South Farallon Islands Restoration Project

Annual Report to the U.S. Fish and Wildlife Service

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1. PROJECT BACKGROUND, GOALS AND OBJECTIVES

This annual report is submitted in fulfillment of the annual reporting requirements of Cooperative Agreement No. 81640AJ123 which was signed September 23, 2010 between the U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex and Island Conservation. This report summarizes the activities undertaken by Island Conservation between September 2010 and March 31, 2011 on tasks related to the proposed South Farallon Islands Restoration project for mouse removal, as defined in the Cooperative Agreement/Scope of Work.

Background

The Farallon Islands provide critical habitat for seabirds and pinnipeds, and support some of the world's largest nesting seabird colonies including Ashy Storm-Petrel (*Oceanodroma homochroa)*, Brandt's Cormorant (*Phalacrocorax penicillatus)* and Western Gull (*Larus occidentalis)*. On the South Farallon Islands, which include two main islands- Southeast Farallon and West End Islands, introduced house mice (*Mus musculus)* appear to be directly and indirectly impacting the breeding success of burrow nesting seabirds. The U.S. Fish and Wildlife Service (USFWS), partnering with PRBO Conservation Science (PRBO) and Island Conservation, proposes to protect and restore the ecosystem of the Farallones, particularly seabirds and other native biological resources, by removing non-native house mice.

House mice were introduced to the South Farallon Islands during the 19th century and the islands have experienced considerable ecosystem degradation as result of their presence. On the South Farallon Islands, introduced house mice appear to be indirectly impacting the breeding success of burrow-nesting seabirds (Ainley and Boekelhide 1990; Sydemann et al. 1998; Pyle 2001). The presence of invasive mice on many islands throughout the world has resulted in direct and indirect impacts to nesting seabirds, eggs and chicks. On the Farallones the mice have attracted and supported a population of migratory burrowing owls that over-winter to feed on the abundant mice and then, in the spring, the owls switch to prey on Ashy Storm-Petrels (*Oceanodroma homochroa*), a rare species whose largest breeding colony is on the South Farallon Islands. Impacts also include mice preying on and competing with many native and endemic species of invertebrates, salamanders, and foraging heavily on native plants and are dispersing invasive plant species.

Project Goal

The goal of the project is to restore the native ecosystem of the Farallon National Wildlife Refuge (FNWR) and reverse the declining Ashy Storm-Petrel population by

eliminating the introduced house mouse population from the South Farallon Islands. The most common technique for removing mice from islands is an application of pelletized grain bait containing rodenticide across the island. Prior to commencing with the proposed eradication, a series of work objectives must be met to trial the efficacy of eradication techniques and an assessment of the environmental impacts of the Federal action must be conducted in accordance with the National Environmental Policy Act (NEPA) and its associated regulations. The goal of this phase of the project was to conduct a field trial and to further develop the Environmental Assessment (EA) for the project.

Objectives

The two major project objectives for the time period covered by this annual report (Phase 1: Sept. 23, 2010 to March 31, 2011) were:

A. **Research & Development** in the form of Communications Planning and conducting Field Trials to inform operational planning and to assist in impact assessments, and,
B. **Revision of the Administrative Draft Environmental Assessment** for the project as required by the National Environmental Policy Act (NEPA).

2. ACTIVITIES UNDERTAKEN

From September 23, 2010 to March 31, 2011, the following activities were conducted on the project, as specified in the Cooperative Agreement and Scope of Work of September 23, 2010. The various activities undertaken during this period fall within two distinct types of tasks: Research & Development and Environmental Compliance.

Research & Development

The two main areas of Research & Development undertaken during this phase of the project were the design and implementation of a Biomarker Field Trial during November 2010 to test potential eradication techniques with non-toxic bait pellets and the development of a Draft Communications Plan.

Biomarker Field Trial

Island Conservation (IC) staff and partners conducted a field trial on Southeast Farallon Island (SEFI) in November 2010 to assess the efficacy of mouse eradication at a specific target application rate of a preferred bait (using a placebo replica infused with the non-

toxic biomarker Pyranine) and to monitor non-target species exposure to broadcast pellets. Island Conservation staff designed, planned, and prepared for the field trial in October 2010. Staff members ordered and purchased Sherman mouse traps, trap supplies, biomarker bait, bait application and monitoring supplies, UV lights for biomarker screening, DNA collection supplies, and materials for gull capture devices, in addition to food and other supplies for the field crew. IC coordinated with USFWS and PRBO staff to address logistical considerations as well to review and revise existing and proposed budgets for the project.

Aspects of the proposed project evaluated during the fall 2010 Biomarker Trial were those in the Scope of Work:

i) mouse density and reproductive status using mark-recapture techniques;
ii) mouse ranging and movement;
iii) mouse acceptance and palatability of preferred bait type using paired food trials;
iv) the rate of bait removal using bait consumption plots to extrapolate a target application rate for the eradication;
v) the probability of eradication by assessing mouse exposure to a biomarker from a non,-toxic, biomarker-infused bait applied at the target application rate in study plots;
vi) what non-target species are at risk of primary or secondary rodenticide exposure using a non-toxic, biomarker-infused bait applied at the target rates

Some additional elements were added to the study design and a few items were omitted (Section 4). The complete study design with methods used and protocols followed can be found in the attached Biomarker Study Plan (Grout 2010) submitted to the USFWS by IC on October 28, 2010.

Four IC staff members, assisted at times by available PRBO and USFWS staff, conducted the field trial during three weeks in November 2010 (November 1-22, 2010). A *Draft Biomarker Field Trial Report* is in preparation, which includes considerations for target species eradication and non-target mitigation. The results of the field trial are summarized in Section 3 of this report.

A subsequent Gull Hazing Field Trial was also conducted on SEFI in January 2011 to assess the use of possible gull hazing techniques and methods. Results from this five-day field assessment are also summarized in Section 4 of this report and a Gull Hazing Trial Report is currently being prepared.

Communications Planning

To support the primary goal of the project – to protect and restore the ecosystem of the South Farallon Islands by removing non-native house mice – the project partners created a draft strategic communications plan. The purpose of communications planning is to:

i. Assist the USFWS by supporting the NEPA process with strategic communications to educate local and regional agencies, decision-makers, NGOs, and members of the public about the proposed action and to solicit public comments during the NEPA process;
ii. Mitigate any potential opposition to eradication by educating and reaching out to key audiences;
iii. Develop a strategy for handling crisis communications

The three primary project partners created a core communications team made up of one staff member each from the USFWS (Doug Cordell), PRBO Conservation Science (Melissa Pitkin), and Island Conservation (Amy Carter). The team held a phone conference on Nov. 7th, met on Dec 8th 2010 at USFWS Refuge Office in Fremont, and met by phone at least monthly in early 2011 to further the development of the draft Communication Plan and its key elements.

The primary focus of the communications planning at this stage consisted of identifying key audiences, key messages, and producing background information to educate constituencies about the project (via web sites, printed materials, PowerPoint, etc.). Communications materials were developed to prepare for the USFWS release of a Notice of Intent to prepare an Environmental Impact Statement for the project.

Tasks completed included:

- Communications Plan – draft written and edited; will be finalized for current phase of the project in April 2011
- Crisis Communications Plan – draft written and circulated for partner review
- Website - domain name purchase, hosting, design, content creation with partners, and publishing
- Interested party list – draft created with partners to be completed by USFWS staff
- Fact sheet – design, layout, content creation and editing with partners
- Frequently Asked Questions - draft written and circulated for partner review
- Power-point presentations – developed with and reviewed by the partners, one for use for an agency briefing and one for public scoping period outreach to the public and key audiences at meetings.
- Bids were solicited from potential contractors for assisting with messaging and outreach for later project phases.

Environmental Compliance

Two major environmental compliance tasks were conducted in Phase 1 of the project:

A. A quantitative gull risk analysis model was contracted and developed, and,

B. The administrative draft Environmental Assessment (EA) was revised and submitted to the partners (USFWS and PRBO) for their review and comments in January 2011.

Gull Risk Analysis

Prior NEPA analysis revealed critical environmental issues which required additional scrutiny. The primary environmental issue identified during the early EA process was the potential vulnerability of gulls to non-target impacts from the mouse eradication. 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. The importance of understanding the potential risk to gulls was underscored by the observation of numerous gull mortalities following a rodent eradication operation on Rat Island in the Aleutian Islands, Alaska in 2008.

In order to better understand the potential risk to Western gulls, IC contracted experts in risk analysis modeling to quantify potential impacts to gulls on the Farallones as result of mouse eradication operations (Intrinsik Contract, signed Nov. 2010). IC arranged for a member of the contracted analytical firm to make a day-visit to Southeast Farallon Island in November 2010, and we provided them with an orientation to acquaint them with the species, issues, maps and local geographical setting of the project.

In December 2010 and January 2011, IC coordinated with the contractor to provide them the best-available scientific information to assist in developing a high and low estimate for the number of expected gull mortalities following aerial application of rodenticide.

Intrinsik created a model which included input variables of expected gull population size, spatial and temporal bait availability, environmental fate of the toxicant, and a likelihood index for each possible gull exposure pathway based on dietary preference, among many other additional variables. In February and March 2011, IC continued to obtain, collect, and provide the modelers with additional information sources to further refine the input variables. Where uncertainty existed, it was noted; conservative estimates of anticipated impacts were selected in order to err on the side of overestimating potential gull impacts.

IC reviewed the appropriateness of the initial models developed and the input parameters selected by the contractor, and provided the contractors with as much information as was available to us from our USFWS and PRBO partners. A draft model was emailed to IC on March 30 2011, and a Draft Gull Risk Analysis Report is expected in May 2011 for review by IC, USFWS and PRBO. The Draft Gull Risk Report will be revised by Intrinsik and a final report will be submitted to IC and USFWS. Model results will be applied to complete the comprehensive environmental compliance process for mouse eradication on the Farallones.

NEPA Review and Revisions

On September 23, 2010, Island Conservation obtained the funding necessary to continue developing and assessing the environmental impacts of the proposed mouse eradication project, as required by the National Environmental Policy Act (NEPA). From December 2010 to January 20, 2011, the Administrative Draft of the Farallon Mouse Environmental Assessment (EA) was revised by IC to incorporate the results of the November 2010 field trials and the recent developments in assessing non-target impacts learned from ongoing risk assessments.

Several meetings were held with USFWS and PRBO during this period to update the information in the EA and to determine how to proceed with various parts of the NEPA documents, including treatments of alternatives and analysis of potential impacts. The partners also discussed how to plan and interpret field trial results and a variety of funding, planning and communication issues related to NEPA.

IC submitted a Draft EA for partner review to the USFWS and PRBO on January 21, 2011. Partner review of the Draft EA occurred from January 21, 2010 to February 28, 2011, when IC received the USFWS' completed comments.

On February 10, 2011, the USFWS hosted a meeting at the USFWS Regional Office in Sacramento to brief attendees on project developments thus far and to make key decisions about how to proceed with NEPA compliance. The meeting was attended by Refuge staff, and representatives from IC and PRBO, as well as the Assistant Regional Director of Refuges, other senior USFWS staff and some representatives from other agencies involved in permitting or consultation for the project.

At the February 10th meeting, following the presentation of the preliminary trial results and alternatives being considered in, After reviewing the EA, the USFWS leadership determined that the development of an Environmental Impact Statement (EIS) would be more appropriate for the project than continuing with an EA.

Proceeding with an EIS required that the project implementation be rescheduled from fall 2011 until fall 2012, as the EIS process requires more time, specifically for the preparation and publishing of a Notice of Intent (NOI) to prepare an EIS, and additional time for public input and comment, as well as additional time and costs associated with preparing and revising a larger document. While this delay may cost more and take more time, it was deemed the appropriate course of action for the project.

The USFWS decision to prepare an EIS will require that the Scope of Work, budget and timeframe governing the work to be conducted be revised, as stipulated on page 15 of the existing Scope of Work submitted with the Cooperative Agreement of Sept 23, 2010.

Following the receipt of the USFWS comments on the EA on February 28, a comment matrix was created in order to track incorporation of PRBO and USFWS comments on the EA, and work began in March to revise the EA based on partner comments and on its transformation into an EIS. The NEPA and project timelines was revised, and work began to revise the budget and to coordinate the communications planning efforts in order to accommodate the scoping requirements of the new timeline.

Additional Environmental Compliance

In February 2011 preliminary discussions were initiated with some key agencies to help with applying for permits or authorization to conduct the eradication. The more lengthy and/or complicated permits application discussions included those for:

i) Manager's Permit from Gulf of Farallones National Marine Sanctuary
ii) Incidental take of migratory birds (under the Migratory Bird Treaty Act)
iii) National Pollutant Discharge Elimination System permit (Clean Water Act)

3. DATA COLLECTED

The results of the Biomarker Trial and Gull Hazing Trial surveys that were conducted are summarized and presented below. Further analysis of the Biomarker Trial data and the Gull Risk Assessment model are currently being completed by IC and its contractors, and the final reports will be made available when they are completed. .

Biomarker Trial Results

The studies conducted during the November 2010 biomarker trial were subject to the conditions outlined in the USFWS Special Use Permit #81640-2010-040. The studies described in this trial plan supersede the tasks (1-6) described in the Scope of Work (Exhibit C) of the Cooperative Agreement 81640AJ123 between USFWS and Island Conservation signed September 23, 2010.

3.1 Mouse Abundance

Mice were extremely abundant on the island during the November 2010 trial period. A 10 x 10 grid of 100 traps set out with 5m spacing were set out and checked for five consecutive nights in the intended bait zone prior to broadcasting of bait to assess an Index of Abundance (IOA) for mice (Figure 1). Out of 500 possible trap nights, 434 mouse captures were recorded. Trap success averaged 93% on all but the first night, when trap door setting sensitivities may have resulted in a lower trap success rate of 62%.

A total of 250 unique individual mice were captured and marked in the trapping period in the ~0.25ha trapping area. Recapture rates of marked individuals on nights 2 through 5 were: 35%, 40%, 56% and 66%, respectively. Mice were extremely abundant and easily trapped, likely due to a combination of high population levels and a scarcity of other food resources. Mice were commonly seen foraging throughout the daylight hours, as well as at night, but traps were only left open at night.

While final density estimates have not been calculated, the raw data alone suggests extremely high mouse abundances on the island in the study area at this time of year, with several hundred mice per hectare possible. Mice densities at these levels have only rarely been reported elsewhere and usually only during plague-level eruptions in a few locales world-wide. These high abundance levels are a factor of ten times higher than reported densities in most environments. The fact that mice were quite obviously hungry and trappable on the island during this time of year bodes well for an eradication attempt during this period, as they will more readily accept bait under these stressed and food deprived conditions.

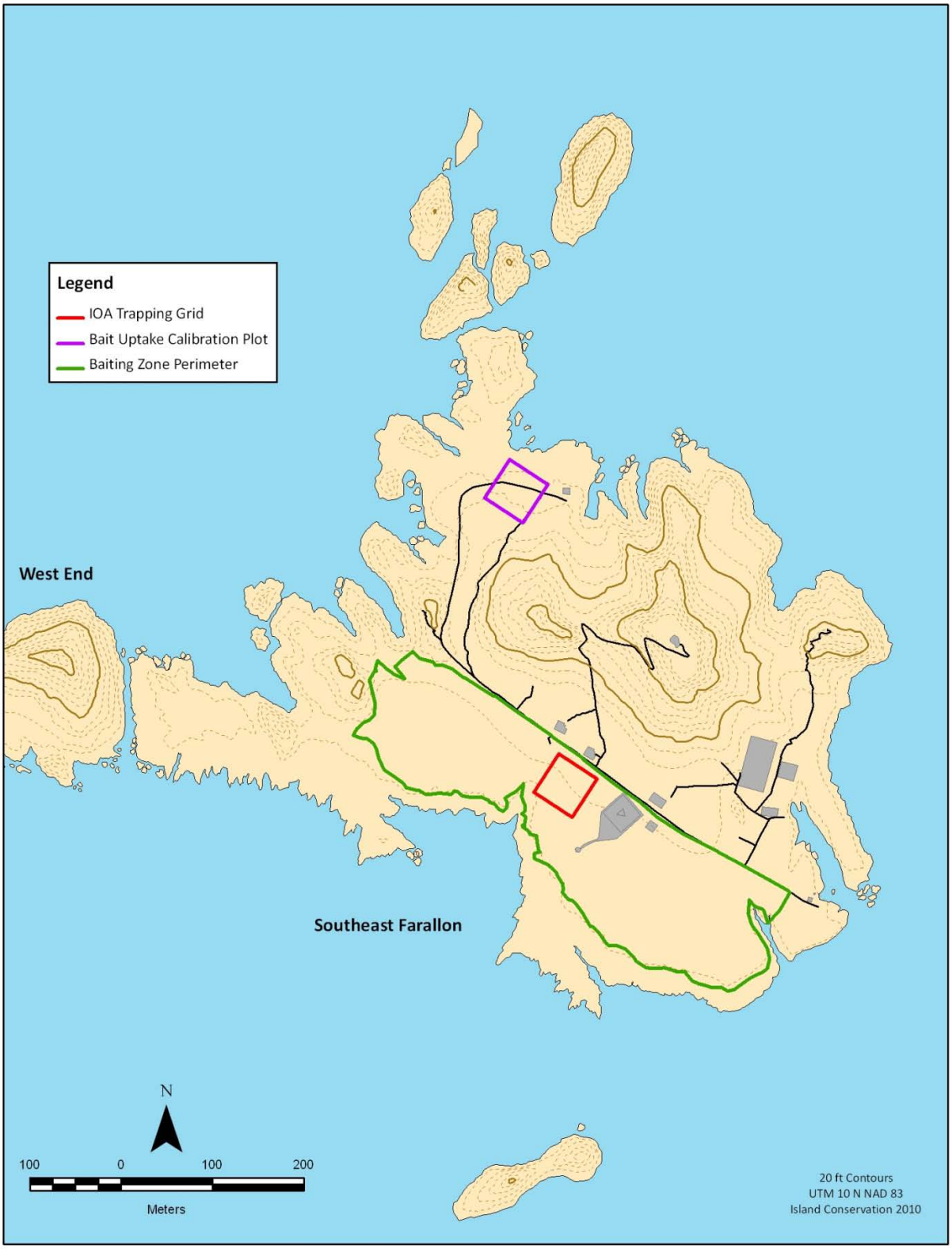


Figure 1. Study Areas and Location of Index of Abundance Trapping Grid

Monthly Index of Abundance Plots

A set of 33 permanent mouse trapping locations were also established on the Southeast Farallon for conducting monthly mouse trapping to establish a monthly index of mouse abundance throughout the year as the population cycles. While 28 of these sites were located where prior USFWS mouse trapping studies conducted from 2001-2004 (Irwin 2006) a total of five new locations were established in the Lighthouse Hill area to get a better representative sampling from this habitat type.

Plots were marked with white PVC, aluminum tags, and the GPS coordinates were recorded (Figure 2). The results of these monthly surveys will be provided after the completion of a one-year cycle of data collection.

3.2 Mouse Reproductive Status

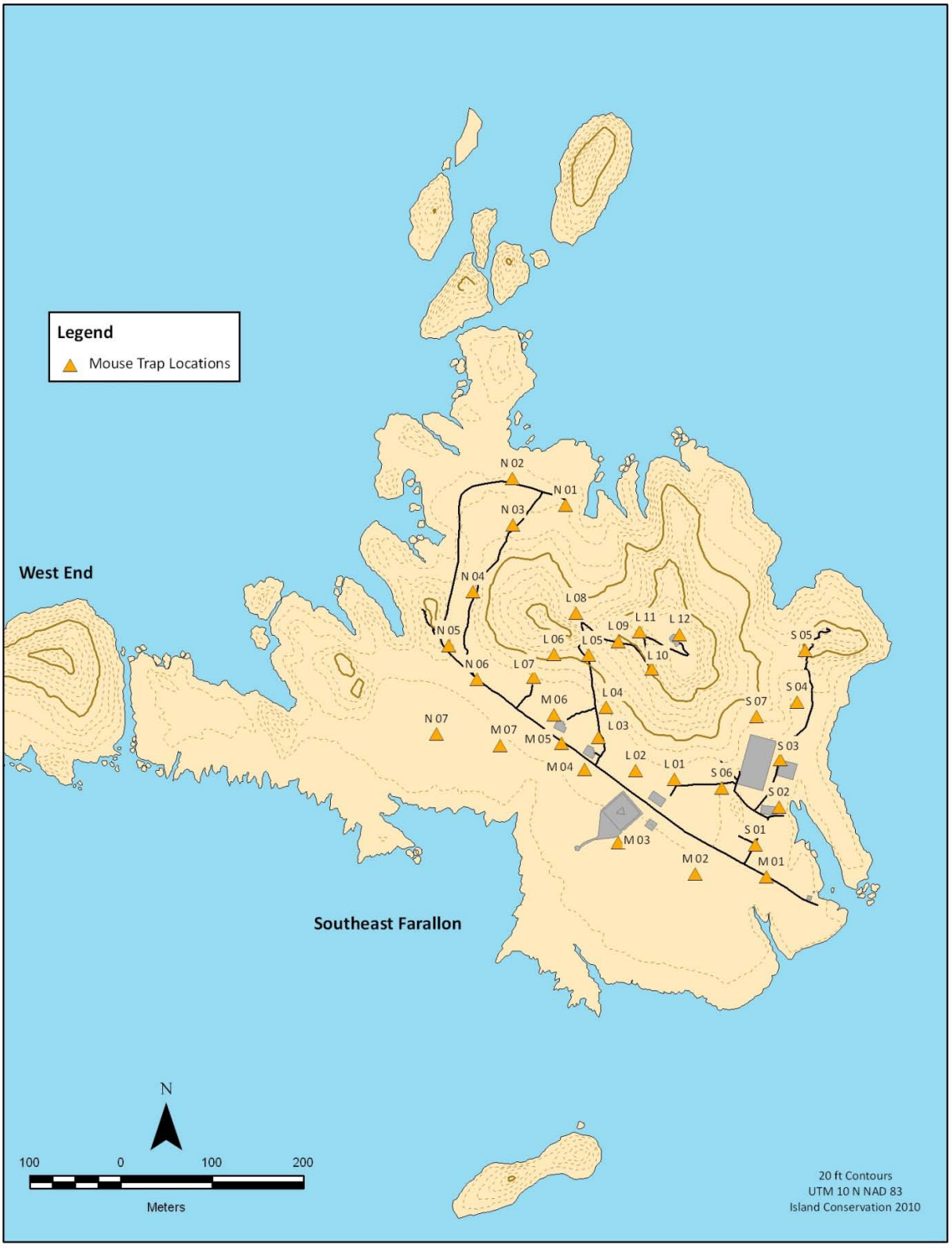
Live-trapping of over 900 individual mice on the South Farallon Islands during the November 1-22 period revealed no pregnant females and only three males that were scrotal and five that were partially scrotal. Thus while some breeding may occur at this (or any) time of year, it would be considered a very rare event during this period based on these trap results. This also bodes well for a fall eradication attempt, as it means that the risk of juvenile weanlings being missed by any of the bait application events is very low.

3.3 Mouse Movements

While specific mouse home-range studies were not conducted during the trial, the five-night mark-recapture study resulted in 101 mice that were captured at least twice, and some as many as five times. The mean maximum distance moved (MMDM) for mice captured two or more times was 11.7m. Over 82% of the relocated mice moved less than 16m between most distant captures. Over 92% of the mice recaptured moved less than 24m. Only six mice moved more than 35m, and the longest recapture distance was 43m.

While the size of the trapping grid (45m) may have biased some of the longer ranging results downward slightly, 95% of the maximum distances moved here on the Farallones are within the expected diameters for reported mouse home ranges of 10-29m^2 reported for house mice on other island environments and on mainland California.

Figure 2. Monthly Index of Abundance Mouse Trap Locations Established



3.4 Biomarker Persistence and Bait Palatability in Mice

Biomarker Persistence Assay

Because the use of pyranine as a biomarker in cereal rodenticide pellets is a relatively new development in recent years, laboratory studies on the island were conducted using locally captured mice to determine how readily the mice would consume the non-toxic pyranine-infused bait pellet. The non-toxic form of the bait Brodifacoum-25D Conservation (Bell Laboratories, Madison, WI, EPA Reg. No. 56228-37) was used in this test. The bait pellets were infused with 0.20% pyranine biomarker. A six-day no choice trial was conducted on the island in a lab setting using 12 mice in an exposure group and two mice in a control group.

The three exposure groups consisted of four mice in each group, with two males and two female adults in good condition randomly placed in each group. Mice in each group were fed the approximate equivalent of 0.5LD50, 1LD50 and 2LD50 of Bell Labs non-toxic Conservation 25D (with 25ppm brodifacoum) on the first day of the study. Amounts fed were approximately 0.5g of pellet, 1g pellet, and two 1g pellets for each group. These estimates were based on estimates that a mouse must eat 1-2.6% of its body weight of 20ppm brodifacoum bait to achieve acute oral toxicity (Fisher 2004). The two mice in the control group were fed similar non-toxic bait pellets without a biomarker. All mice were individually housed and provided water.

All mice that were given the pyranine-infused bait tested positive for external sign of biomarker fluorescence (on mouth or anus) under UV exposure after 24, and 48 hours. On the third day (after 72 hours) however, one of the mice tested negative for external biomarker presence. By day four (96 hours) only two of the mice still tested positive for externally biomarker sign. The assay results indicated that the biomarker trapping efforts later in the field study should be completed within 72 hours of bait broadcast in order to ensure that false negative results for biomarker do not influence the efficacy trapping results in the core trapping areas.

Bait Palatability and Preference Trial

A two-choice *ad libitum* food preference trial was conducted to determine consumption rates and food preferences. Ten adult mice were daily given a choice between non-toxic bait pellets with pyranine and naturally occurring food alternatives described by Hagen (2003). The tests were conducted on island and continued for eight days, with each mouse housed individually. Natural food alternatives included coleopteran larvae, and fresh local vegetation (endemic *Lasthenia maritime* and *Hordeum murinum leporinum*). Each mouse was daily supplied with 2.8g of bait and 2.06g of the naturally occurring

food items, totaling 4.86g of food per day. Each mouse consumed an average of 3.8g of food each day, with individual daily consumption ranging between 2.7-4.7g. Consumption was on average about 20% of their body weight each day.

All ten mice preferred the bait over the natural food items, eating on average 62% of the bait pellets, and 38% overall preference for the naturally occurring foods when measured by overall percentage of their diet by weight. All mice showed a higher palatability for the bait than the local food items presented. Percentage palatability tended to be lowest on the first day (50%) but climbed quickly to 63% on day two and stayed high for the duration of the study.

Ten random opportunistic observations were also made of five different individual mice as to the first food type consumed after the choices were presented. On nine of the ten occasions, the pellets were visited and eaten first, and in the tenth instance, the coleopteran larva was eaten first.

In addition, the mice were observed to see if the ~1.1g pellet was sufficiently small and light enough for the mice to be able to pick up, handle, as house mice are known to forage much differently than rats. Visual observations confirmed that the bait pellets were easily picked up, handled and carried by the mice. This was also noticed in the field where pellet caching was seen at burrow entrances.

Overall bait trial results indicated that the bait being considered was readily accepted by the mice, and that all mice consumed the equivalent of a lethal dose of nontoxic bait within 48 hours.

3.5 Bait Removal Rates

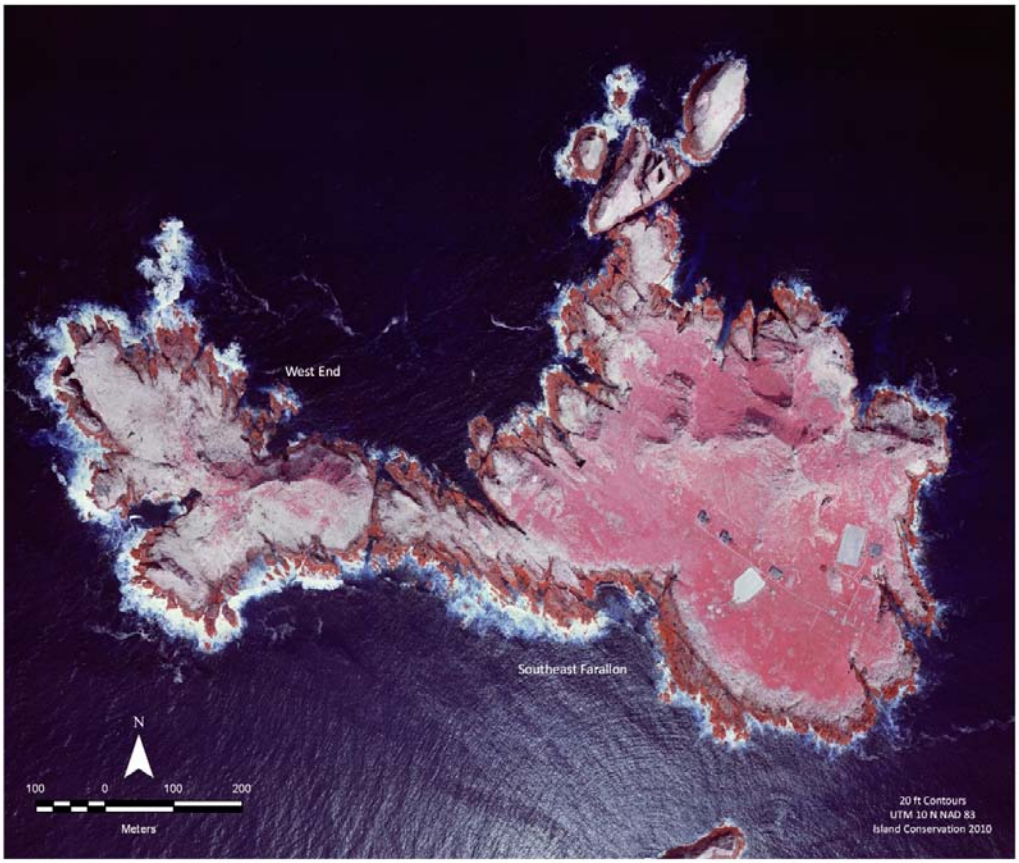
In order to assess whether the EPA label registration of 27 kg/ha would be sufficient to expose all mice to the bait during an operation, a non-toxic bait pellet with biomarker was broadcast over a 6.4 ha study area on Southeast Farallon Island. Prior to the large broadcast, a small 0.25 ha calibration broadcast was conducted in the North Landing area using 36kg/ha (Figure 1). Bait uptake rates in this calibration area were quite high. While some of the high uptake rates could have been due to edge effects, it was decided that two application rates would be applied in the larger 6.4 ha study area in order to determine their relative efficacy rates at exposing all mice to the bait.

Target application rates of non-toxic bait pellets were hand broadcast in a 6.4 ha study area. Approximately half of the 6.4 ha study area was baited at density equivalent to the EPA label rate, and other half was baited at a slightly higher rate. Two applications were

conducted, separated by five days. The eastern half of the study area (area B) received the equivalent of the EPA label registration dose of 27 kg/ha (at 18 kg/ha and 9 kg/ha), and the western half of the study area (area A) received a higher dose of 36 kg/ha (at 18 and 18 kg/ha) to test the efficacy of a slightly higher density, should it be needed (Figure 3).

Ten bait pellet uptake monitoring plots of 1 m x 50 m were checked daily to determine rates of bait removal (Figure 4). Bait was removed at an average rate of 3.6 kg/ha/day, with daily uptake rates per plot ranging from 1.6 - 6.3 kg/ha/day over five days. Bait remained present for four nights, which has been the target exposure period for most rodent eradication projects. Bait was virtually gone by the fifth night after the first application (Figure 5). Bait disappeared at faster rates after the second application. Within two days of the second application, most of the bait was gone from the four uptake plots in the eastern bait area (B) that received the lower application rate of 9kg/ha. Much of this uptake was likely due to the high abundance of mice here compared to area A, as the number of mice captured in area B was over ten times higher than in area A.

South Farallon Islands



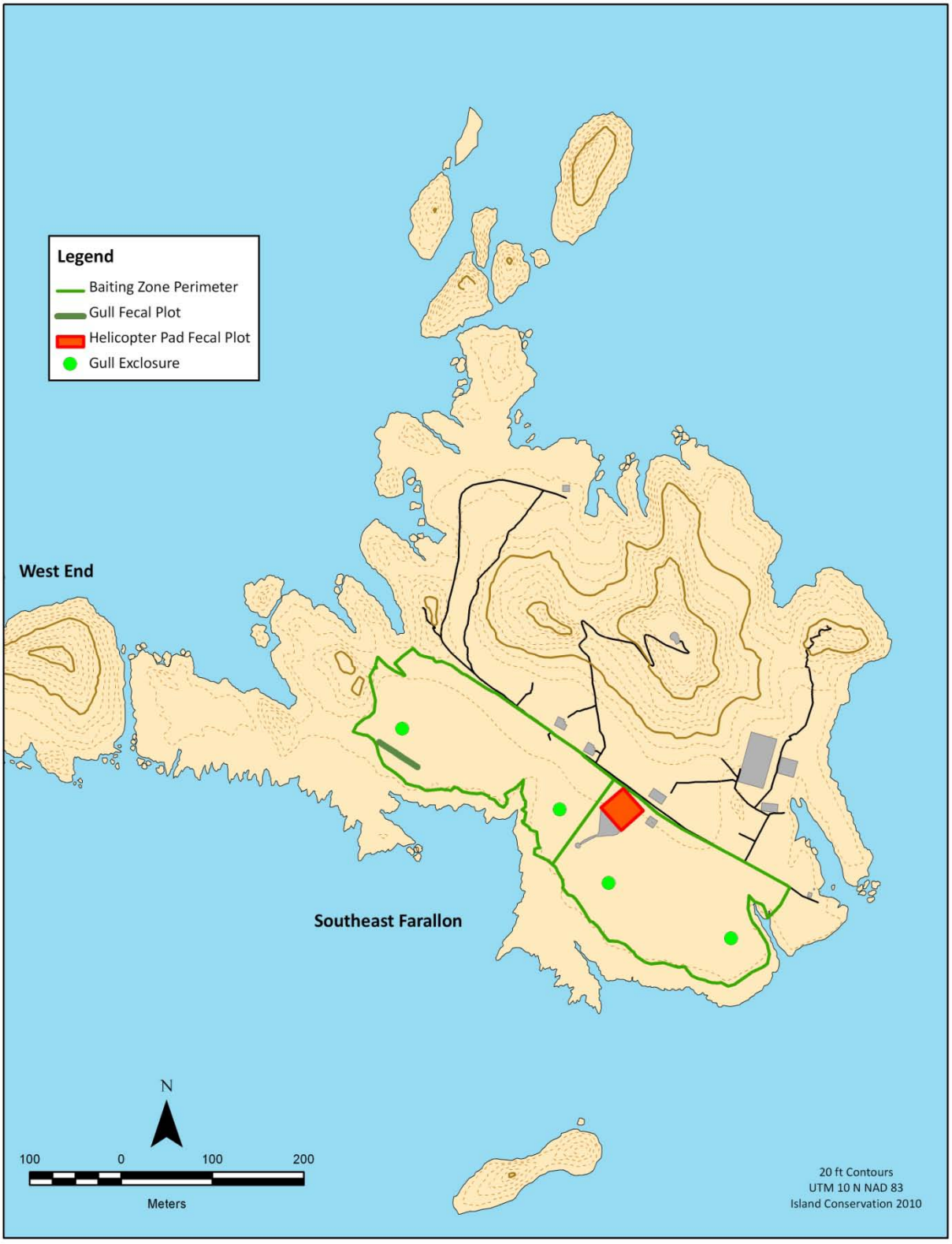


Figure 3. Baiting Zones (Western half is Area A; Eastern half is Area B); Fecal Plots

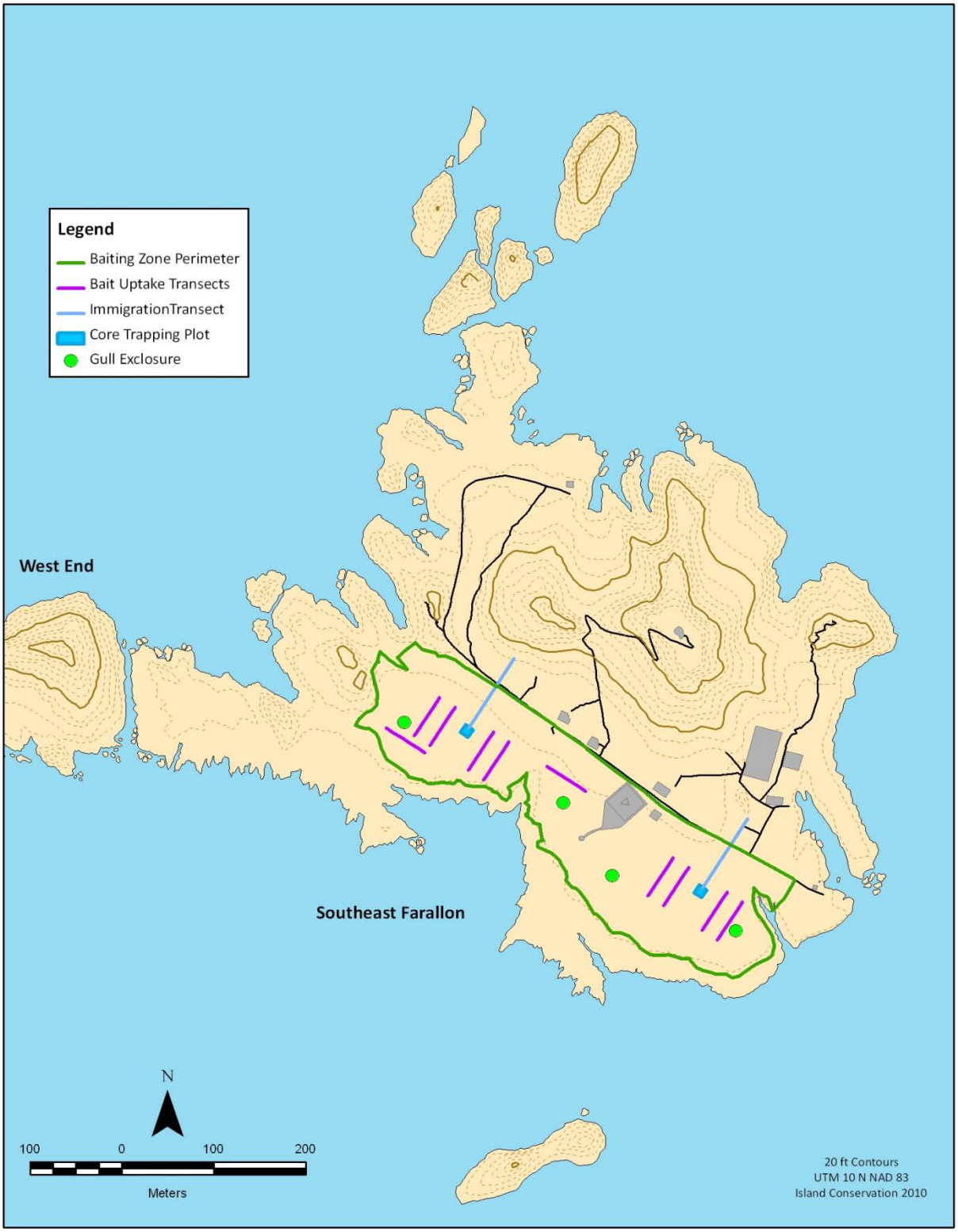


Figure 4. Bait Uptake Monitoring Plots, Core Trapping Plots & Immigration Plots

On the second application, area A received twice the amount of bait (18kg/ha) than Area B (9kg/ha), yet most of the bait pellets on the uptake plots in area A were also consumed in two days. It is likely that some of the bait consumption was due to non-target uptake of the bait, as by this time some of the roosting Western gulls in this area had learned to identify the pellets as a food item and were observed foraging for bait heavily in area A, and to a lesser extent in area B. The relative abundance of mice in Area B was much higher than in Area A, and so mouse uptake of bait was likely higher in B than in area A.

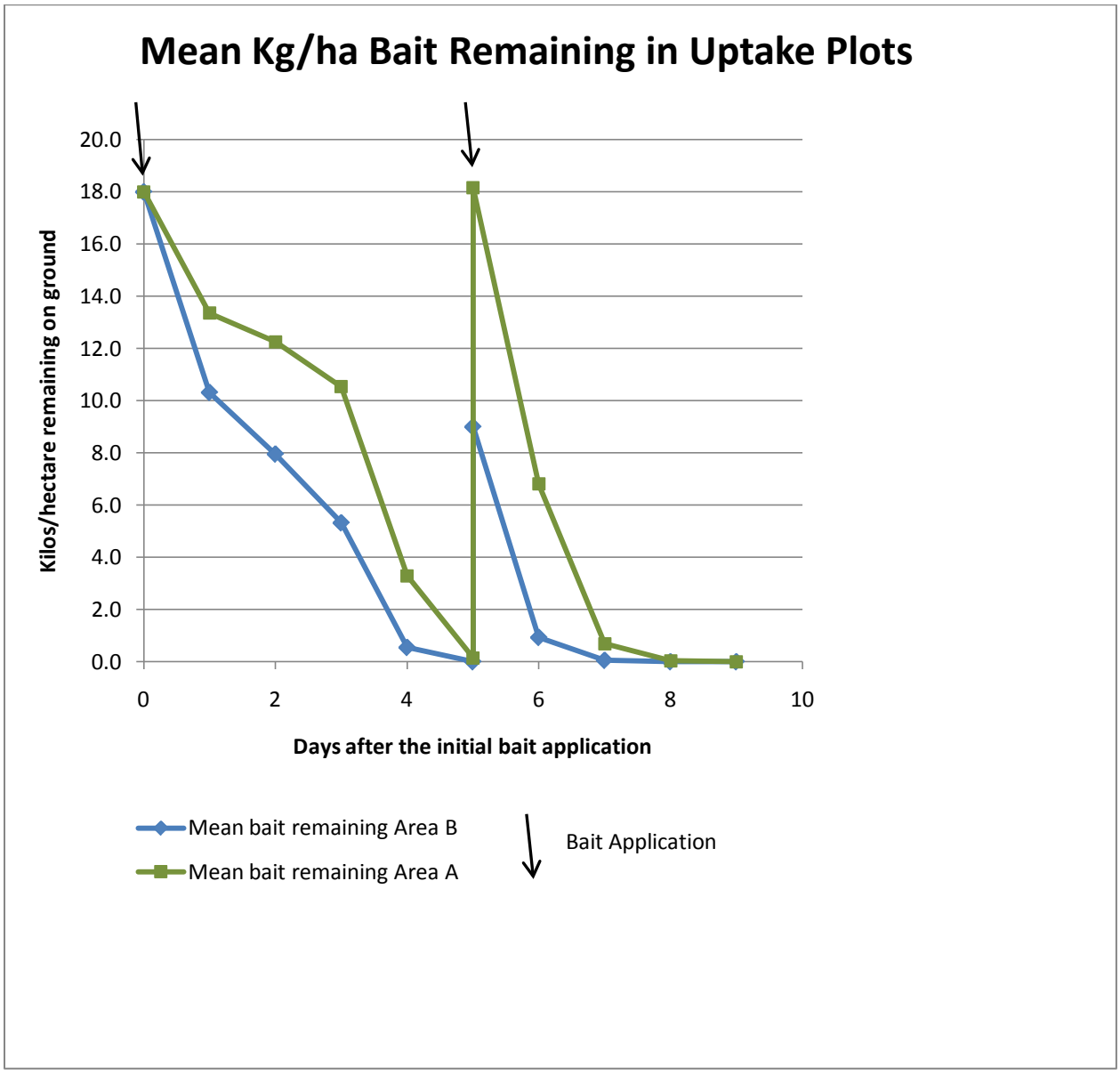


Figure 5. Bait Remaining in Uptake Plots

An innovative portion of the bait uptake study design on the Farallones included the use of four non-target exclusion devices to prohibit gull consumption while allowing for mouse uptake. The four 2.4m x 2.4m gull exclosure devices made of wood and chicken wire resulted in some bait pellets being present in the gull exclosures for as many as 9 days after application in areas of lower mouse abundance in area A. Gull exclosures in area B with mouse abundances several times higher than area A had bait completely taken up from the exclosures by mice in as few as 1 or 2 days.

The fact that mice were readily consuming the bait and that the pellets on average lasted at least four nights after initial application is encouraging in that this is the target exposure period targeted for eradications using this particular bait pellet.

3.6 Mouse Biomarker Exposure Rates

The probability of a successful eradication was assessed by measuring mouse exposure rates to a biomarker from a non-toxic, biomarker-infused bait applied in study plots. The trap results indicated a very high likelihood of bait exposure to mice in the core trap study areas. Four trap nights were conducted in each of the two core trap grids (A and B), making for eight total sampling events. Six of the eight sample events resulted in biomarker exposure to 100% of the mice captured in each core grid. The other two nights resulted in 97% and 96% exposure rates (Table 1). These high exposure rates are highly encouraging, and the few individual mice that did not appear to be exposed to biomarker were likely a result of edge effects inherent in the trial study design.

Study Area A

On trap grid A (with 18 kg/ha broadcast for both applications) 100% of the mice captured tested positive for biomarker bait consumption after each of the two applications. A total of 13 mice were captured in grid A, amounting to ~2% trap success.

Study Area B

On trap grid B (with 18 kg/ha and 9 kg/ha application rates) mouse trap success rates were much higher, with 25 mice captured after the first application (6.5% trap success), and 129 mice captured after the second bait application (~32% trap success). All 25 mice captured on grid B after the first bait application tested positive for biomarker (100% exposure). After the second application, 124 of the 129 mice captured in area B were positive for biomarker, resulting in an overall 97% exposure rate for grid B.

Table 1. Efficacy Summary Statistics: Mouse Trap Results for Biomarker Presence

Trap Area	# Traps Set	# Mice	# Positive (%)	# Negative (%)
Core Grid A Nov. 12	200	2	2 (100%)	0 (0%)
Core Grid A Nov. 13	200	2	2 (100%)	0 (0%)
Core Grid A Nov. 17	200	3	3 (100%)	0 (0%)
Core Grid A Nov. 18	200	6	6 (100%)	0 (0%)
Core Grid A - Total	**800**	**13**	**13 (100%)**	**0 (0%)**
Core Grid B Nov. 12	200	16	16 (100%)	0 (0%)
Core Grid B Nov. 13	200	9	9 (100%)	0 (0%)
Core Grid B Nov. 17	200	32	31 (97%)	1 (3%)
Core Grid B Nov. 18	200	97	93 (96%)	4 (4%)
Core Grid B Total	**800**	**154**	**149 (97%)**	**5 (3%)**
Inner Immigration A	40	16	16 (100%)	0 (0%)
Inner Immigration B	40	17	16 (94%)	1 (6%)
Outer Immigration A	16	11	1 (9%)	10 (91%)
Outer Immigration B	40	25	0 (0%)	25 (100%)

Discussion

The high mouse exposure rates (96-100%) found during the trial is very encouraging that this bait matrix would have a high chance of success at exposing all mice on the Farallones when applied at the densities used. While the exposure rate was not perfect every night, the less than 100% results are likely due to inherent edge effects necessitated by the trial design, and which would not be present during an actual eradication.

The perimeter of the bait zone created an edge effect and allowed for migration of individual mice into the trapping area from outside of the bait zone, and so mice could have been trapped before being exposed to bait. The data seems to supports this hypothesis, as total number of mice trapped on grid B during the second two trap nights was 32 and 97, respectively, indicating that mice appear to have moved into the trap zone over time. Most of the five unexposed mice were caught in traps closest to the non-baited area 50m to the north of the trap grid.

There is also the additional possibility that bait uptake in this area at this time was so fast that not all resident mice were exposed to bait due to an insufficient exposure period. The non-target (gull) bait uptake in this area during the days leading up to and following the second bait application, in combination with the lower application rate, could have contributed to the five mice not being exposed. The fact that all bait was gone within two days in this area lends credence to these as causal factors, as three to four nights is the preferred target exposure period.

The fact that mouse captures increased 300% over one night in this area might indicate that a wave of immigration may have likely occurred into the baited zone. This is supported by the fact that a rapid increase in the number of mice trapped on grid B occurred, even though the mice testing positive for exposure were removed from the population each day.

Immigration Transect Results

Immigration transect trapping was conducted concurrent with core grid trapping in both areas A and B. Immigration trapping revealed positive test results for biomarker in all but one mouse captured in traps within the baited zone, and just a few negative exposure results were for those mice trapped well outside of the baited zone. Table 1 summarizes the traps results for all biomarker trapping areas.

NON-TARGET SPECIES ASSESSMENTS

3.7 Western Gull Exposure

Attempts were made to identify what non-target species could be at risk of primary or secondary rodenticide exposure using a non-toxic biomarker bait pellet applied at the target application rates in the study area. The non-target species considered during the biomarker trial on the South Farallones were the Western gull, burrowing owl and arboreal salamander. The greatest concern was for impacts to Western gulls, as effective avoidance measures had already been considered and were quite feasible for the burrowing owls and salamanders, and because there is no scientific evidence to suggest that the salamanders would be at high risk to the rodenticides being considered. Thus the majority of the non-target field efforts in November 2010 were focused on documenting the possible risk and exposure to Western gulls from a bait broadcast.

Western Gull Bait Uptake

Bait uptake patterns by gulls was determined using several parameters: Direct daily counts of gull numbers, over 324 hours of visual observations of gull foraging patterns, bait uptake rate comparisons with bait inside gull exclosures, and fecal plot analysis. All studies indicated that Western gulls were responsible for a measurable fraction of the pellet uptake in some portions of the study areas on some days.

Bait uptake and foraging by roosting Western gulls increased each day, as no gull hazing was done during this bait trial. Gulls were allowed to naturally congregate and forage on bait pellets without any human interference. During a rodenticide broadcast, some form of gull hazing will likely be necessary to reduce gull mortalities and to ensure that sufficient bait is present to expose all mice to the bait pellets for several nights.

The daily bait uptake monitoring in the four gull exclusion devices set out in the baited zone demonstrated that gulls were a factor in consuming bait in the larger bait zone. Bait inside the two gull exclusion devices in area A (that had relatively fewer mice) the bait lasted for three to four days longer than those immediately adjacent areas where bait was accessible to gulls and where they were roosting nearby and present in large numbers.

In area B, the bait in the exclosures were consumed by mice within one to two days, not much different than the bait uptake rates outside the exclosure where gulls were seen to be foraging on the bait as well. Although the small size (2.4 m x 2.4 m) and small number (four) of the gull exclusion devices limits the ability to extrapolate the results to an island-wide scenario, the results indicate that it is possible that gulls could consume significant amounts of the bait if no gull avoidance measures are taken.

Gull Observations

In addition to these pellet counts, 324 hours of visual observations were made of the baited areas each day after baiting over 8 days to determine how many gulls were present in and near the baited zone and how many were observed actually or potentially foraging on the bait. Within a day of the first application less than a dozen western gulls were seen beginning to forage on the bait in a few small areas. By the second day ~188 gulls were detected consuming pellets in the bait zone and by the third day a maximum of 233 gulls were consuming pellets.

On days four and five, the fraction of foraging gulls dropped below 12% of those present, perhaps due to a paucity of remaining bait. After the second application of bait on Day 5, however, the number of pellet-foraging gulls had again grown from 22% to 43% of the gulls present in the study area, likely a response to the second bait application (Figure 6). On average, the percentage of gulls foraging on bait during the eight days it was available in the study area averaged 27%. Gull fecal plot counts were conducted after each bait application in two separate study areas where gulls are known to roost (Figure 3). The percentage of gull fecal deposits that were positive for biomarker in these areas also averaged approximately 25% as well.

It should be noted that the study area happened to occur in the area of Southeast Farallon where the roosting gull population is generally highest and most dense, so these results and foraging rates here may not be indicative of the potential exposure rates elsewhere on the islands.

The gull foraging behavior on the non-toxic pellets was a learned behavior that seemed to attract additional gulls as they witnessed the foraging motions of nearby gulls. If most gulls could be kept from learning that the bait is food source, this type of density-dependent mass foraging behavior may be significantly reduced or avoided. In addition, the majority of the gull foraging occurred in the first two hours after sunrise and during the 2 hours preceding sunset. This behavioral pattern could be useful if or when applying any gull-avoidance measures during any eradication effort.

Gull Counts

In addition to counting the number of gulls within and near the study area, daily island-wide gull counts were conducted by IC and PRBO staff during November 2010 to estimate the number of gulls on the South Farallon Islands each day. The total number of western gulls was highly variable from day to day, ranging from approximately 525 to 3800 individuals a day, and generally increasing with time. The population is thought to shift sporadically from mostly non-breeding intertidal roosting gulls in November to a larger percentage of territorial breeding gulls later in December and January. Breeding

birds begin to spend more time on potential breeding sites throughout the island in advance of their breeding season, with the earliest egg-laying dates generally occurring in late April, when up to 17,000 gulls may be present on the island.

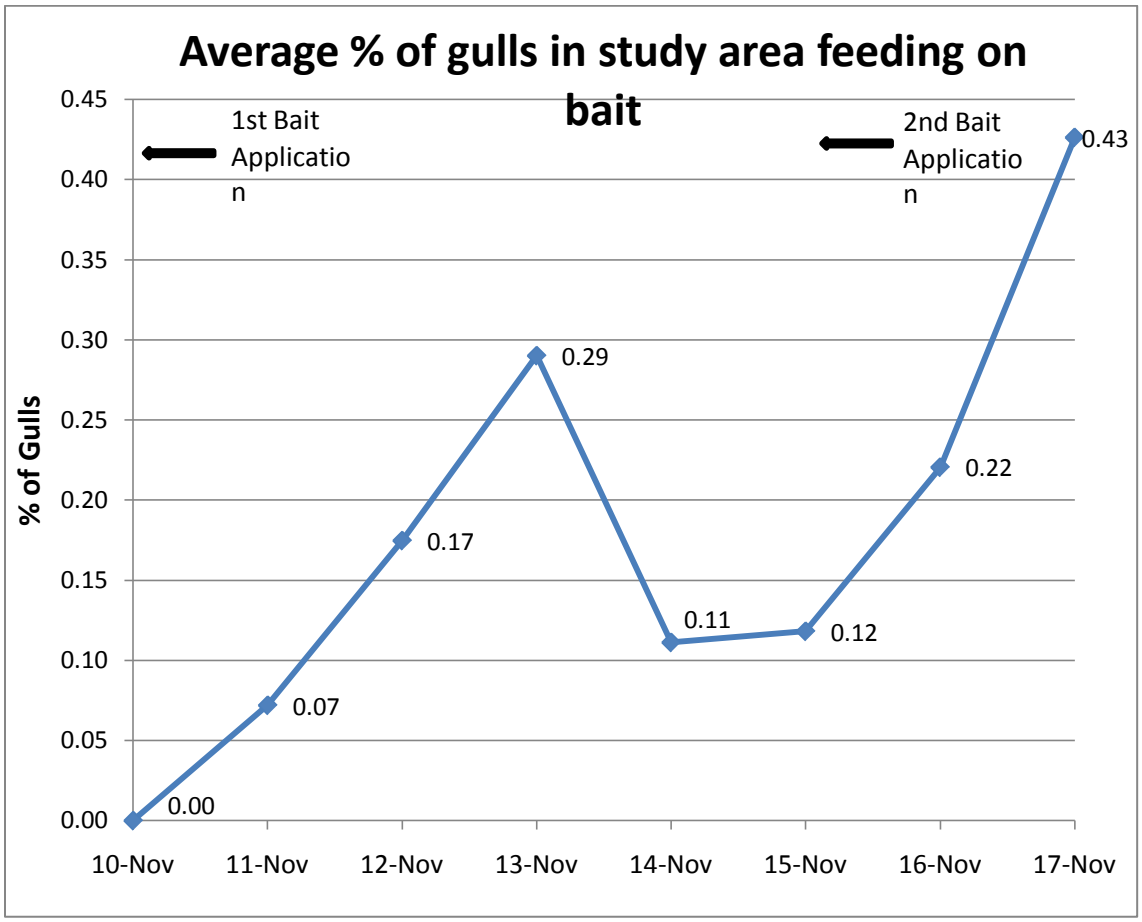


Figure 6. Average Number of Gulls in Study Area Feeding on Bait

Additional Gull Studies

A focused gull risk analysis to determine the extent of the risk posed to gulls has been contracted to a team of independent professional risk analysts familiar with pesticide issues. This quantitative gull risk analysis model will assess the risk that a rodenticide broadcast poses to Western gulls in more detail, and the report will be made available when it is completed.

3.8 Burrowing Owl Studies

A total of 10-12 burrowing owls were likely present on island during the November trial, many of which have been captured and banded and/or fitted with a radio-transmitter by PRBO as part of an ongoing graduate student research project. During the biomarker trial a total of two owls were captured in mist nets and examined under UV lights for primary or secondary exposure to the biomarker, but none showed any UV external fluorescence due to Pyranine.

In addition, a total of 26 fresh burrowing owl casts were collected from over 10 locations within and near the study area both before and after the biomarker bait broadcasts, and none showed any fluorescence that would have indicated biomarker exposure. It is very likely that at least some of the mice eaten by some of the owls were exposed to Pyranine, but it is thought that it is not likely that the water-soluble dye is detectable in secondary owl cast deposits after having gone through the mice and owl's digestive processes.

3.9 Salamander Studies

A total of 52 cover boards were put out in the Marine Terrace study area in order to assist in measuring biomarker bait exposure to the endemic subspecies of arboreal salamander (*Aneides lugubris farallonensis*) that occurs on the island (Figure 7). Boards were set out in October 2010 a month prior to the biomarker study in hopes they would attract salamanders in the study area.

Inspection of these boards before and after the bait broadcasts in November revealed that no salamanders had moved under them as of November 20, 2010. The arboreal salamander on the island seems to prefer moist habitats with rocks and talus, so the relatively exposed and xeric micro-habitat of the marine terrace may not be suitable habitat for the salamanders, or there was not adequate time for the highly territorial salamanders to find the new artificial refugia. For these reasons, it was not possible to measure direct salamander exposure to the bait or via secondary pathways, such as ingestion of insects which may have been exposed to the bait.

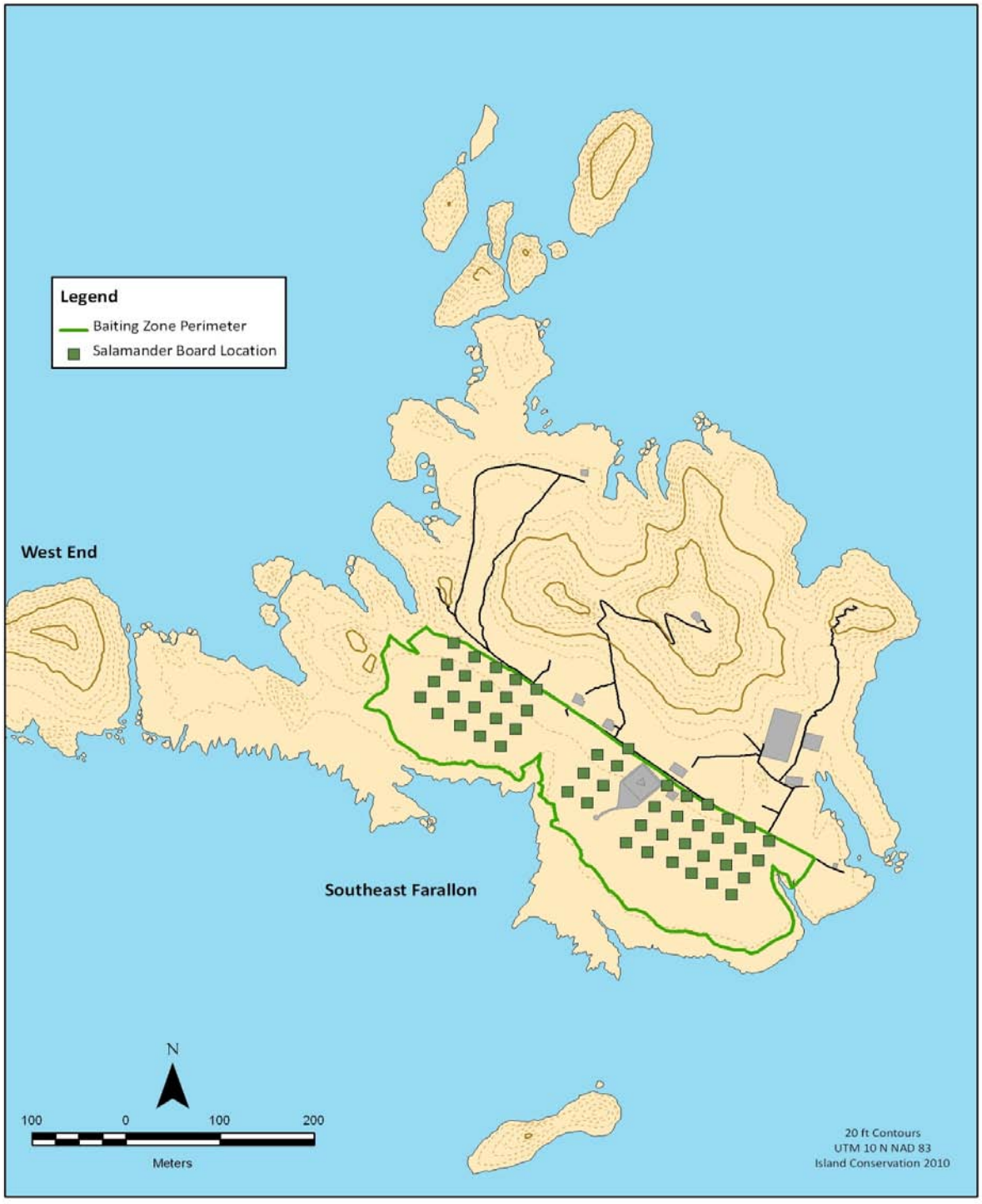


Figure 7. Salamander Cover-Board Locations

3.10 DNA Sample Collections

Over 100 DNA tissue samples were collected during the trial, with 50 from both Southeast Farallon and West End Islands (Figure 8). These samples have been preserved and stored for future analysis. A brief genetic report is forthcoming from a small sub-sample of these, but the majority will remain in storage in order to compare to any future post-eradication samples to determine whether any subsequent mice detected on the islands are repopulations from the current gene pool (failed attempt), or whether they represent a new and recent invasions from another population of mice in the future.

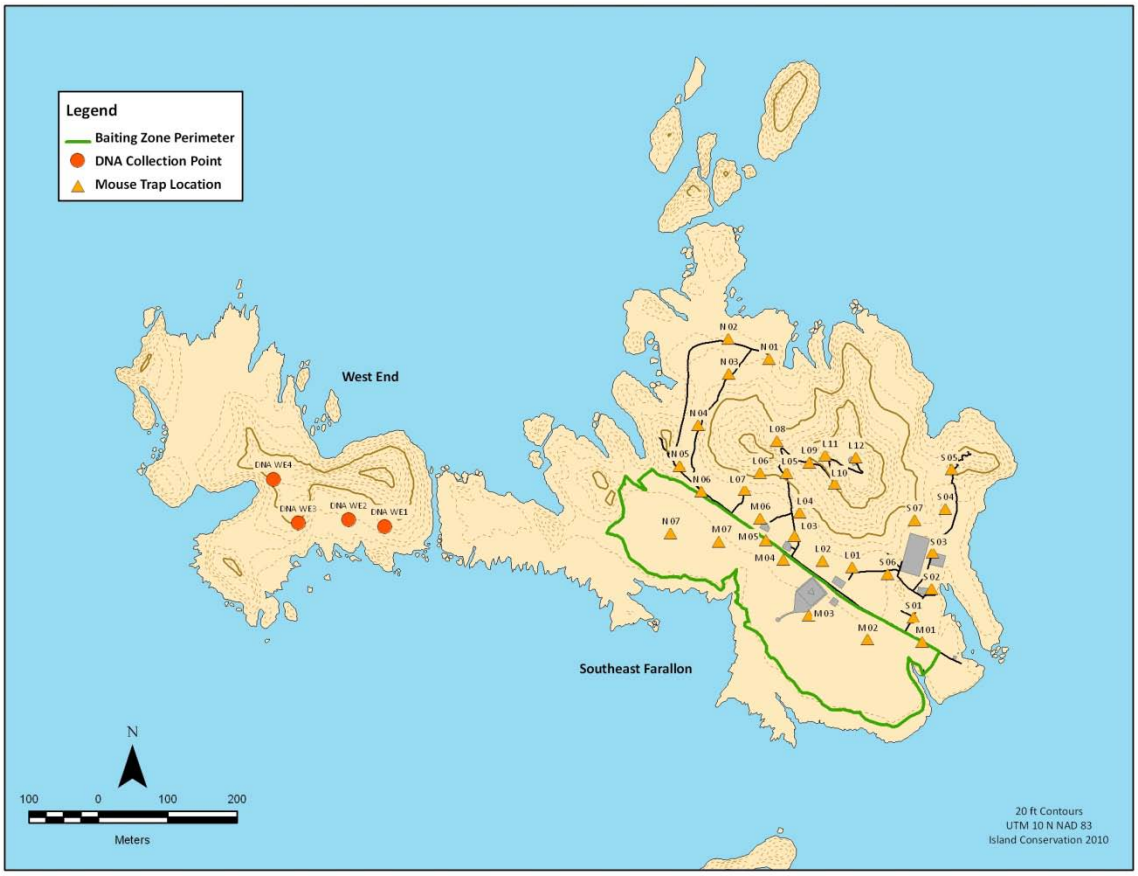


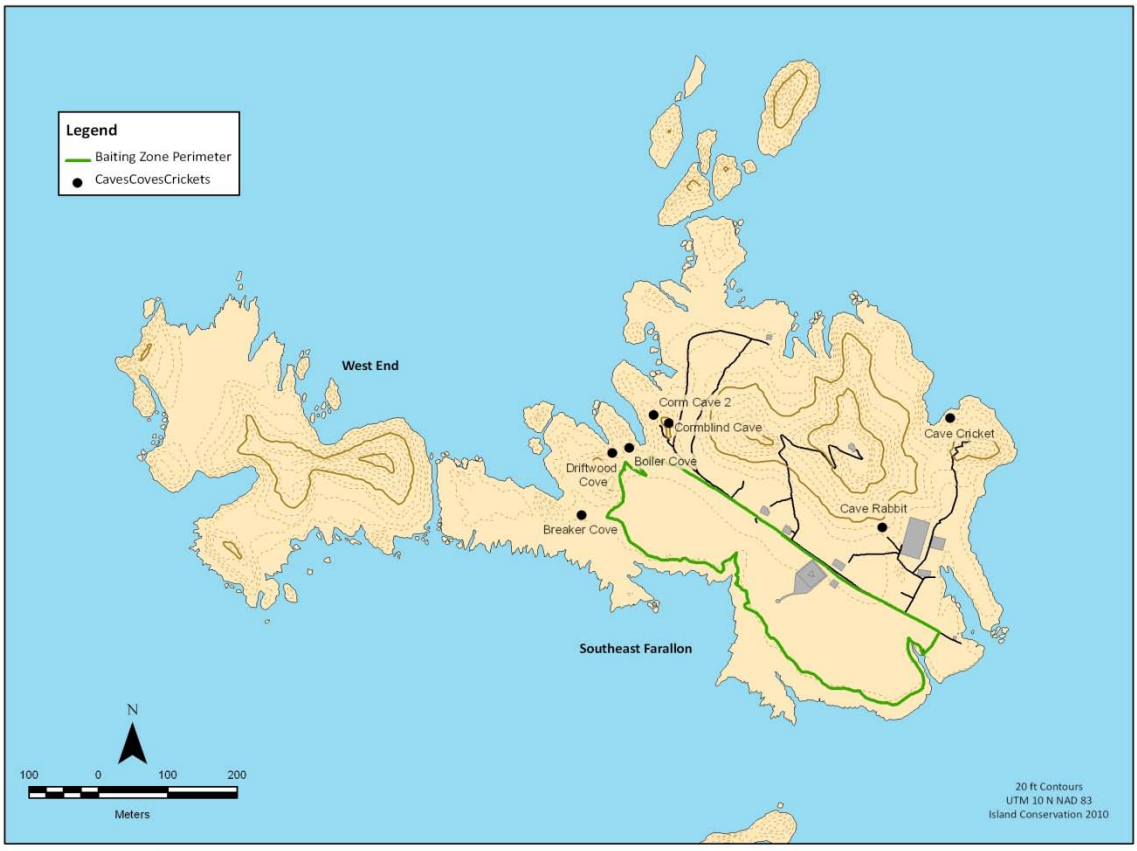
Figure 8. Mouse DNA Collection Locations - November 2010

3.11 Cave and Cave Cricket Assessments

The presence of numerous caves, coves, and coastal features on the South Farallones that may require special baiting treatments during eradication resulted in the field team visiting and mapping the location of many of the caves using GPS equipment (Figure 9). Many cave locations still need to be added to the existing draft map. Some rough measurements of the dimensions of the geographic features of some of the caves were made.

Several caves on Southeast Farallon are inhabited by the endemic Farallon camel cricket (*Farallonophilus cavernicola*). Presence and general abundance of these crickets were noted for assistance for designing future invertebrate surveys.

Figure 9. Caves and Coves inspected during the November 2010 Biomarker Study



Summary of the Biomarker Trial Results

The biomarker trial was very successful in addressing all of the intended major study goals that were set, and in informing several important areas that were not previously considered. These results will help inform the alternatives and mitigation measures to be considered and developed in the future:

A. Mice were exceptionally abundant on the Farallones, with over 93% trap success, and over 250 uniquely marked individual mice captured in a 0.25ha study site, indicating densities of several hundred mice per hectare.
B. Mice do occur on West End and are relatively abundant there as well as on SEFI. Many mice are active during the day during the fall months on the Farallones.
C. Mouse densities are not uniform, but are quite variable from site to site.
D. Mice are having major impacts on the island's native plant and animal resources.
E. While some mice may be able to breed year-round, most mice were not in reproductive condition in November, and most breeding activity appears to have been over at the time, with no pregnant females or young juveniles detected.
F. Mice abundances were highly variable from site to site, perhaps by a factor of 10.
G. The ~1g bait pellet with pyranine was highly acceptable and palatable by mice
H. The EPA registered application rate for Conservation 25D (27kg/ha at 18 and 9 kg/ha) would likely be effective at exposing all mice under certain conditions.
I. Some Western gulls would readily learn to eat the bait pellets within several days
J. Secondary exposure to gulls raptors and ravens from exposed mice could occur unless mitigation measures were implemented to limit exposure and predation.
K. Measures to limit pellet consumption by gulls will likely be necessary to maintain bait for the time required for complete exposure to all the mice on the islands, and to limit non-target impacts to gulls.
L. No exposure to the biomarker was observed in burrowing owls but that this was likely a function of limited secondary pyranine persistence via this pathway.
M. The numerous caves, coves and steep slopes may require special bait treatments
N. The many areas of steep terrain, tidal zones, restricted entry and sensitive resources means large portions of the islands can't be treated using bait stations
O. The houses, buildings or other man-made features will require special treatments
P. Access to various portions of the islands and surrounding islets will need to take into account logistics, wind, waves, tides, weather, and marine mammals.
Q. The number and location of roosting and territorial Western gulls on the island can be quite variable from month to month, day to day, and even hour to hour.
R. Effective gull hazing measures could significantly reduce the number of gulls exposed to the bait pellets directly or indirectly through exposed mice.

4. DEVIATIONS FROM ORIGINAL SCOPE OF WORK

Changes to the work activities conducted during this period that differs from the original Scope of Work elements fall into four main categories: Biomarker Trial Study Design, Gull Hazing Trial, and NEPA procedural changes.

4.1 Biomarker Trial Study Design

Some changes to the biomarker trial methods mentioned in the September 2010 Scope of Work were necessary. Most of the changes involved additional elements being added to the study plan in October 2010 and other additions were made on the island in November. None of the additions added any additional cost to the project in terms of staff of duration of study, but the two deletions from prior study designs saved considerable time and expense on techniques that would have yielded useful results.

Additions to the Biomarker Trial Study Design:

- Biomarker persistence and palatability studies were added
- Estimate rates of bait removal by mice and gulls
- Detection of biomarker in burrowing owls and salamanders
- Uptake rates of mouse carcasses by birds to determine secondary uptake rates
- Collection of 100 mouse DNA samples from Southeast Farallon and West End
- Located and assess caves, coves and areas that may need special bait treatments
- Delineate which areas can/should be treated using bait stations
- Assess treatments that may be needed for buildings or other man-made features
- Determine access to various portions of the islands and surrounding islets
- Estimating the number of gulls and other non-target bird species on the islands

Omissions from the Biomarker Trial Study:

- Mouse radio-telemetry home-range study (omitted from Trial Plan)
- Gull capture studies to assess biomarker exposure (attempted but aborted)

These two aspects were eventually omitted from the plan due to a combination of time and staff constraints, limited effectiveness of the methods, and because other parameters were higher priority. The mouse telemetry study was considered too labor intensive, and the movement data could be captured using trapping data. The gull capture attempts were abandoned after several days of trapping efforts resulted in only four gull captures, too few to assist in providing any useful gull exposure rate estimates. This was not considered an unsurprising or problematic development, however, as other methods were successfully used to estimate this parameter (gull monitoring and fecal plot counts).

4.2 Gull Hazing Trial

Because the results of the November 2010 Biomarker Trial revealed that Western gulls and other gull species are able to consume bait, it was decided that some form of hazing may likely need to be conducted in order to reduce the amount of bait that would be ingested by gulls as well as to reduce the non-target impacts. For this reason, a five-day Gull Hazing Trial Plan was submitted it to USFWS in January 2011, and was conducted on Southeast Farallon Island (SEFI) from January 21-26, 2011, with the goal of determining which methods could be effectively used to haze gulls from the island. This study was subject to a separate USFWS Special Use Permit.

The field trial team consisted of one Island Conservation Resource Specialist (Maddie Pott) and two professional bird hazing experts: Winston Vickers of the Office of Spill Prevention and Response (California Department of Fish and Game) and Derek Milsaps of USDA-APHIS Wildlife Services. The individuals involved regularly haze gulls and other birds from airport runways, oil spills and other hazardous areas.

While a separate Draft Gull Hazing Report is currently being developed, the basic results of this preliminary study were that a number of techniques regularly used by the USDA-APHIS Wildlife Services branch in protecting the nation's airports against bird airstrike hazards were effective in dissuading gulls from using and roosting large portions of the island. Hazing techniques tested during the trial were conducted in very limited study areas on the islands and were implemented so as to avoid disturbance to marine mammals in the area.

Results indicated that intensive and persistent use of hazing techniques could be effective in hazing gulls off the island and discouraging them from alighting on the island for the duration of the five-day study. An extended trial of several weeks is recommended to provide further insight into what techniques and methods and personnel would constitute an effective sustained hazing regime for this gull population, as some techniques could be subject to habituation by the resident gulls over time.

4.3 NEPA Procedural Changes

The February 10, 2011 USFWS decision to move from an Environmental Assessment to an Environmental Impact Statement for the Farallon Restoration project was the major procedural change. As a result, proposed implementation of the project was delayed from fall 2011 to fall 2012 based on NEPA requirements and timeline constraints. A new budget and Scope of Work will need to be drawn up under a revised Cooperative Agreement between the USFWS and Island Conservation for the development of an EIS.

5. RECCOMENDATIONS FOR FUTURE ACTIVITIES

The following revisions to the project's Scope of Work are recommended:

- An extended/expanded fall 2011 gull hazing trial on SEFI (~4 weeks in duration)
- A concurrent extended bait degradation study on SEFI (~4+ weeks - fall 2011)
- Invertebrate surveys, including Farallon camel cricket surveys and cave mapping
- Salamander bait exposure studies (both direct and indirect pathways) on the island
- Assessment of the number of juvenile salamanders present in population
- Map distribution & abundance of native/non-native vegetation before eradication
- Continued owl monitoring and telemetry to assess numbers, location, stay length
- Continued daily gull counts (September through April)
- Continued monthly mouse index of abundance trapping at 33 permanent plots
- Development and implementation of a Biosecurity Plan for the Farallones
- Development of a Structure Maintenance Plan to address commensal rodents
- Development and implementation of Monitoring Plans for Efficacy (mice), for Non-target species, and for Conservation Measure parameters
- Development of a Comprehensive Non-Target Mitigation Plan by USFWS:
    - Raptor Capture and Hold/release Protocols
    - Passerine Capture Protocols
    - Gull Hazing Plan and Trial Test
    - Salamander and Cricket Survey and Mitigation protocols

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