# 2011 Farallon Islands Field Trial

Trial to Assess Measures to Mitigate Risk to Non-Target Species during a Proposed Invasive House Mouse Removal Project

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# Contents

## 1. Introduction

This study intends to inform several aspects of the planning process to eradicate mice (*Mus musculus*) from the South Farallon Islands of the Farallon National Wildlife Refuge. A field team of four Island Conservation staff will initiate four major studies from November 8-17, 2011 on Southeast Farallon Island to monitor uptake of bait and appraise methods to reduce non-target mortality. The two main goals of this trial are 1) To determine how long bait pellets may take to degrade and therefore be unavailable to non-targets, and 2) Whether bait stations can be an effective means of limiting non-target exposure in small areas of the island. Weathering and degradation rates of placebo (non-toxic replicas) of four available rodenticide products will be assessed under the environmental conditions expected during the eradication period to determine the longevity and availability of each product to non-target species. A novel bait station design will be also deployed and compared to commercially available bait stations to determine which is more effective on the Farallones. Interactions that non-targets (gulls) have with the stations will be observed, and use by mice will be monitored. If the stations are effective for mice eradication and are tamper-proof to gulls, bait stations may be used as a tool to prevent gulls from encountering bait in some limited areas of the island, such as roost sites. Only non-toxic placebo bait will be brought and used on the island for these trials.

Weather during the proposed eradication period will be recorded and compared to historical data provided by Point Reyes Bird Observatory (PRBO Conservation Science). Mice tissue samples will be collected and stored for genetic analysis, and the breeding status of trapped mice will be determined. Cave dwelling non-target species (crickets, etc.) will be identified to the lowest

possible taxonomic level. A pilot census of crickets from three caves will inform baseline survey designs to be employed to sample cricket populations prior to and after any eradication.

## 2. Rodenticide Products

### 2.1 Bait Formulations

The following four rodenticide products are commercially available in the United States and are potential candidates for use on the Farallones (Table 1).

Table 1: Rodenticide Products

| Bait Name | Avg. Pellet Weight | Active Ingredient | Condition | Manufacturer |
|---|---|---|---|---|
| Conservation 25D | 1g | Brodifacoum | Dry | Bell Laboratories |
| Conservation 25D | 2g | Brodifacoum | Dry | Bell Laboratories |
| Conservation 25W | 2g | Brodifacoum | Wet | Bell Laboratories |
| Ramik® Green | 1g | Diphacinone | Dry | Hacco® |

The dry (Conservation 25D) formulation was developed by Bell Laboratories for dry temperate climatic conditions similar to the Farallones and coastal California, as it will degrade rather rapidly after a significant rain event(s). A wet formulation (Conservation25W) was developed by Bell Laboratories for humid locations where bait pellets must withstand regular rainfall and humidity in order to expose all target individuals to the rodenticide. Ramik® Green undergoes a hot extrusion process during manufacturing that makes it weather resistant without the use of wax.

### 2.2 Non-Toxic Placebo Bait Containing Biomarker

The Conservation 25D 1g and Ramik Green 1g non-toxic bait formulation are infused with the non-toxic biomarker dye pyranine (concentration of 0.2%). Pyranine (also known as Solvent Green 7) is a commonly used water-soluble dye found in commercially available products such as fluorescent marker pens, shampoos, soaps and cosmetics. It is also used to trace water-flows such as in plumbing systems, sewers and natural water-courses. It is non-hazardous, non-flammable and is not regulated as a hazardous material. Pyranine fluoresces green under ultra-violet light, providing easy detection in species that consume the pellets. The Conservation 25W pellet (2g) used in this trial study does not contain a biomarker.

## 3. Bait Degradation

### 3.1 Effects of Weathering

Longevity of rodenticide broadcast on islands varies with exposure to environmental and biological factors. Temperature, humidity, wind, salt spray, rain events, and invertebrates contribute to the amount of time that both target and non-target species may be exposed to bait. The period of time that toxic bait remains intact and palatable to rodents depends on the bait matrix, local environmental conditions, half-life of the rodenticide and the substrate type. Bait degradation can complicate eradications when bait degrades before all mice are exposed to a lethal dose. To ensure success, bait must be available and palatable until all mice have been exposed, including weanlings that may begin to forage after bait application. However, pellets that remain for prolonged periods pose risks to non-target species.

The risk of exposure to non-targets is greater for certain species like gulls. The risk of gull exposure increases the longer bait is available on the ground. Once gulls overcome initial neophobia of a novel food source like pellets, some gulls will select and consume bait pellets. Pellets that disintegrate into small crumbs are less feasible for consumption by gulls and most bird species, and yet may remain available to any remaining mice. Determining the length of time required for bait pellets to degrade under the temporal and environmental conditions specific to the Farallon Islands will inform the eradication planning and allow project managers to minimize non-target risk.

### 3.2 Study Locations

Bait weathering can vary greatly between different habitat types at the same location, thus it is important to trial the bait in as many of the major habitats as possible. Three major habitat types exist on the Farallones; Rock, Soil, and Vegetation. These habitats may further vary among location depending on the islands micro-climactic conditions. Potential sites will be evaluated upon arrival and classified as wet, dry, windswept, etc.. An equal number of sampling replicates will be placed in all climate types.

### 3.3 Sampling Design

Exclusion cages will be constructed to prevent all bird and rodent non-target species from consuming bait during the degradation study, with the exception of insects and other tiny consumers. Fifteen exclusion cages will be available for deployment. All cages will be uniquely labeled with aluminum tags for identification.

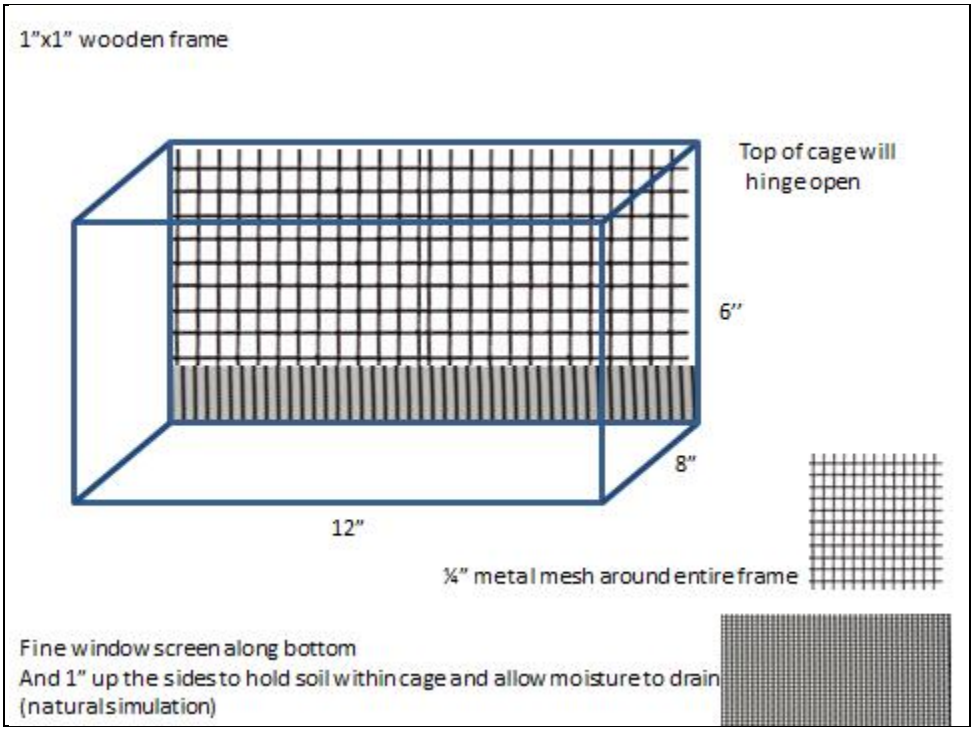


Figure 1: Exclusion cages for monitoring bait degradation.

Each exclusion cage will initially contain 16 bait pellets. Four pellets of each bait formulation will be placed in the cage and its location recorded for monitoring.

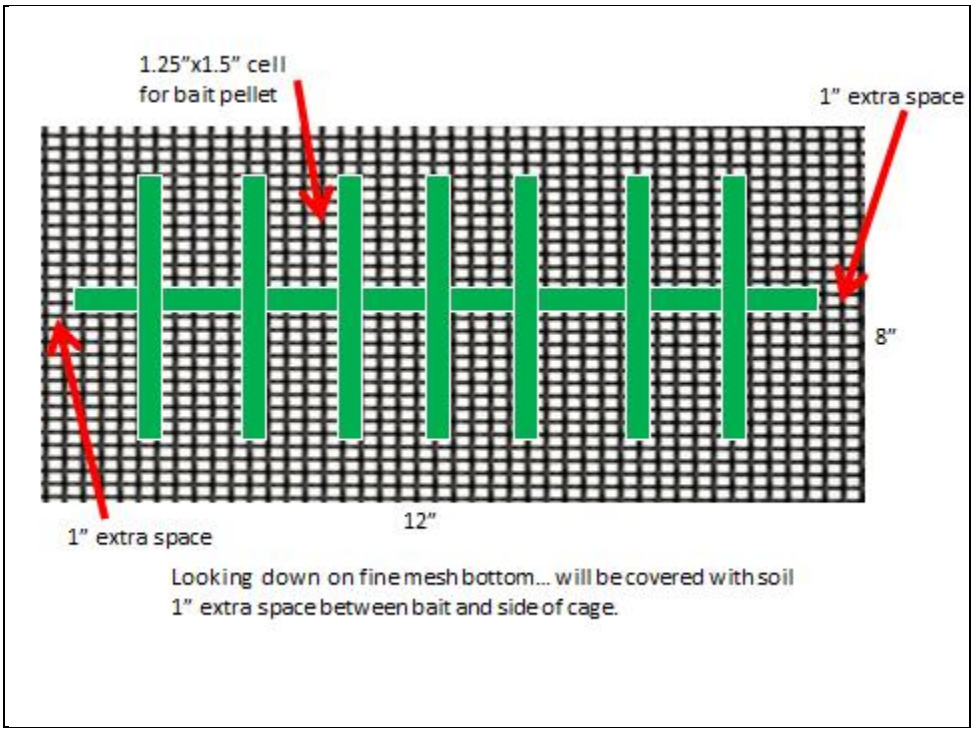


Figure 2: Divider placed in exclusion cage to prevent clumping of bait pellets.

Seven cages will record climatic data using Easy Log USB data loggers (Lascar Electronics). Data loggers will record ambient temperature, humidity, and dew point every half hour, and will be strategically placed to capture variation in local environmental conditions on island.

### 3.4 Monitoring

The condition of each pellet will be monitored daily using a bait degradation scale defined below (Table 2).

Table 2: Bait degradation scale after Craddock (2004).

| | Pellet matrix | Change in shape | Presence of mold | Loss of volume |
|---|---|---|---|---|
| **Condition 1** ***Fresh pellets*** | Identical to fresh bait | Identical to fresh bait | None | None |
| **Condition 2** ***Soft pellets*** | <50% pellet matrix is or has been soft/moist | Distinct cylinder still; smooth sides may have been lost | <50% bait pellets mold | Little or no volume lost |
| **Condition 3** ***Mush pellets*** | >50% bait matrix is or has been soft/moist | <50% pellet has lost distinct cylinder shape | >50% bait pellets have mold | Bait has lost some volume (<50%) |
| **Condition 4** ***Pile of mush*** | 100% of bait matrix is or has been soft | Pellets lost distinct cylinder shape & resembles a pile of mush with some grain particles in matrix showing distinct separation from main pile | >50% bait pellets have mold | Bait has lost some volume (<50%) |
| **Condition 5** ***Disintegrating Pile of mush*** | 100% of bait matrix is or has been soft | Pellet has completely lost distinct cylindrical shape and resembles a pile of mush with >50% of the grain particles in the bait matrix showing distinct separation from each other and the main pile | >50% bait pellets have mold | Bait has lost a significant amount of volume (>50%) |
| **Condition 6** ***Bait gone*** | Bait is gone or is recognizable as only a few separated particles of grain or powder. | Bait is gone or is recognizable as only a few separated particles of grain or powder. | Bait is gone or is recognizable as only a few separated particles of grain or powder. | Bait is gone or is recognizable as only a few separated particles of grain or powder. |

The contents of each exclusion cage will be assessed and photographed during daily inspection by Island Conservation staff during Nov. 8-17 (Table 3). After Island Conservation field staff departs (Nov. 17, 2011), the study will be carried on by PRBO staff/interns, with sampling to occur every 5-7 days, including bait condition data collection and photographs.

*Table 3: Example of Bait Degradation Data Record*

| Date | Cage # | Bait Type | Scale | Pellet Description | Weather/ Notes |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

The location of the 10-15 bait degradation cages will be placed largely on/near existing footpaths so as to avoid impacts to island resources, and to avoid impacts to existing study plots. Exact placement of the cages will be coordinated with PRBO staff on island prior to securing them.

**4. Analysis of Weather Data**

Heavy winter rain events are common during the late fall and early winter on the Farallon Islands. PRBO weather records for the Farallones indicate that the islands get up to 70% of their annual rainfall in just one or two major rain events in December or January (Figure 3). The weather during the field trial will be recorded and compared with historical weather data. This will include daily rainfall, minimum and maximum ambient temperatures, wind-speed and direction and approximate cloud cover.

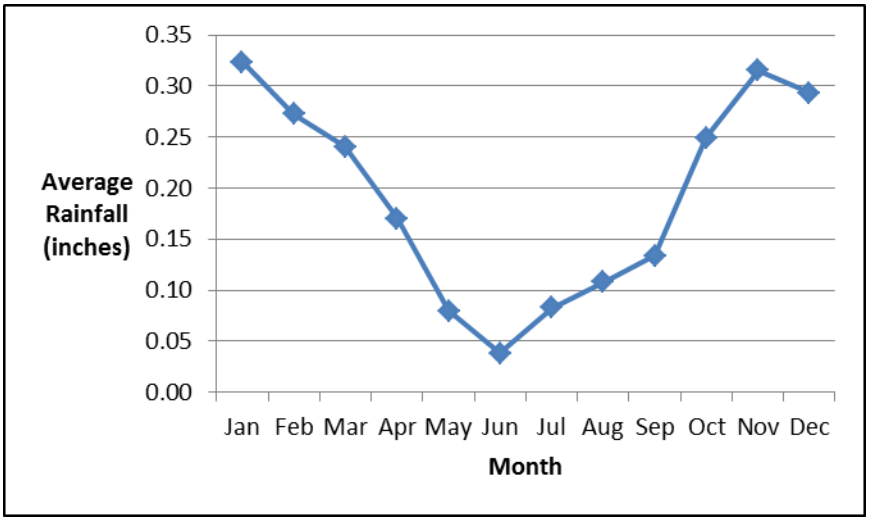


Figure 3: Average rainfall throughout a typical year on the Farallon Islands.

PRBO records contain accurate weather data extending back to 1968 for historical purposes. These data will be used to determine the most appropriate time for the mouse eradication.

### 5. Bait Stations

The potential vulnerability of gulls to non-target impacts from the mouse eradication must be reduced as much as possible. The Farallones are home to the world's largest colony of Western gulls, and the population ecology of the Farallones western gull colony is unique. Containing rodenticide inside bait stations in areas of heavy gull roosting may minimize gull exposure to pellets. However, use of bait stations must not compromise the success of eradicating all mice. If mice present neophobia that delay their use of bait stations or are deterred by the structure, bait stations may not be a viable option as an eradication tool. Mice visitation and efficacy of commercial and novel bait stations will be evaluated during this trial. If bait stations are determined to be effective, these data will also demonstrate which model of bait station is most appropriate on the Farallones.

Bait stations must be robust to withstand the environmental and biological pressures presented on the Farallones. Bait stations will be tested at known seasonal gull roosts near Little Arch and Mussel Flats; strategically placed to maximize exposure to high gull densities, areas with high ocean spray and splash, and interaction with hauled out marine mammals. Stations must be "gull proof". Gull heads must not be able to enter the bait stations or access bait and stations must be anchored to the ground so gulls cannot pick them up.

Two types of bait stations will be deployed. The *Protecta* is a commercially available bait station made of impact-resistant, injection molded plastic (Bell Laboratories, Inc., Madison W.I.). It can be staked to the ground for security. The box opens from the side for servicing using an Allen key wrench (Figure 4). Its dimensions are 6" x 5" x 2.5". Tracking pads will be installed inside the station to track mouse visitation.

Figure 4: *Protecta* bait station design.

A novel bait station will be constructed by Island Conservation staff (Figure 5). A PVC conduit body with PVC extensions on either side allow two entry/exit sites for mice. The top of the conduit body easily unscrews for inspection and refilling. Tracking pads will be placed in the extension tubes to track visitation by mice.

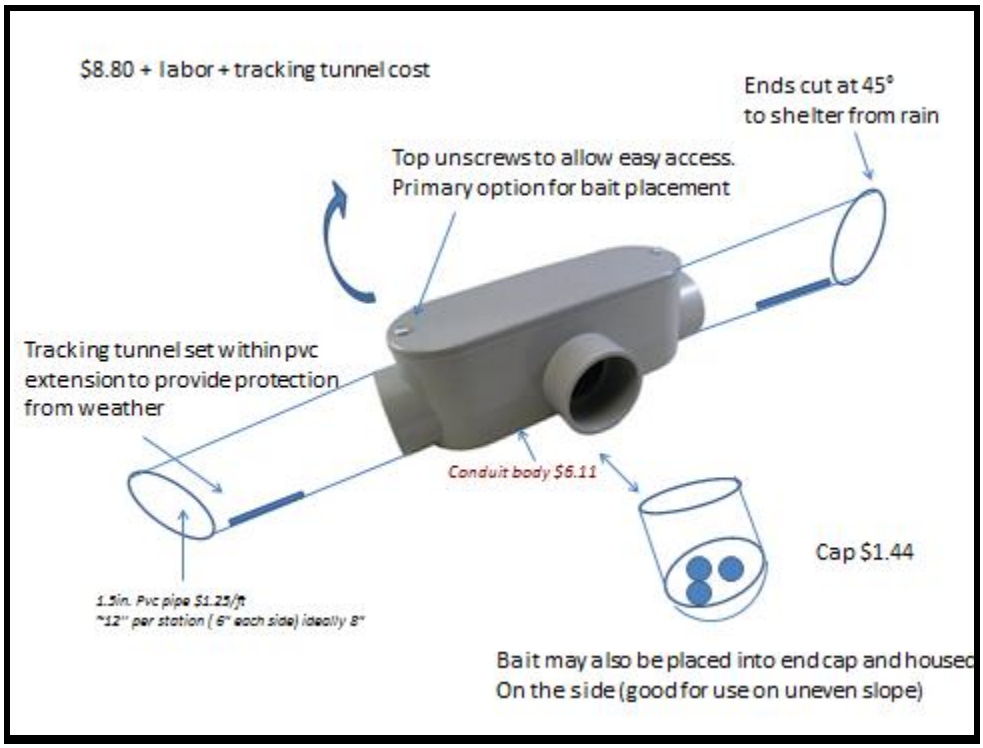


Figure 5: Novel bait station design.

Ten novel bait stations and ten commercial bait stations will be deployed. To evaluate mice visitation, both bait station types will have tracking pads installed inside the body of the station. A tracking pad consists of a strip of felt moistened with peanut oil and oil based black ink and fastened to a length of white absorbent paper. Once a mouse enters the station and steps on the felt pad, its tracks are imprinted on the paper.

Tracking pads and bait removed from the stations will be evaluated and restocked daily if needed. Considerations for bait station efficacy include noting whether mice use one station type preferentially, more frequently, or if they are neophobic to a specific model. The same number of non-toxic replica pellets (to be determined on island) will be placed inside, and the rate of pellet removal will be calculated for both station types. If neither station is used adequately or if mice do not begin using stations for several days or weeks, then bait stations may not be a valuable eradication strategy for this island. Bait stations will be inspected daily for pellets remaining, pellet condition, and evidence of mouse visitation (Table 4). Stations will be periodically monitored to assess the ability of gulls to disturb the stations or access any pellets.

***Table 4: Bait Station Data Sheet Example***

| Date | Station # | # Pellets | Pellet Condition | Tracks | Scat |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

## 6. Live Trapping

### 6.1 Mouse Morphometrics

Mice will be live trapped using Sherman traps (H. B. Sherman Inc., Tallahassee, FL). Live traps will be baited with rolled oats and placed haphazardly on Southeast Farallon Island. All captured individuals will be weighed using a 50 gram Pesola scale. Mice are extremely difficult to sex at an early age; therefore, only mice weighing more than 14 grams will be sexed. The distance between the anus and the genitals is called the "anogenital distance" and is larger in males than females. Females possess a vaginal orifice, while the males do not.

### 6.2 Breeding Status

When possible, implementation of eradications should occur during non-breeding periods for rodents to reduce the risk of weanlings surviving. Reproductive condition will be noted (whether males are scrotal, and whether females have enlarged mammae, are pregnant, and whether they are perforate or not. The breeding status of trapped individuals will be assessed, including the percentage of pregnant females, scrotal males, and underweight individuals. Live-trapping of over 900 individual mice on the South Farallon Islands during November 2010 revealed no pregnant females and only three males that were scrotal and five that were partially scrotal. Thus while some breeding may occur at this time of year, it is likely a rare event.

## 6.3 Genetic Analysis

In the event that mice are detected on the Farallon Islands after the eradication, it will be useful to verify whether the population is due to missed target animals, or an incursion from another population source. Collection of genetic samples of the mouse population prior to the eradication will allow for future genotyping and comparison with the post-eradication population (if necessary). To ensure that the current Farallones mouse population is adequately sampled genetically, at least 50 samples will be collected to replace previous samples from Southeast Farallon Island that were compromised. DNA collection methods and protocols will remain consistent with IC standards used in previous eradications (Ross 2009). Tail tissue will be collected from mice trapped during the trial. Samples will be labeled using the following convention: (FI_Date_Mouse #), and stored at Ecogene in New Zealand for future analysis.

A small percentage of trapped mice may be euthanized according to AVMA standards and frozen for a collaborative genetic study. These whole carcasses will be transported off island on ice, and may be shipped to North Carolina State University for further RNA genetic analysis, as per requests to Gerry McChesney from Fred Gould , David Threadgill and John Goodyear.

## 7. Salamanders and Crickets

No native reptiles or terrestrial mammals inhabit the Farallon Islands, but arboreal salamanders (*Aneides lugubris*) are found across the island. The species is endemic to mainland California and Baja California where it is distributed primarily along the coast, with populations on some offshore islands and in the Sierra Nevada foothills. The Farallon subspecies is endemic to the South Farallon Islands. Although not threatened or endangered, Farallon arboreal salamanders will also be evaluated for exposure during the biomarker trial. Salamanders are not expected to consume bait pellets directly, but their status as an endemic subspecies warrants further investigation. Two or three caves will be selected to census this species, whose numbers and distribution may increase after mice are removed from the island.

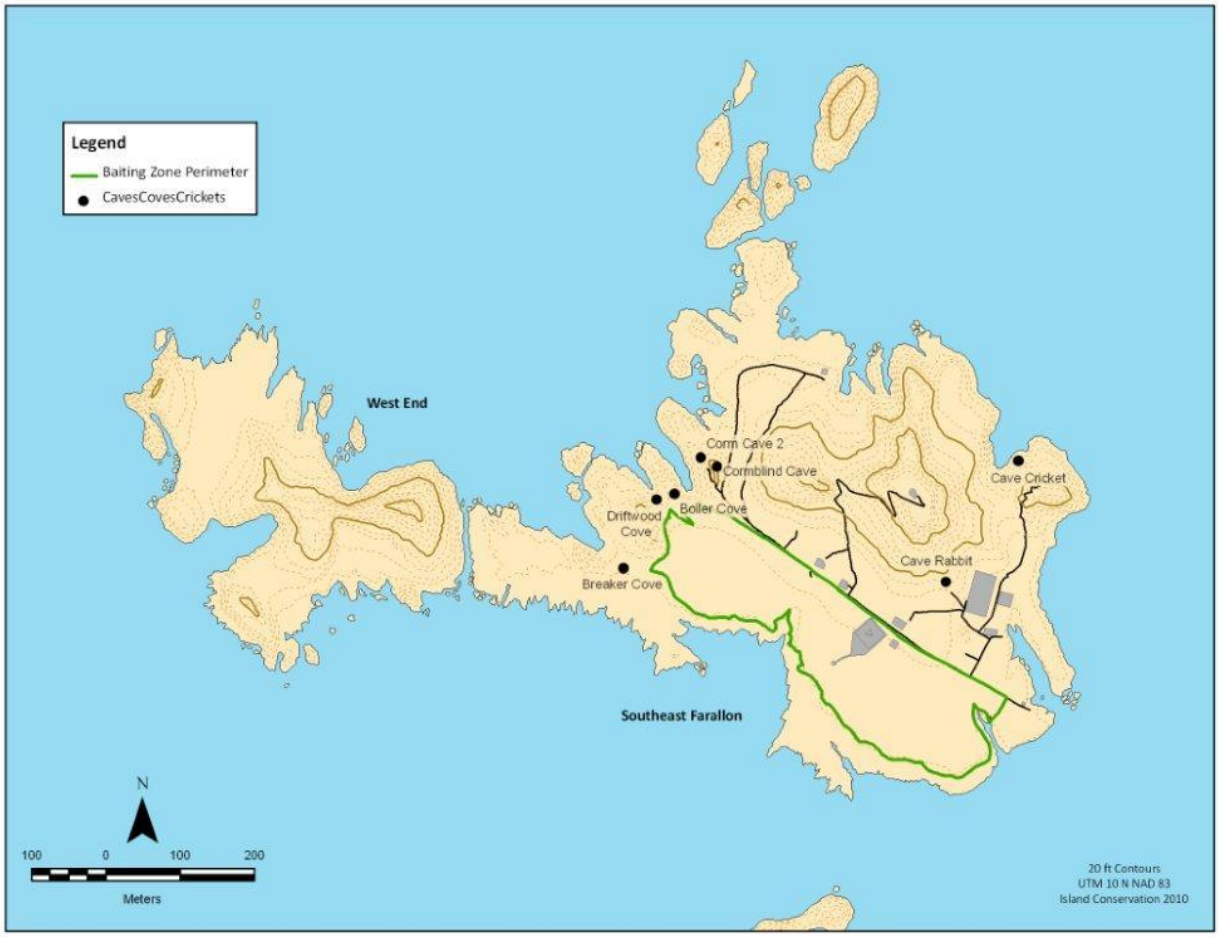


Figure 6: Topographical map of the Farallon Islands depicting cave locations.

Cave census will include documenting the species that each cave contains, and estimating how many individuals reside per square meter in the cave, and what portions of the cave harbor the majority of the crickets, distance from the entrance, and location (wall, ceiling, floor). Exact methods will depend on accessibility and feasibility upon arrival, but may include counting how many are on one wall of a cave, or counting all individuals inside a cave. These data will inform the sampling design to be employed by the partner Conservation Measures team that will follow up and conduct baseline and post-eradication monitoring of this species post-eradication.

## 8. Logistics

### 8.1 Field Schedule

The initiation date is set for November 8th, and the termination date of the trial will likely be on or around November 17th. It is estimated that approximately 10 days will be required to conduct the field trials as described (Appendix I). Field trial time could also be extended due to weather and other delays. The exact calendar dates of the trial are not fixed, and will be subject to staff-time available, logistical considerations, weather and unanticipated trial assessment results. All of the studies and methods proposed in this plan may not be executable in the field as anticipated. Some techniques are innovative and are being employed for the first time and may not work as intended, and others may be needed to be improvised on the spot, but there is redundancy built into the plan for that reason. The focus of the work on island will be given to the most critical aspects, and we will use what time remains to conduct the remainder of the studies.

### 8.2 Staffing

To complete the trials as described a core group of 4 Island Conservation staff will be required. This group includes Dan Grout (Project Manager), Aurora Alifano (Field Manager), Erik Oberg and Rory Stansbury (Island Restoration Specialists). Additional support of PRBO may be required during the time on island, and PRBO staff/intern time of approximately 2 hours/week will be required to complete the pellet degradation study from November 17$^{th}$ until the bait has disintegrated after significant rain events (into December or possibly into January.)

### 8.3 Field Staff Accommodation

Accommodation for the four Island Conservation staff during the trial has been provided by the USFWS in the former Coast Guard ("Sally") house.

### 8.4 Field Resource Needs

Island Conservation researchers will need to coordinate with USFWS/PRBO staff regarding logistics, timing, and transport of field staff and equipment to the island. During the field trial IC researchers will attempt to remain as self-sufficient as possible so as not to disrupt ongoing PRBO research. Researchers will require access to basic utilities on the island, including power for charging camera and laptop batteries, restrooms, and water, while maintaining awareness of and compliance with standard operating procedures for water and power.

Prior to and during the transit to SEFI on Nov. 8, the USFWS Refuge Manager and PRBO Field Crew leader will provide IC staff with a briefing on the USFWS/PRBO safety and communication plan procedures, as well as procedures for avoiding any impacts to sensitive island resources, such as avoiding stepping on seabird burrows and avoid disturbances to marine mammals. IC staff will communicate with PRBO biologists using handheld radios when necessary, and will undergo a safety briefing and coordinate activities with PRBO staff on island on a daily basis.

Transit onto the island is currently to be charter boat "Outer Limits", and transit off island may occur by boat but depending on weather may occur by helicopter on Nov. 17, following

established approach and departure paths to avoid wildlife disturbances. Any remaining equipment that is not needed by IC, PRBO or FWS for work in the immediate future that does not transit off island on November 17 will be transported off-island in the subsequent days/week by returning empty boats as space and weather permit.

## 9 References

Craddock, P. 2004. Environmental breakdown and soil contamination by Pestoff poison bait (20ppm brodifacoum) at Tawharanui Regional Park, north of Auckland- Winter 2003 trial. Unpublished report for Northern Regional Parks, ARC.

Appendix I: Field Schedule GANTT

| 2011 SEFI Field Trial | November | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | T | W | Th | F | S | Su | M | Tu | W | Th | F |
| | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Drive to Larkspur | X | | | | | | | | | | | |
| Purchase Food | X | | | | | | | | | | | |
| Drop gear at Boat | X | | | | | | | | | | | |
| Transit to SEFI via boat | | X | | | | | | | | | | |
| Unload gear from Boat | | X | | | | | | | | | | |
| Set up work/living station | | X | | | | | | | | | | |
| Island Orientation and Scoping- identify field sites | | X | X | | | | | | | | | |
| Place and traps around the house | | X | X | | | | | | | | | |
| Assemble and install Bait Stations/tracking pads | | | X | ? | | | | | | | | |
| Build Bait Degradation Cages | | | X | ? | | | | | | | | |
| Install Bait Degradation Cages/data loggers | | | X | ? | | | | | | | | |
| Check Traps, process mice, collect tissue, reset | | | X | X | X | X | X | X | X | | | |
| Check Bait Stations/tracking pads | | | | X | X | X | X | X | X | X | | |
| Check Degradation Cages/take photos | | | | | X | X | X | X | X | X | X | |
| Monitor & Photograph non-targets interacting with bait stations | | | | | X | X | X | X | X | X | | |
| Cave/cove Scoping/ perimiter walk- (weather dependent) | | | | ? | ? | X | X | | | | | |
| Cave census (Cricket count - biomarker exposure test) | | | | | | | ? | X | X | | | |
| GPS-map gull roosts, count gulls in those zones at sunrise/set | | | | | | ? | ? | ? | ? | | | |
| Assist in PRBOs Salamander Surveys | | | | | | | | ? | ? | | | |
| Train PRBO staff to continue studies (as time allows) | | | | | | ? | ? | ? | ? | X | | |
| Observe non-targets for biomarker (bird guano, inverts) | | | | | | | | X | X | X | | |
| Remove Experiments (traps, bait stations, etc.) | | | | | | | | X | X | X | X | X |
| Break down camp | | | | | | | | | X | X | X | X |
| Pack up/store field gear | | | | | | | | | | X | | |
| Transit off SEFI (Helo) | | | | | | | | | | | X | |
| Enter/Analyze data | | | | | | X | | X | | X | | X |
| Send field report | | | | | | | | | X | | | |
| Demobilize | | | | | | | | | | | | X |
| Debrief | | | | | | | | | | | | X |
| Sample day: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |