history of resistance
Aerial Brodifacoum (25W)	34	Dismissed	Intended for wet climates, potential for higher non-target impacts than 25D
Aerial Difethialone	34	Dismissed	Not registered, similar to 25D
Aerial Bromadiolone	34	Dismissed	Not registered, similar to 25D

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Alternative Selection Process Objectives

1. **Identify a reasonable range of alternatives that meet the Purpose & Need for action based on input from project scoping** *(and in conformance with 40 CFR 1502.14 & 43 CFR 46.415)*

2. **Explore and assess each alternative to be considered according to a set of established *Minimum Operational Criteria, Environmental Concerns, and Operational Considerations*.**

    a. Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated (§1502.14(a)).

    b. Use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize the adverse effects of these actions on the quality of the human environment (§1502(e)).

    c. The range of alternatives discussed in Environmental Impact Statements shall encompass those to be considered by the ultimate agency decision-maker (§1505.1(e), §1502.2(e)).

3. **Systematically accept or dismiss alternatives from further consideration for development in the DEIS based on whether they meet the *Minimum Operational Criteria* for success.**

4. **Objectively assess the remaining alternatives for mitigation potential to assist in deciding which alternatives will be developed as Action Alternatives in the Draft EIS for the Farallon Mouse Eradication project.**

5. **Fully document the Alternatives Selection Process and the rationale used to select alternatives based on the *Minimum Operational Criteria, Environmental Concerns,* and *Operational Considerations.***

Alternative Selection Uncertainty Model Inputs and Parameters

1. Identify the Minimum Operational Criteria for the Project (Product 1)

- The Minimum Operational Criteria identify the necessary characteristics that an alternative must have to be fully developed in the Draft EIS.

2. Purpose Statement

A. The Purpose Statement serves to focus the scope of alternatives to be considered. The Purpose Statement was defined by FWS refuge staff with core partners PRBO & IC.

Purpose = *The purpose of the proposed action is to meet the Service's management goal of protecting and restoring the ecosystem of the Farallones, particularly seabirds and other native biological resources, by eradicating non-native house mice.*

3. Compile a List of All Available Operational Tools and Methods (Product 2)

- Record each tool and method as a row heading in the matrix.

<u>*Tool examples include*</u>:

I. Trapping
II. Predator introduction
III. Non-rodenticide bait products (*i.e.* Eradibait)
IV. Rodenticides

<u>*Rodenticide Delivery Method examples include:*</u>

V. Aerial broadcast
VI. Bait Stations
VII. Hand Broadcast

4. Identify the Major Environmental Concerns, Operational Considerations, and Mitigation Measures to be Analyzed in the Matrices (Product 3)

A. Review Environmental Issues, Operational issues, and potential Mitigation Measures from EIS scoping and the EA planning process

B. Synthesize results of recent EIS scoping with issues identified and analyzed during previous EA development and EA scoping process

C. Add suggestions for additional issues brought forward by cooperating agencies

D. Identify the Environmental Concerns, Operational Considerations, and Mitigation Measures that should "drive" the alternatives development

5. For each Tool/Method, assess their effects on Environmental Concerns, Operational Considerations, potential Mitigation; then determine if they meet the Minimum Operational Criteria (Products 4 – 13)

A. <u>Write a qualitative description of the decision criteria and scoring rational</u>

B. <u>Analysis Control vs. Eradication</u>
   I. Analyze the cost/benefit of control tools
   II. Determine if any control projects meet the Purpose and Need of the project

C. <u>Summary of mouse vs. rat ecology</u>
   I. Summarize the differences and similarities between mouse ecology and rat ecology, and determine how species ecology impacts operational success in eradicating the target species.

D. <u>Conceptual Model of the Matrices</u>
   II. Develop a conceptual model that illustrates the matrix process, as well as describes the thought process behind the step.

E. <u>Assess Environmental Concerns</u>
   III. To what extent is the potential alternative likely to lead to short term negative impacts?
   IV. How will Environmental Concerns be evaluated for each potential alternative?

F. <u>Assess Operational Considerations</u>
   I. To what extent is the potential alternative likely to negatively impacts island resources?
   II. How will Operational Considerations be evaluated for each potential alternative?

G. <u>Assess if Alternatives Meet Minimum Operational Criteria for Further Consideration</u>
   I. All Minimum Operational Criteria must be met in order to fully develop and analyze alternatives in the EIS

H. <u>Determine Mitigation Measures that could address the Environmental Concerns</u>
   I. Assess the extent to which impacts could be reduced for each potential alternative
      - Examples:
         - Carcass removal
         - Gull hazing
         - Raptor capture/relocation
   II. Determine the scoring system for mitigation

I. <u>Determine the Total Mitigated Score for each Alternative</u>
   I. Combine scores from the Mitigated Environmental Concerns and Operational Considerations to obtain a Total Mitigated Score for each alternative

J. **Rank the Alternatives based on their Overall Scores**
   I. Ranked alternatives will be used as a guide to select the action alternatives that will be fully developed and analyzed in the EIS

Alternative Selection Model Procedures

1. **Import lists (Products 1, 2, and 3) into Matrix columns and rows (Products 7-12)**

2. **Assess the difference between a control and eradication projects (Product 4)**
   A. Describe the differences between control projects vs. eradication projects. What is the ideal scenario to use a control or an eradication technique?
   B. Determine if both control and eradication projects have the potential to meet the goals of the Purpose and Need statement; if they do create a list of potential control alternatives to consider in this analysis.

3. **Summarize the similarities and differences between mouse and rat ecology (Product 5)**
   A. What are the differences and similarities between mouse and rat ecology
   B. What information about rats and rat eradications is usefully when planning a mouse eradication and what information is not?

4. **Develop a Conceptual Model illustrating the Alternatives Selection Process (Product 6)**

5. **Develop Matrices (Biological Resources Worksheet and Overall Environmental Concerns) that evaluate the alternatives for Environmental Concerns (Products 7a-b)**
   A. Identify all of the major environmental concerns (Product 3) for the matrix
   B. Develop matrices for short term negative impacts to the island population and long term positive impacts to the global population for each species or group of species
   C. Determine how each environmental concern will be evaluated and scored within the matrix
   D. Score each tool and delivery method for environmental concerns
   E. Total scores for each implementation tool and delivery method
   F. Provide justification for scores

6. **Develop a Matrix that evaluates the alternatives for Operational Considerations (Product 8)**
   A. Identify all of the operational issues (Product 3) for the matrix
   B. Determine how each operational consideration will be evaluated and scored within the matrix
   C. Score each implementation tool and delivery method for operational Considerations
   D. Total scores for each implementation tool and delivery method
   E. Provide justification for scores

7. **Develop a Filter that determines if each alternative meets the Minimum Operational Criteria (Product 10)**
   A. Determine if each alternative meets the Minimum Operational Criteria to be considered further

B. Provide justification for dismissing alternatives that do not meet the Minimum Operational Criteria

8. **Develop a Mitigation Matrix that includes the alternatives that meet the minimum Operational Criteria and determine the mitigated score for each alternative (Product 11)**
    A. Create a list of alternatives that meet the Minimum Operational Criteria (**Product 1**)
    B. For each Environmental Concern reevaluate the short term impacts of the alternative with mitigation measures.
    C. Determine and justify the amount of relief (score) each mitigation measure will have on the overall impact to the Environmental Concerns and Operational Considerations
    D. Combine scores from the Operational Considerations Matrix (**Product 8**) and Mitigated Environmental Concerns (**Product 11**) to determine the Total Mitigated Score of the alternative

9. **Develop a ranked list of alternatives based on their Total Score and determine which of the alternatives will be dismissed or considered and evaluated fully within the EIS (Product 12)**
    A. Rank the alternatives using their unmitigated scores from the from the ranked overall scores (Product 9)
    B. FWS will determine which alternatives will be developed in the EIS from the ranked list
    C. From this list determine what field studies might be necessary to fully develop each of the identified alternatives

10. **Write a qualitative analysis of the decision criteria and the rational for scoring each alternative (Product 13)**
    A. Analysis should be a direct reflection of the matrices
    B. Analysis should provide a justification and explanation for how each alternative was scored throughout the process
    C. Careful analysis and review of the rational for all dismissed alternatives will be the priority

Products

List of Products:

1. **List of Minimum Operational Criteria**
2. **List of Operational Tools and Methods**
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10. **Minimum Operational Criteria Filter** comparing each of the potential alternative
11. **Mitigation Matrix** that includes a subset of potential alternatives that meet the Minimum Operational Criteria and are evaluated for mitigation potential
12. **Potential Alternatives List** with a described outcome from the Alternatives Selection Process based on the Total Score from the above ranked matrices.
13. **Summary Report** describing how the Potential Action Alternatives were assessed and scored

- **Product 1 - Minimum Operational Criteria for Action Alternatives**

  A. Must be Consistent with the USFWS Farallon Refuge Management Guidelines

  I. *Mission of USFWS Refuges*
  II. *Mission of the Farallon NWR*
  III. *Farallon CCP*
  IV. *DOI Policy on Introduced/Invasive Species*
  V. *Wilderness Act Minimum Requirements*
  VI. *Endangered Species Act Take Requirements*

  B. Implementation of the Alternative is Feasible to Implement

  I. *Product is available and registered for conservation eradication or could affordably be developed and registered for conservation eradication within 2 years, including research, trialing, manufacturing, registering, planning, and implementing. (See USDA letter regarding rodenticide registration process).*

Table 1. Economic Feasibility Description

Economic Feasibility	Affordable	Expensive	Exorbitant
Description	$50,000 or less above current project budget	$50,000 to $100,000 above current project budget	$100,000 or more above current project budget
Method/Product	• Introduced Predators • Hand & Aerial Diphacinone-D50 • Hand & Aerial Brodifacoum-25D	• Hand & Aerial Zinc Phosphide • Hand & Aerial Warfarin • Hand & Aerial Chlorophacinone • Hand & Aerial Cholecalciferol • Hand & Aerial Bromethalin • Hand & Aerial Bromadiolone • Hand & Aerial Difethialone • Bait Station Diphacinone-D50 • Bait Station Brodifacoum-25D & 25W	• Eradibait • Immunocontraception • Introduced Disease • Genetic Engineering • Live-trapping • Snap-trapping • 1080 • Hand, Aerial, & Bait Station Pindone • Hand, Aerial, & Bait Station Strychnine • Hand, Aerial, & Bait Station Flocoumafen • Hand, Aerial, & Bait Station Coumatetralyl • Bait Station Zinc Phosphide • Bait Station Warfarin • Bait Station Chlorophacinone • Bait Station Cholecalciferol • Bait Station Bromethalin • Bait Station Bromadiolone • Bait Station Difethialone

C. **Alternative Meets with Personnel Safety and Logistical Guidelines**
   I. *Is the alternative safe and unlikely to put personnel at undo physical risk and can it be implemented without accessing the entire island by foot?*

- ## Product 2 – Operational Tools and Methods
  - *Tools include*:
    - Live Trapping
    - Snap Trapping
    - Disease
    - Genetic Engineering
    - Sterilization
    - Non-native Predator introduction
    - Non-rodenticide bait products
      - Eradibait
    - Rodenticides:
      - Tools
        - Acute
          - Zinc phosphide
          - Bromethalin
        - Subacute
          - Cholecalciferol
        - First Generation Anticoagulant
          - Diphacinone 50 (Hacco)
          - Warfarin
          - Chlorophacinone
          - Diphacinone (non-Hacco)
        - Second Generation Anticoagulant
          - Brodifacoum 25D
          - Brodifacoum 25W
          - Bromadiolone
          - Difethialone
        - Non-US Registered Rodenticides
          - Pindone – 1st Generation
          - 1080 (Sodium Fluoroacetate)
          - Strychnine - Acute
            Coumatetralyl – 1st Generation
          - Flocoumafen – 2nd Generation
        - Aerial broadcast
        - Bait Stations
        - Hand Broadcast

- **Product 3 – Environmental Concerns, Operational Considerations, and Potential Mitigation Measures**

Environmental Resources of Concern

<u>Physical Resources</u>

- Water- drinking water and ocean water
- Soil
- Wilderness

  <u>Issues to Consider</u>

  - Risk of water contamination – solubility and persistence
  - Risk of soil contamination or compaction
  - Risks to "wilderness character"

<u>Biological Resources</u>

- Seabirds – Western gulls, Ashy storm petrels, Leach's storm petrels, , other cavity nesters (Pigeon guillemont and Tufted puffin), surface nesters (Brandt's cormorant, Pelagic cormorants, and Common murre), burrow nesters (Cassin's auklet and Rhinoceros auklet), and other gulls (California gull, Glaucous-winged gull, and Heerman's gull)
- Shorebirds - Black Oystercatchers (resident breeder), Black Turnstone, and Wandering Tattler
- Raptors – Burrowing owl, Peregrine falcon, Common raven, American kestrel, Red-tailed hawks, and other rare transient raptor species
- Passerines- Migrant or Vagrant
- Farallon Arboreal Salamanders
- Marine mammals – Stellar sea lions, N. Elephant seals, California sea lion, N. fur seal, Harbor seal
- Vegetation –
  - **Native:** Maritime goldfield (*Lasthenia maritime* = "Farallon weed"); *Sticky sandspurry (Spergularia macrotheca)*; Miner's lettuce (*Claytonia perfoliata*.
  - **Introduced**: New Zealand spinach (*Tetragonia tetragonoides*), Ripgut brome (*Bromus diandrus*); Foxtail barley (*Hordeum murinum leporinum)* Cheeseweed (*Malva parviflora*) and Plantain (*Plantago coronopus*).
- Invertebrates –
  - **Terrestrial**: Farallon Camel cricket, Kelp fly, Beetles (Lepidoptera) , spiders;
  - **Marine:** Mussles *(Mytilus californianus, Chthamalus dalli/Balanus glandula, Lottia scabra, L. giganita* & *Tetraclita rubescens*), Colony anemone *(Anthopleura elegantissima),* limpets, barnacles
- Nearshore Fish
- Human Health and Safety

  <u>Biological Issues to Consider</u>
  - T = Toxicant Risk (toxicity + exposure = toxicant risk)
  - D = Disturbance Risk (e.g. trampling vegetation, temporary breeding disturbance, etc.)
  - H = Habitat alteration/destruction (e.g. long-term habitat alteration)

Social/Historical Resources

- Historical features – buildings and artifacts
- Fisheries and tourism – recreational and commercial

Issues to Consider
- o Impacts to recreation
- o Impacts to historical features
- o Impacts to commercial fisheries

Scoring Likely Resource Impacts
- o All resources score 0 to 3 for impacts from method to island resources
  - 0 = Negligible or Not Applicable
  - 1 = Low
  - 2 = Medium
  - 3 = High

Operational Considerations
1. Efficacy
2. Legal availability of technique
3. Physical availability of technique
4. Economic feasibility
5. Personnel safety
6. Logistical/Technical feasibility
7. Research needs

Table 2 below is a breakdown of the valuation system for each Operational Consideration.

Table 2. Operational Consideration Scoring System

Value	Efficacy	Legal Availability	Physical Availability	Economic Feasibility	Personnel Safety	Logistical Feasibility	Research Needs
3	Ineffective	Illegal	No Known Source	Exorbitant (more than $100,00 above current budget)	High Risk	Unfeasible	Exorbitant
2	Low	Not Legally Available	Needs a Redesign	Expensive ($50,000 to $100,000 above current budget)	Moderate Risk	Low	Extensive
1	Moderate	Legal for Other Purposes	Could be Manufactured	Affordable (within $50,000 of current budget)	Low Risk	Moderate	Some Required

List of Potential Mitigation Measures

1. Mouse Carcass removal
2. Gull Hazing – intended to reduce gull take to a minimal level
3. Raptor capture/hold/relocation
4. Captive holding of Salamanders
5. Captive holding of Camel Crickets
6. Tarp drinking water
7. Bait deflector
8. Reducing wildlife disturbance (eg. Crouching, walking slowly, etc.)
9. Controlled surveillance flights to decrease impacts to pinnipeds

- **Product 4 – Assessment of Control vs. Eradication**

Eradication

Rodent eradications are one-time operations that can take years to plan, but are usually implemented in a limited time-frame of a few weeks or months. Rodent eradications are primarily attempted on isolated islands where the invasive rodent species impacts the native species of plants and animals, as well as the islands natural ecological processes. The intent of an eradication is the complete removal of every single individual of the target rodent species from the island. Complete removal (100% removal) is required for an eradication to be considered a success, as failure to remove every individual from an island population can result in the surviving individuals repopulating the island to their former levels in the span of a few months due to their prolific breeding abilities.. It was found that 20 mice placed in an outdoor enclosure became a population of 2,000 within 8 months (Corrigan 2001) as one female can produce 6-8 litters per year with up to 7 young per litter, and the young mature and become reproductively active about three weeks after birth. In some cases, surviving rodent populations may develop avoidance behaviors to the removal method and even develop a physiological resistance to the rodenticide (eg. warfarin).

More than 332 successfully rodent eradications have been conducted on over 284 islands in 18 countries, mostly within the last 20 years (Howald et al. 2007). The successful eradication of an invasive rodent species typically results in a natural recovery of the native and endemic island biota. Furthermore, without the presence of the invasive rodent species most island species flourish. The only major follow-up efforts that are typically required are biosecurity measures intended to reduce the likelihood of island recolonization by the target species or any other non-native species. On all but the very smallest islets, the only rodent eradication technique that has been successful involves the use of a lethal dose of rodenticide distributed to every individual on the island.

The risks of rodenticide use to non-target species are limited in that the extent of exposure to the rodenticide is confined to a largely closed island ecosystem and because the rodenticide is used one-time only, and is not chronic, continuing with unrestricted use, as is the case with mainland "control" efforts. Pathways of exposure to higher order predators are much more limited on islands compared to the mainland since there are far fewer species on a given island than on the mainland and the limited window of exposure during rodenticide eradications minimizes the unintentional toxicant impacts from a single exposure event compared to chronic long term exposure during a control operation. In addition, most non-target species that are negatively impacted during an eradication usually recover within a matter of months or a few years, while the positive impacts to the ecosystem are significant and permanent.

The generally high cost and logistical complexity of conducting a whole-island rodent eradication requires the use of techniques and tools that maximize the probability of conducting a successful rodent eradication on the first attempt, while minimizing the impacts to non-target species.

Control

Rodent control efforts, however, are primarily used on the mainland, for agricultural purposes or for reducing rodent numbers near residential areas and buildings. The intent of a rodent control effort is to keep the rodent population as small as possible in a confined management area, usually because it is impossible to entirely eliminate an introduced rodent species in a large mainland area where immigration is usually inevitable. Because the goal of control efforts is to reduce the invasive rodent population level temporarily, and not to eliminate it entirely, it is not necessary for control operations to remove every single rodent. For this reason, less toxic compounds are often used for control purposes; however, these same compounds are not generally considered suitable for eradication purposes on islands where it is essential that every rodent receive a lethal dose of the toxicant. For rodenticide control projects, rodent reduction methods must be maintained in perpetuity, usually on a daily and yearly basis. While the initial lower cost of control efforts on islands appears affordable at first, when one factors in that they will need to be conducted year after year, in perpetuity, they become increasingly less cost-effective and less effective overall than a one-time eradication event.

The non-target risks of rodenticide use for control on the mainland are generally much greater than island eradication risks due to the open ecological system on the mainland, where the toxin can be distributed through a variety of pathways by a wider range of scavengers and predators. A mainland rodent control project that uses a rodenticide indicates that a toxicant will be chronically available in the environment for the duration of the control project and will be continually resupplied. Often uncertified applicators are responsible for resupplying and maintaining bait stations with little or no oversight as to application rates; this practice has led to an increase in secondary exposure and mortality of non-target species and humans.

The net conservation gain achieved by successful rodent control (i.e. reducing and maintaining rodent populations at low levels) compared to complete eradication could be similar, if a means of effective rodent control were possible. However, the risks to non-target wildlife from control operations are greater than the risks from an eradication operation due to the indefinite timeline for which a control operation must be sustained, long-term bait or personnel presence, and repeated disturbances from control operations all put non-target wildlife at constant risk of exposure. In addition, should scheduled control operations be interrupted, rodents are able to quickly reproduce and rapidly re-populate the island reaching former population sizes relatively quickly, thus requiring an intensification of control operations once more. The constant maintenance of an ecologically beneficial rodent control program (i.e. control of island-wide rodent populations to levels low enough to eliminate them as an ecosystem threat) is far less cost-effective, increases personnel safety risks, and does not result in the permanent conservation benefits of an island-wide eradication.

• Product 5 – Assessment of Mouse vs. Rat Ecology

As a consequence of human activity, one or more species of introduced rodent are now found on more than 80% of islands worldwide (Towns et al. 2006). The most frequent introductions have been the rat species (*Rattus rattus, R. norvegicus and R. exulans*) or the house mouse (*Mus musculus*). House mice are now the most widely distributed mammal species in the world (Mackay 2011). The introduction of rodent species has led to the extinction of many endemic island plants and animals and their presence continues to threaten those that still persist (Shiels 2010, Witmer et al. 2006).

While rats may weigh up to 80 times more than house mice, the impacts of house mice on island ecosystems can be as severe as rats, although their impacts have until recently been overlooked (Simberloff 2009, Angel et al. 2009, Wanless et al. 2007). In addition, the house mouse is also a vector for many human and wildlife diseases and is a major factor in the destruction of food supplies.

More than 330 successful rodent eradications have been undertaken on islands since 1971 (MacKay 2007). Success rates for mouse eradication have historically been lower on average than for rat eradications (Howald 2007, Parkes et al. 2011), but recent operations that have taken into consideration the differences in behavior and physiology between rats and mice have resulted in mouse eradication programs being as effective as rat eradications (MacKay 2011).

While many of the aspects of a rodent eradication are the same regardless of the rodent species targeted, understanding the unique behavior and biology of the target species allows for greater likelihood of eradication success and minimization of impacts to non-target species. Eradication methods effective for some rat species may not be as successful with house mice due to differences between mice and rats in their foraging ecology, home range, density, and physiology (Clapperton 2006).

The following discussion summarizes the most relevant differences in foraging ecology, home range, density, and physiology between rats and mice to help inform the planning process for the removal of introduced house mice from the South Farallon islands of the Farallon National Wildlife Refuge.

Foraging Ecology

All rodent species are opportunistic omnivores, readily consuming seeds, plants, invertebrates, and bird eggs and chicks (IUCN 2011, MacKay 2011). Mice tend to consume more invertebrates than rats (Shiels 2010) and are considered to be lighter and more intermittent feeders (Crowcroft & Jeffers 1961). Rats are also known to cache and store food more regularly than mice. Mice consume approximately 3-4 grams of food per day on average (~17% of their body weight) whereas rats need to consume approximately 43 grams of food per day (Ruscoe and Murphy 2005, Wanless et al 2007). Careful planning is therefore required to ensure that each rodent has access to and consumes the required amount of bait. Levels of neophobia may also differ between the species (Barnett 1988).

Home Range Size/Density

Rodent home range is a factor that is likely to affect the efficacy of eradication techniques. Rats generally have significantly larger home ranges than house mice (MacKay 2011). On average the home range for many rat species is typically greater than one hectare and can be as large as 11 hectares (Shiels 2010), whereas home ranges for house mice, are typically 0.25 hectare or less (Pickard 1984) with house mice in the San Francisco Bay area having home ranges from 0.14 hectares to 0.36 hectares (Liddicker 1966). The smaller home range size for mice accentuates the need to ensure comprehensive bait coverage when targeting a mouse population to ensure that every individual within the targeted population has access to bait or a trap, with no gaps in coverage.

Rodent home ranges are often dependent on the density of the population, and home ranges tend to expand as the population decreases or as food sources become scarce. Densities of introduced rats on islands are typically much lower than densities of invasive mice. Introduced house mice are physiologically different than rats, and are able to sustain much higher densities than rats, especially when they are the only rodent species present (MacKay 2011). Rat densities on Pacific islands are typically in the 5-10 individuals per hectare range, while most reported house mouse densities fall into the 10-50 individual per hectare range (Pearson 1963, MacKay 2011). However, estimated densities on islands can be an order of magnitude higher for mice than for rats. In a mark-recapture study on Southeast Farallon Island in 2010, mouse densities were calculated to be approximately 1,300 per hectare (95% CI 799-1792). This density estimate is among the highest ever reported for this or any other rodent species (Grout, in prep).

Most rodent populations typically show cyclical changes in population density (Ruscoe and Murphy, 2005), especially in higher latitudes when food or weather are variable MacKay 2011). Mouse removal operations must be designed and timed to consider these cyclical population fluctuations.

Physiology

Adult house mice generally range from 15 grams to 25 grams in weight, while introduced rat species can be as much as 80 times heavier (King 2005). Mice also differ in their physiology with higher metabolic and reproductive rates (MacKay 2011). Female mice can breed for the first time at 6 weeks of age and can produce litters of 6-8 young every 4 weeks after that (Berry 1981). Such reproductive capabilities can lead to massive irruptions and population crashes for mice (Singleton et al. 2005). In one study 20 mice placed in an outdoor enclosure with abundant food and water became a population of 2,000 in only 8 months (Corrigan 2001).

Mice and rats also react to toxicants differently (MacKay 2011). The LD50 (the amount of a toxin required to kill 50% of tested individuals) for mice for second generation anticoagulants such as brodifacoum is more than twice that required for Norway rats by body weight. The LD50 for diphacinone is as much as 350 times higher for mice than for rats (O'Conner and Booth 2001). These results suggest that mice are much less susceptible to anticoagulants than rats (O'Connor and Booth, 2001). Resistance by mice to first generation toxicants such as warfarin and diphacinone has also been recorded (Billing 2000, *in MacKay 2011*).

<u>Mouse Eradication Success Rates</u>

Many more island eradication operations have been undertaken for rats (>300) than for mice (60) and prior to 2007 reported operational failure rates were higher for mice (19-32%) than for rats (~5%-10%). Reasons for many of these failures are unclear but some of these operations targeted rats with little consideration of the differences between the rodent species present (Howald et al. 2007, MacKay 2007).

Much has been learned from earlier successes and failures and since 2007. Ten of the last eleven mouse eradications attempted have succeeded, amounting to a 91% success rate. Mice have now been removed from islands as large as Rangitoto and Motutapu (3,854 ha) in New Zealand, and although not yet confirmed successful Macquarie Island, at 12,800 hectares in size.

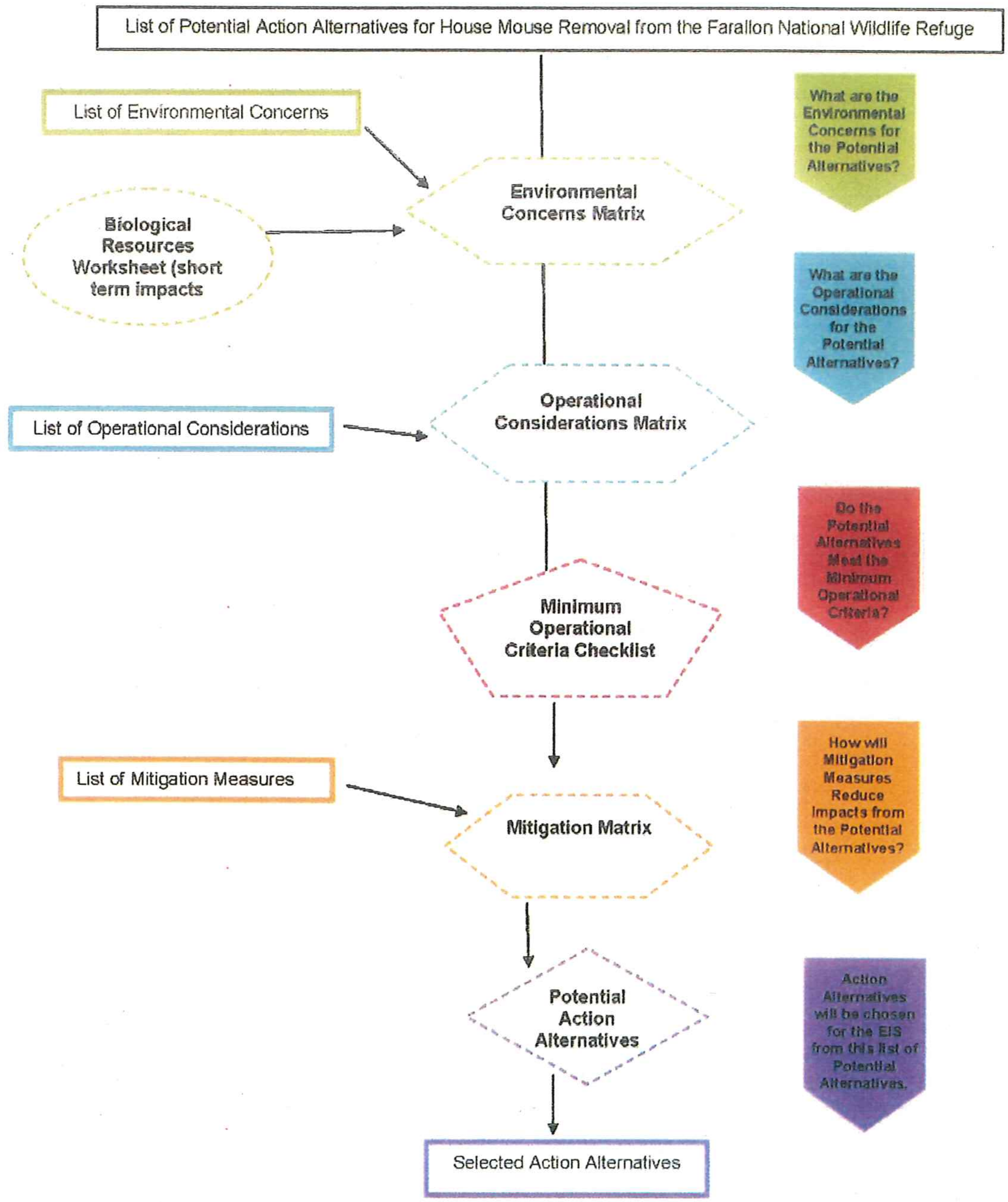
All of the successful mouse eradication attempts worldwide have relied on the use of toxins and, with only one exception, through the use of second generation anticoagulants. Of the 40 successful eradications, all but one used brodifacoum or a closely related second generation anticoagulant (see Table 3 below). Only one eradication using a first generation anticoagulant (warfarin) was successful (MacKay 2011).

Bait stations were used as the primary method in 30 of 60 mouse eradication attempts on 48 islands. Hand broadcasting was used in two attempts and aerial broadcast was used in 25 attempts. A total of 29 mouse eradication attempts have been completed on islands where another pest mammal species was present, and 13 of these operations failed. Early mouse eradication failures may have been complicated by the presence of other species and the eradication design may not have accounted for the presence of mice. Several operations that used bait stations used bait station spacing inappropriate for mice. When mice were the only target species on the island the eradication success rates has been over 90% (MacKay 2011).

Table 3. Summary of Mouse Eradication Method Attempts and Success Rates

Toxicant Used	Successful Attempts	Failed Attempts	Total # of Attempts	Percentage Success of Eradication
Second Generation Anticoagulants				
Brodifacoum	30	14	44	68%
Bromadiolone	4	1	5	80%
Flocoumafen	2	1	3	67%
First generation Anticoagulants				
Diphacinone	0	1	1	0%
Pindone	0	1	1	0%
Warfarin	1	0	1	100%
Combinations of Anticoagulants				
Pindone & Brodifacoum	3	0	3	100%
Brodifacoum & Flocoumafen	1	0	1	100%
Other Toxins				
1080 (Sodium Fluoroacetate)	0	1	1	0%

- **Product 6 – Conceptual Model of the Alternatives Selection Process**



- ## Product 13 – Report Summary

Introduction

The Alternatives Selection Process is a quantitative decision tool that utilizes available data and the expertise of eradication specialists and island resource specialists to systematically and objectively analyze and compare potential action alternatives to include in the Draft EIS: Invasive House Mouse Eradication from the Farallon National Wildlife Refuge. The wide range potential methods that are analyzed within this tool were assessed if they were consistent with the purpose of the project, which states that the proposed action will meet the Service's management goal of protecting and restoring the ecosystem of the Farallones, particularly seabirds and other native biological resources, by eradicating non-native house mice. Potential alternative methods were considered based on comments received during the NEPA scoping processes from 2006 to 2011, as well as methods that have a history of use in island invasive rodent eradication operations throughout the world during the past 40 years.

A total of 55 potential mouse removal methods were analyzed, including sixteen rodenticides with three different application methods (48 methods), as well as a seven other mechanical and theoretical methods (e.g. trapping and immunocontraception). This preliminary analysis assesses the primary removal method that would be used if implemented. The analysis does not assess the myriad of possible combinations of methods in an attempt to reduce the uncertainty within the model and to most accurately reflect the information available. It is possible that the Action Alternative eventually selected for implementation could utilize a combination of delivery methods; however, all alternatives will likely utilize one primary delivery methods assessed in this analysis. This model is not intended to provide a full scale impacts analysis, rather it is intended to allow decision makers to compare the potential impacts of each method to island resources and determine which methods have the greatest potential to effectively eradicate mice from the Farallon Islands. A full impacts analysis will be conducted for all Action Alternatives that will be included, described and developed in the Draft EIS.

Each method was analyzed for its potential impact to island resources (biological, physical, and social), as well as its availability for use and its potential for successfully eradicating mice from the Farallon Islands. The scores allowed for easy comparison of the potential alternatives to better understand the relationship between various operational and environmental concerns.

Every method was also filtered through a checklist to establish a subset of potential action alternatives that meet the Minimum Operational Criteria. The Minimum Operational Criteria checklist is a coarse filter that provided a framework for eliminating methods that were unsafe, logistically or technically unfeasible (cost, timing, and availability), or violated the Refuge's guidelines for island use. Of the 55 potential alternatives, eight satisfied all of the minimum operational criteria. All eight methods meeting the Minimum Operational Criteria ranked in the top ten (Scores of 24 - 34) when the scores for environmental concerns and operational considerations were combined (Product 9).

The final eight potential Action Alternative were also rescored under a potential mitigated scenario based on a selected suite of possible mitigation measures that could be employed during a mouse eradication. Two methods were identified as potential Action Alternatives for the Draft EIS based on their current availability as a registered product for island eradication and conservation purposes in the US, their potential to successfully eradicate mice, the ability to minimize most environmental impacts, as well as meeting the Minimum Operational Criteria.

Potential Alternatives

Fifty-five potential alternatives were analyzed within the alternatives selection decision-making tool. The following is a brief description of how each potential alternative will likely be implemented if it is chosen for full analysis in the Draft EIS.

Non-Rodenticide Methods:

Live Trapping –This would involve the setting and checking of live-traps throughout all portions of the South Farallon Islands, and removing all mice captured from the islands. The captured mice would likely be euthanized humanely on site and incinerated for human and environmental health reasons.
This technique would involve accessing all portions of all islands and conducting daily trapping efforts repeatedly for months, likely years. If traps were placed every 10 meters, approximately 5000 traps would be necessary to cover the 50ha island area. Traps would need to checked and baited and mice removed almost daily. If each person checked and baited 100 traps per day, 50 personnel on foot would be required to check the 5,000 traps daily. Trapping would be required for several years, perhaps indefinitely.

Snap Trapping –This method would likely involve much of the same personnel effort as the live-trapping technique above, although the mice would already be dead when captured. Over 5000 traps might be required if traps were placed at 10m spacing. Traps may need to be checked daily for weeks and less frequently for several years, perhaps indefinitely. If each person checked and baited 100 traps per day, 50 personnel on foot would be required to check the 5,000 traps daily. Trapping has been used successfully for eradication only on one very small flat island (less than 1-5ha).

Non-native Predator introduction – This technique would involve the introduction of an unknown number of non-native predators that are known to prey on rodents in the hopes that they would prey on and kill every last mouse on the islands. Cats and snakes were suggested in some of the public scoping comments.

Eradibait (Bait station only) - A biodegradable cellulose maize food product that blocks the digestive system of rodents, but it does not affect other mammals or birds. It causes rodent death by dehydration, blood thickening and circulatory collapse. It requires multiple feedings for 4-7 days, of at least 10-15 grams per mouse. It has never been used as an eradication tool, only for control in urban/residential settings. Since it is highly water soluble it can only be used in an enclosed bait station, and bait stations may need to be checked and refilled several times a week initially and continued for up to or exceeding two years. Eradibait has never been used an eradication tool.

Theoretical Methods (Not yet developed or ready for field testing)

Immunocontraception – Mammalian birth control, likely delivered in a food pellet matrix, aerially, that could theoretically inhibit conception and reproduction of mice. No such product yet exists in a deliverable or permitted format, and none is expected to be on the market for mouse eradication purpose in the near future. Since mice live up to 18 months or more before they die naturally of old age, delivery of this product would have to be to every mouse on the island for up to and likely exceeding two years to have a chance at eradication of all the mice. Bait would likely need to be continually delivered periodically for months or years.

Disease -Like immunocontraception, the technique of introducing a fatal disease that would kill only mice has been researched for decades, but no product or process is currently available for field testing for eradication. Theoretically, if developed in the future, this technique might involve introducing infected mice or food infected with some infectious agent that could kill mice, likely delivered aerially. A number of exposure attempts would likely be necessary during different portions of the island and throughout the year, possibly over many years.

Genetic Engineering –Another theoretical technique, but if developed, it might involve multiple releases on the islands of strains of genetically modified house mice that might cause an eradication by producing a sex-bias (daughterless method) so severe that mouse reproduction might eventually cease. Some lab and small field trial work on mosquitoes suggests that this might be a possibility for mice in the future, but this technique is at least 5-10 years away from being ready for any practical field use.

Rodenticide Methods:

Acute Rodenticides: Zinc phosphide, bromethalin, 1080 (sodium fluoroacetate), strychnine

Subacute Rodenticide: Cholecalciferol

First Generation Anticoagulants: Diphacinone-D50, warfarin, chlorophacinone, diphacinone non-D50, pindone, coumatetralyl

Second Generation Anticoagulants: Brodifacoum 25D & 25W, bromadiolone, difethialone, flocoumafen

Broadcast Methods:

Three broadcast methods are available for delivering pelletized rodenticides to all portions of the island:

Aerial Broadcast: Involves the use of sophisticated helicopter delivery using a specially designed calibrated agricultural type of hopper with Digital GPS mapping electronics to spread bait at designated rates over the entire island. One treatment can be accomplished on the Farallones in a few hours time. Two treatments separated by a week or two are usually conducted when using second generation anticoagulants (Brodifacoum 25D, Brodifacoum 25W, bromadiolone, difethialone & flocoumafen). Three or more treatments would likely be necessary if using first generation products (Diphacinone-D50, warfarin, chlorophacinone, non-D50 diphacinone, pindone, or coumatetralyl).

Hand Broadcast: This method would require hand broadcasting of the bait over all portions of the island by accessing all areas on foot, using over 5,000 designated baiting points spaced 10m apart. In order to complete one treatment on 50 ha, up to 50-100 people might be needed to allow for the marking of each bait point and to execute the simultaneous baiting of all 5,000 points in one day. Two applications might be required for second generation anticoagulants, and 3 or more applications might be required for first generation anticoagulants.

Bait Station: Bait Station application methods involve placing and securing bait stations to hold and deliver some Rodenticides, Eradibait , and potentially the Immunocontraception and Disease vectors (in food sources). Bait station operations are typically left in place for several months, and up to two years to ensure 100% delivery to all mice. Approximately 5,000 bait stations would be set out and secured at 10m spacing to cover the entire island, and would need to be checked every other day for several weeks and potentially less frequently for up to several months, up to two years. Approximately 50 bait stations could be checked and refilled per person per day, requiring 100 people to conduct the initial baiting, and 50 people to check all the stations every other day for several weeks/months, and then 15-20 people to check and refill the stations once/week for several months/years.

Scoring

Each method was scored for a suite of impacts and operational considerations using a range from zero to three. The lower the score the less impactful the method is projected to be to island resources, or the more likely the method is expected to satisfy the operational considerations. The scoring is a relative comparison of the methods to each other and is not intended to be used for comparison with other methodologies. The scoring system that was used for each matrix is explained in greater detail within the following discussion. In the instance that gaps in data were present, scores were determined by utilizing the known information for other similar methods. For example, many of the rodenticides that were considered have little to no information regarding their impacts to island resources, therefore, they were scored in a manner similar to other related rodenticides (e.g.. pindone is a first generation anticoagulant with little to no available data and was therefore scored in the same manner as diphacinone, another first generation anticoagulant).

Matrices

Environmental Concerns Matrix

The Environmental Concerns Matrix was split into the Biological Resources Worksheet, which compares the impacts of the potential alternatives to the biological resources and the Overall Environmental Concerns Matrix, which includes impacts to all of the island's resources including the physical, social, and biological resources.

<u>Biological Resources Worksheet</u> (Product 7a)

The Biological Resources Worksheet analyzes the likely expected short term impacts to one individual for each of the biological resources on the Farallon Islands for toxicant risk (T), disturbance risk (D), and habitat alteration risk (H). A score of zero indicates that the impact to the resource is expected to be negligible. A score of one indicates that the impact to the resource is expected to be low. A score of two indicates that the impact to the resource is expected to be moderate, and a score of three indicates that the impact to the resource is expected to be high. Scores were added together for all of the biological resources to obtain a total score. The total score was then incorporated into the Overall Environmental Concerns matrix to obtain the total score for the environmental concerns for each potential alternative.

In general, potential alternatives that utilize aerial methods of application had lower scores for disturbance and habitat alteration risk because they required minimal ground operations, while methods with some ground operations (ie. hand baiting) received moderate scores for disturbance and habitat alteration risk because they only require ground operations for a short period of time, and methods with extensive ground operations (ie. bait stations and live trapping) received high scores for disturbance and habitat alteration because they require extensive ground operations for an extended period of time. Potential alternatives that utilized acute, sub-acute, and secondary anticoagulant rodenticides scored higher than first generation anticoagulants for toxicant risk, while methods that did not include toxicants received negligible (0) scores for toxicant risk.

The score for toxicant risk was based on three factors: a) exposure potential, b) toxicity to the resource, and c) the type of rodenticide. Therefore, a toxicant may be highly toxic to an individual but receive a low score for toxicant risk if the individual is not likely to be present or doesn't have an exposure pathway (i.e. seabirds that primarily eat pelagic fish will be at a negligible toxicant risk since they will not likely come in contact with the toxicant through primary or secondary exposure pathways).

<u>Overall Environmental Concerns Matrix</u> (Product 7b)

The Overall Environmental Concerns Matrix provides scores for the impacts of each potential alternative to physical and social resources combined with the total score from the Biological Resources Worksheet (7a). The physical and social resources are scored from zero to three; zero is negligible impact, one is low impact, two is moderate impact, and three is high impact. For the most part all of the physical and social resources were similarly scored for all of the potential alternatives since none are likely to have significant impacts to any of these resources.

<u>Operational Considerations Matrix</u> (Product 8)

The Operational Considerations Matrix analyzes the potential for each method to be used to successfully eradicate all mice from the Farallon Islands. This matrix looks at the efficacy of the method at eradicating mice, its legal availability, physical availability, economic feasibility, safety to humans and logistics, and the research development costs prior to implementation. Each operational consideration is scored from zero to three, where zero represents the least risk and three has the most risk. Since each operational consideration is different, they have individual valuation systems.

The following table (Table 4) is a breakdown of the valuation system for each operational consideration.

Table 4. Operational Consideration Scoring System

Value	Efficacy	Legal Availability	Physical Availability	Economic Feasibility	Personnel Safety	Logistical Feasibility	Research Needs
3	Ineffective	Illegal	No Known Source	Exorbitant (more than $100,00 above current budget)	High Risk	Unfeasible	Exorbitant
2	Low	Not Legally Available	Needs a Redesign	Expensive ($50,000 to $100,000 above current budget)	Moderate Risk	Low	Extensive
1	Moderate	Legal for Other Purposes	Could be Manufactured	Affordable (within $50,000 of current budget)	Low Risk	Moderate	Some Required
0	High	Legal	Sold Commercially	Free	Negligible Risk	High	Little Required

Generally, methods that are not currently legally available (registered for conservation purposes in the United States) scored higher than those that are currently registered due to the economic feasibility, research needs, and physical availability of the method. Potential alternatives that are more likely to control the mouse population rather than eradicate all of the mice from the island scored a higher risk than methods that had a history of successful eradication use. Methods that required heavy ground operations scored higher than those that could be applied aerially and methods that have the potential to eradicate mice but are not currently available scored higher than those that are available for use at this time.

Combined Matrix of Environmental Concerns and Operational Considerations (Product 9)

The Combined Matrix incorporates the scores from the Overall Environmental Concerns Matrix (Product 7b) and the Operational Considerations Matrix (Product 8) to provide a ranked list of alternatives.

Table 5 below is a list of the top ten scoring methods from the Alternatives Selection Process. The seven aerial rodenticide methods listed in the table below all passed through the Minimum Operational Criteria Checklist and were considered for inclusion in the EIS as potential action alternatives. In addition, sterilization, disease, and genetic engineering are all methods that potential could someday be effective at eradicating mice; however, at this time all three are in the theoretical planning stages, many years from being field tested, and are not available at this time, and thus are not viable action alternatives for selection.

Table 5. Top Ten Scoring Methods of the Alternative Selection Process

Possible Action Alternatives	Total Environmental Concerns (7a + 7b)	Total Operational Considerations (8)	Total Combined Score (9)
Aerial Warfarin	17	7	**24**
Immunocontraception (aerial) *	9	16	**24**
Aerial Diphacinone (D50)	21	6	**27**
Disease (aerial) *	9	19	**28**
Genetic Engineering *	12	17	**29**
Aerial Brodifacoum (25D)	27	3	**30**
Aerial Chlorophacinone	21	9	**31**
Aerial Cholecalciferol	23	8	**31**
Aerial Brodifacoum (25W)	31	3	**34**
Aerial Bromadiolone	27	7	**34**
Aerial Difethialone	27	7	**34**

* Alternatives eliminated from full consideration as they did not meet the Minimum Operational Criteria listed in Product 1.

<u>Minimum Operational Criteria Checklist</u> (Product 10)

The Minimum Operational Criteria Checklist is a coarse filter that requires all methods to meet a set of standards for further consideration as potential action alternatives in the Draft EIS. Each potential action alternative is required to be consistent with the Farallon National Wildlife Refuge management guidelines, be feasible to implement, and meet all safety and logistic requirements. Methods that do not satisfy all the minimum operational criteria were removed from further consideration and will be included in the DEIS in the section: *Alternatives that were Considered and Dismissed.*

Potential action alternatives that utilized mechanical means as the primary method of operation, including the use of snap traps or live traps, did not meet the Minimum Operational Criteria because they did not meet USFWS's safety and logistical guidelines since they require the use of extensive ground measures over the entire island, which is considered to be highly unsafe for personnel due to steep terrain, highly impactful to island resources, and logistically unfeasible. Similarly, all of the rodenticide methods that primarily utilized ground operations (hand baiting or bait stations) were eliminated for human safety, logistical feasibility and for unacceptable habitat and disturbance impacts.

Most rodenticide methods did not meet minimum operational criteria because they are not available or currently registered for any use in the United States, making the method unfeasible to implement in the near future due to the high costs associated with registering, trialing, and manufacturing the product, as well as the unknown time-frame associated with trialing the product for implementation. None of the unregistered products assessed are considered to have any likelihood of being any more effective for mice eradications than the currently registered products/methods. Many are either less effective on mice, and/or have equal impacts on non-target species as the available registered methods.

The eight methods that passed through Minimum Operational Criteria filter include the aerial application of rodenticide products that are currently registered with the EPA for some purpose in the U.S. Three are registered for island eradication use for non-native rodents, and five are registered for some type of control use, but not for aerial use for island eradication/conservation purposes.

<u>Mitigation Matrix</u> (Product 10)

The Mitigation Matrix was designed to compare methods under both mitigated and unmitigated operations. A suite of mitigation measures that may be included in the design of the action alternatives for the EIS were applied and valued for the potential alternatives that remained after the Minimum Operational Criteria filter. Mitigation measures that were included in this portion of the analysis involve techniques that have previously been employed in other island rodent eradication projects for conservation purposes and are intended to reduce the toxicant impacts to nontarget species from rodenticides. The mitigation measures in this analysis represent the type of mitigation measures that could be incorporated into operational plans for the action alternatives developed in the EIS; however, it is too early in the planning process to determine precisely which measures will ultimately be used during project implementation.

Additional mitigation measures not used in this preliminary analysis may also be considered and eventually employed. With the implementation of some mitigation measures (like bird hazing), the toxicant impacts to some species (e.g,. gulls) will decrease, while the temporary disturbance impacts to some non-target species (eg marine mammals) may increase. The overall scores for the mitigated methods are, in general, about the same as for the unmitigated methods, but these scores are not weighted for relative importance It is the responsibility of the USFWS and their cooperating reviewing/permitting agencies to make decisions on the methods and mitigation measures that balance the trade-offs between minimizing risk of toxicant exposure to non-target species (e.g., gulls) and potential increases in temporary disturbance to individuals of other species (e.g., marine mammals) due to some of the possible gull hazing measures.

Potential Action Alternatives

Of the 55 potential alternatives that were initially assessed in the model, a total of eight met the minimum operational criteria. All eight potential action alternatives incorporated an aerial application of rodenticide.

The eight potential action alternatives include:

- One sub-acute toxicant: **cholecalciferol**;
- Three first generation anticoagulants: **chlorophacinone, warfarin, and diphacinone**
- Three second generation anticoagulants: **brodifacoum, bromadiolone, and difethialone.**

Of these eight rodenticides, diphacinone (D50) and brodifacoum (25D and 25W) are the only two that have products that are currently registered with the EPA for conservation use and are legally available for use for island eradications in the United States. The other five other rodenticides in the top eight are not registered for island eradication or conservation use and have properties similar to either the first generation anticoagulant diphacinone, or the second generation anticoagulant brodifacoum. Additionally, the sub-acute toxicant (cholecalciferol) is just as impactful to island resources as the second generation anticoagulants but is not as efficacious at eradicating mice. These conclusions are based on the available toxicological information and information on published eradication success for mice, which have been researched and are included in the bibliography.

Of the three rodenticides available for island rodent eradications for conservation, one (Brodifacoum 25W) is designed for use in wet tropical environments, with a waxy agent that results in the bait pellet lasting for many weeks longer that the dry formulation (25D) in moist/rainy areas, and thus would last even longer in drier climate like the Farallones. The dry formulation (25D) was actually designed specifically for use in drier coastal California islands (Anacapa in the Channel Islands), so it would be a preferable bait, as it would remain available to mice for short time, but would disintegrate after normal winter rainfalls and would thus be less available to non-target species (such as gulls and other terrestrial foraging birds).

Top-Ranking Action Alternatives

Based on all of the information reviewed and assessed in this Alternative Selection Process, the two top-ranking alternatives from the model that could be fully developed and analyzed as action alternatives in the Draft EIS for the Farallon Mouse Eradication are two products that are legally available and currently registered for island eradication and conservation use in the United States: Aerial Diphacinone- D50 and Aerial Brodifacoum-25D. Of the 60 island mouse eradications attempted worldwide, over 82% (49) have utilized one of these two compounds (n=1 for diphacinone, n=48 for brodifacoum). Of the 41 successful mouse eradications world-wide, 98% (all but one) used brodifacoum or a closely related second generation anticoagulant. The potential efficacy of these two products for mice removal are relatively well documented, and the potential impacts of these products on the environment are also relatively well documented, making them the logical choice for Action Alternatives for the DEIS.

Table 6 below illustrates the suggested outcome for each of the eight potential alternatives, and a justification for dismissal from further consideration or inclusion in the DEIS as an Action Alternative.

Table 6. Potential DEIS Action Alternatives Meeting the Minimum Operational Criteria

Potential DEIS Action Alternatives Meeting the Minimum Operational Criteria			
Alternative	**Total Score (Unmitigated)**	**Suggested Outcome**	**Justification**
Aerial Warfarin	24	Dismissed	Not registered, similar to D50, history of resistance
Aerial Diphacinone D50	27	**Action Alternative in EIS**	**Registered, history of use**
Aerial Brodifacoum 25D	30	**Action Alternative in EIS**	**Registered, history of use**
Aerial Chlorophacinone	30	Dismissed	Not registered, similar to D50
Aerial Cholecalciferol	31	Dismissed	Not registered, similar impacts to 25D, history of resistance
Aerial Brodifacoum (25W)	34	Dismissed	Intended for wet climates; potential for higher non-target impacts than 25D
Aerial Difethialone	34	Dismissed	Not registered, similar to 25D
Aerial Bromadiolone	34	Dismissed	Not registered, similar to 25D

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