

# Farallon Islands

National Wildlife Refuge

Invasive House Mouse  
Eradication Project





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# South Farallon Islands

- 120 acres
- 360 feet
- Rugged and remote
- Some islands designated wilderness





# Largest Seabird Colony in the Contiguous U.S.

## 300,000 Breeding Seabirds—13 Species

Brandt's Cormorant



Ashy Storm-Petrel



Western Gull



Tufted Puffin



Common Murre



Pigeon Guillemot



Rhinoceros Auklet



Cassin's Auklet

# Five Species of Pinnipeds

~3,000 – 6,000 Animals

California Sea Lion



Harbor Seal



Steller Sea Lion



Northern Elephant Seal



Northern Fur Seal



# Endemic Species

Farallon arboreal salamander



Maritime Goldfield



Farallon Camel Cricket



# Research and Monitoring on the Islands for 50+ Years

Today, our long-term data sets form **baseline knowledge**.

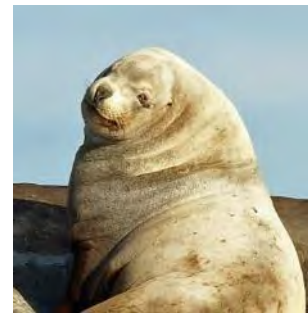
- Breeding seabird populations, demographics, ecology
- Pinniped populations and demographics
- Migrant birds
- Seabird predation
- Migrant burrowing owls
- Arboreal salamanders
- Farallon camel crickets
- Vegetation
- Cetaceans
- White sharks
- Intertidal communities





# The Problem

The effect of invasive house mice on the Farallon ecosystem





# ISLANDS REPRESENT



**5.3%**

Of the Earth's landmass

UNEP-WCMC 2015



**75%**

Of bird, amphibian, mammal,  
and reptile extinctions

Tershy et al. 2015



**41%**

Of all CR and EN  
terrestrial vertebrates

Spatz et al. 2017



**19%**

Of avian biodiversity

Tershy et al. 2015

## INVASIVE ALIEN SPECIES



**86%**

Of recorded extinctions linked  
to invasives occurred on islands

Bellard et al. 2015

# Density of Invasive House Mice on Southeast Farallon Island

- Density estimate of approximately **500** mice per acre
- House mouse densities commonly range from **4 to 20** per acre

## Highest Reported Density of Invasive House Mice for Any Island in the World

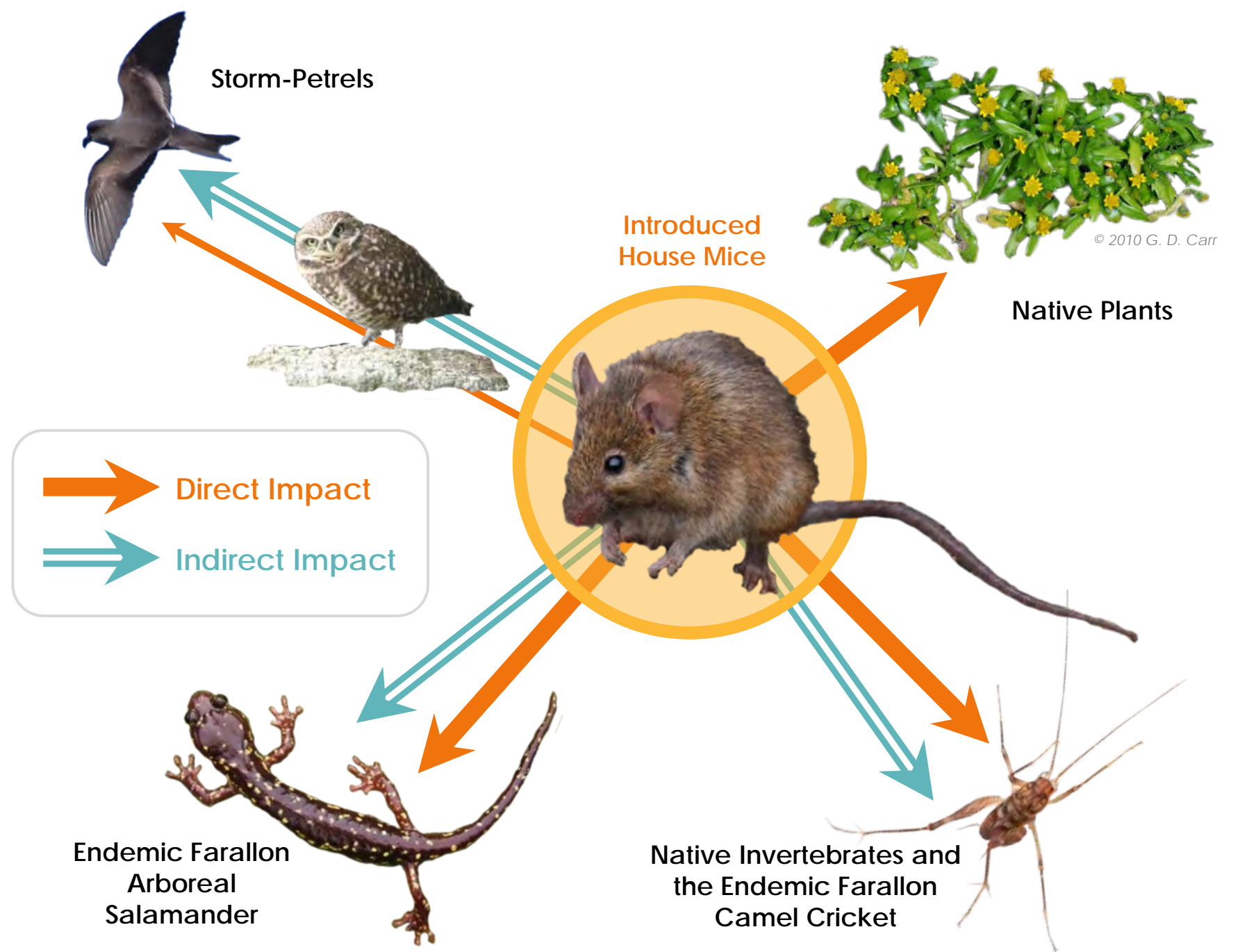




# Ecosystem Damage from Invasive House Mice on Southeast Farallon Island



Mouse on Farallon Islands (Matt Brady)



# Distribution of Ashy Storm-Petrel

- World population **fewer than 10,000** breeding birds



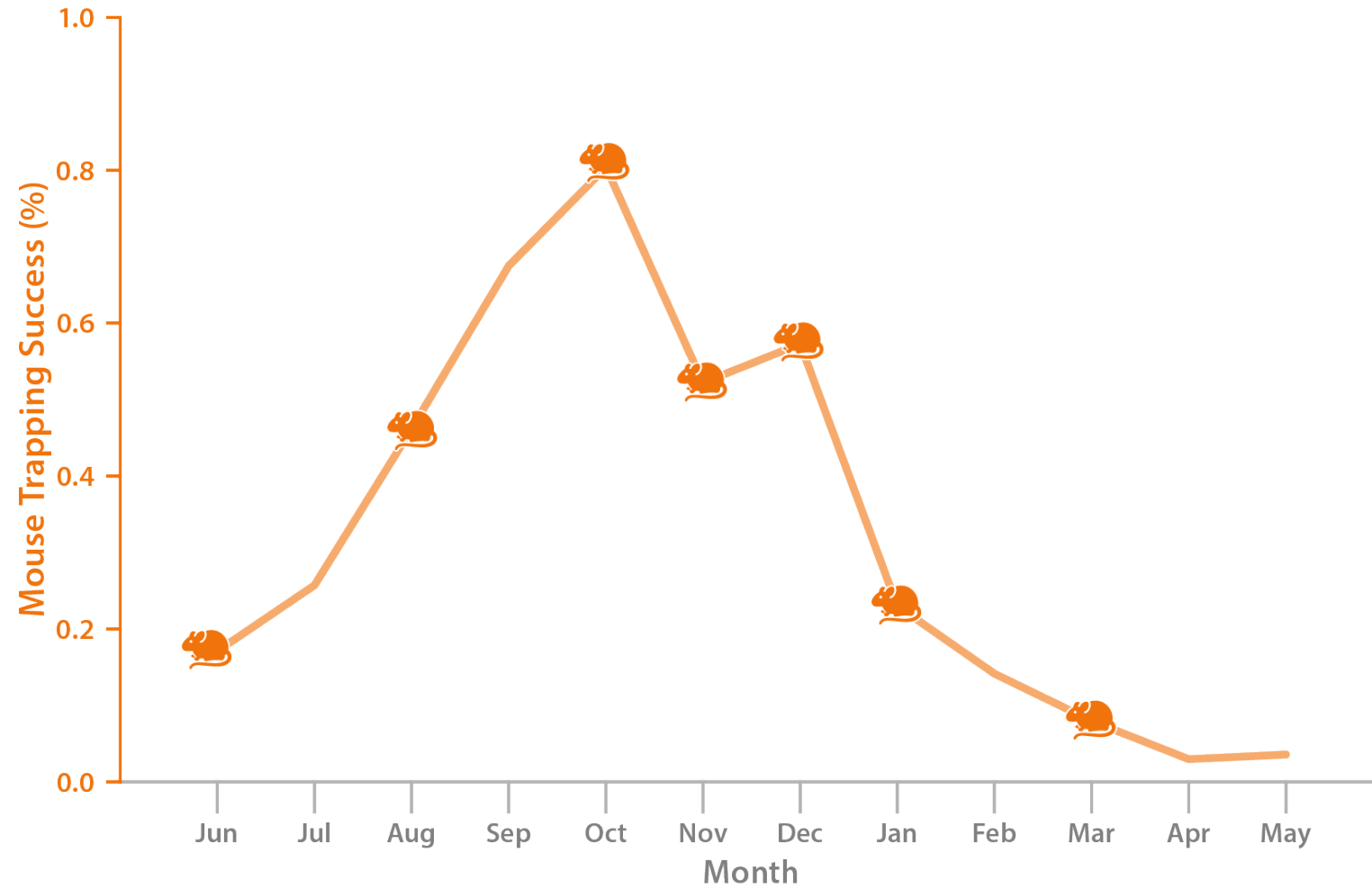


# Relationship of Mouse and Owl Abundance with Ashy Storm-Petrel Predation

## Mouse Trapping Success



Mouse on Farallon Islands (Matt Brady)



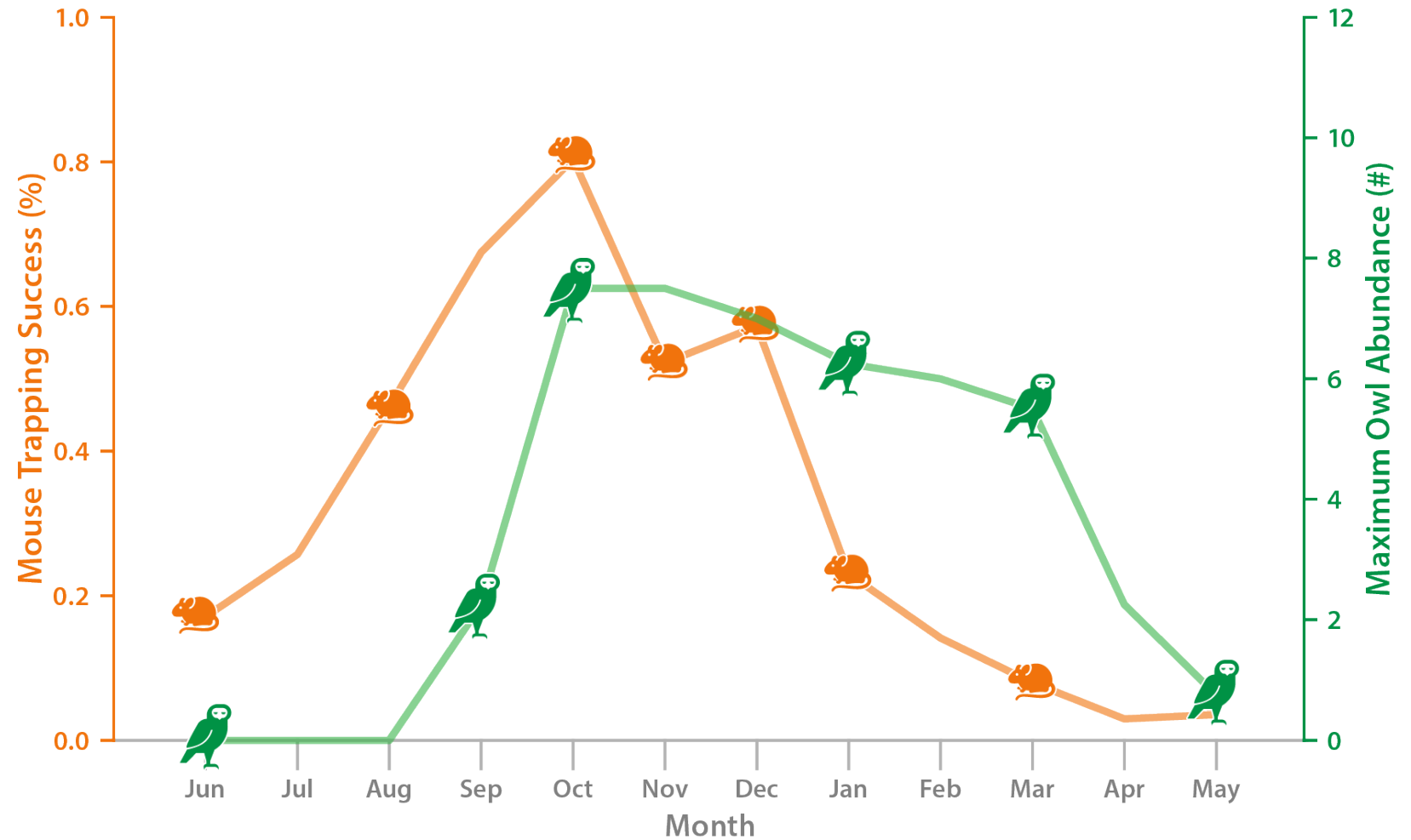
 Mouse population index



Source: Nur et al. 2019



# Relationship of Mouse and Owl Abundance with Ashy Storm-Petrel Predation

Maximum Burrowing Owl Abundance



-  Mouse population index
-  Maximum burrowing owl abundance (# of owls)

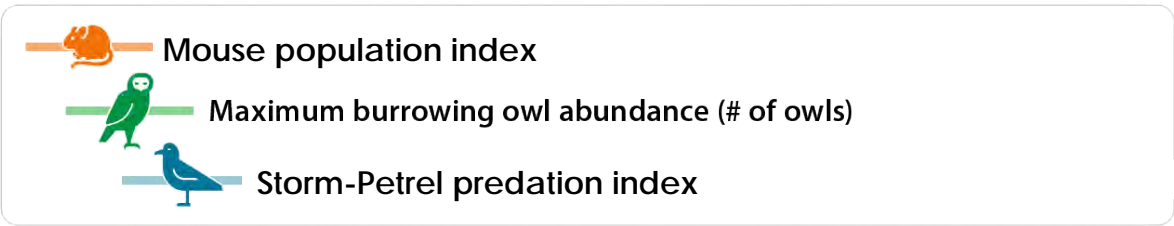
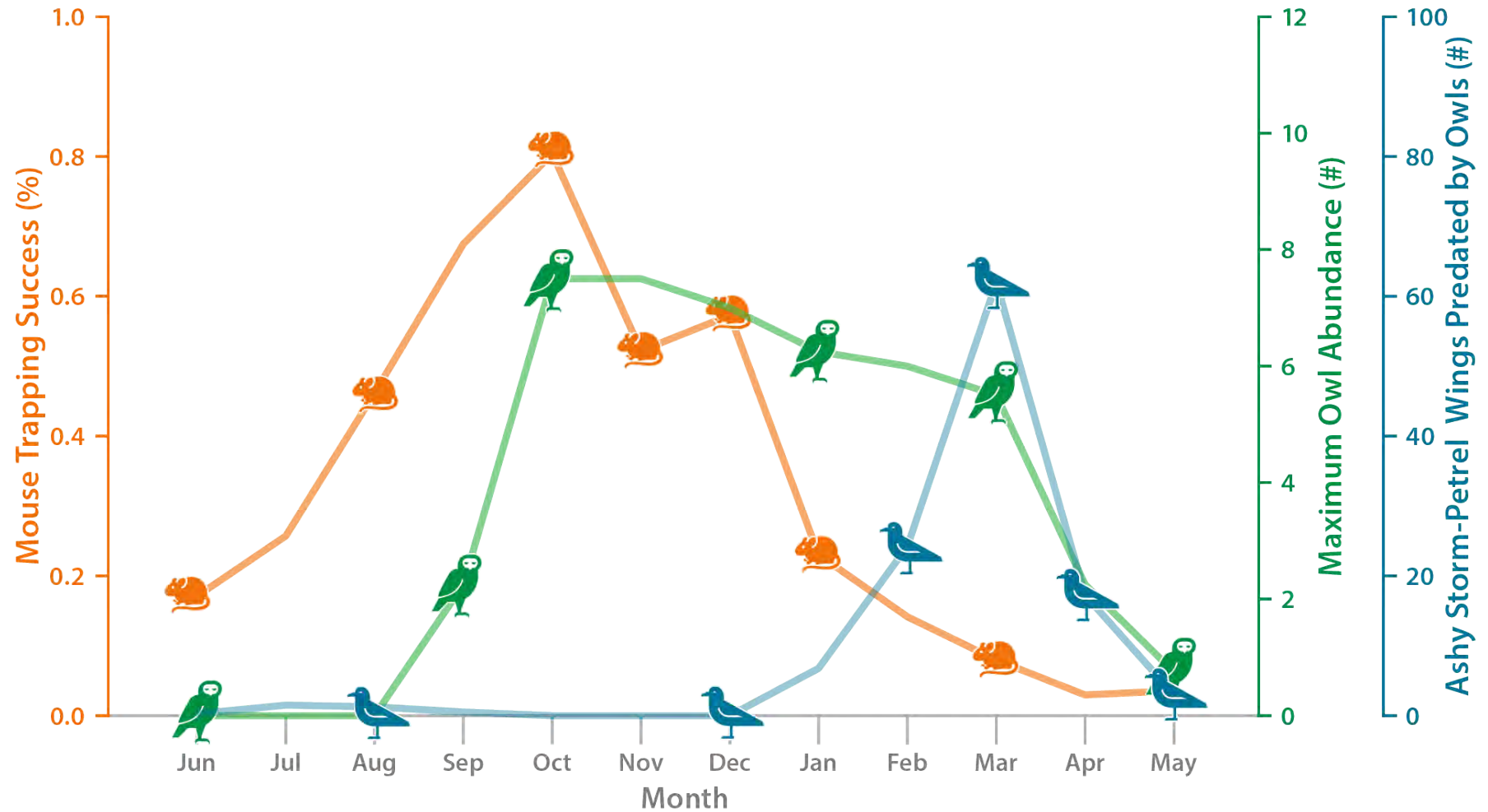
Source: Nur et al. 2019





# Relationship of Mouse and Owl Abundance with Ashy Storm-Petrel Predation

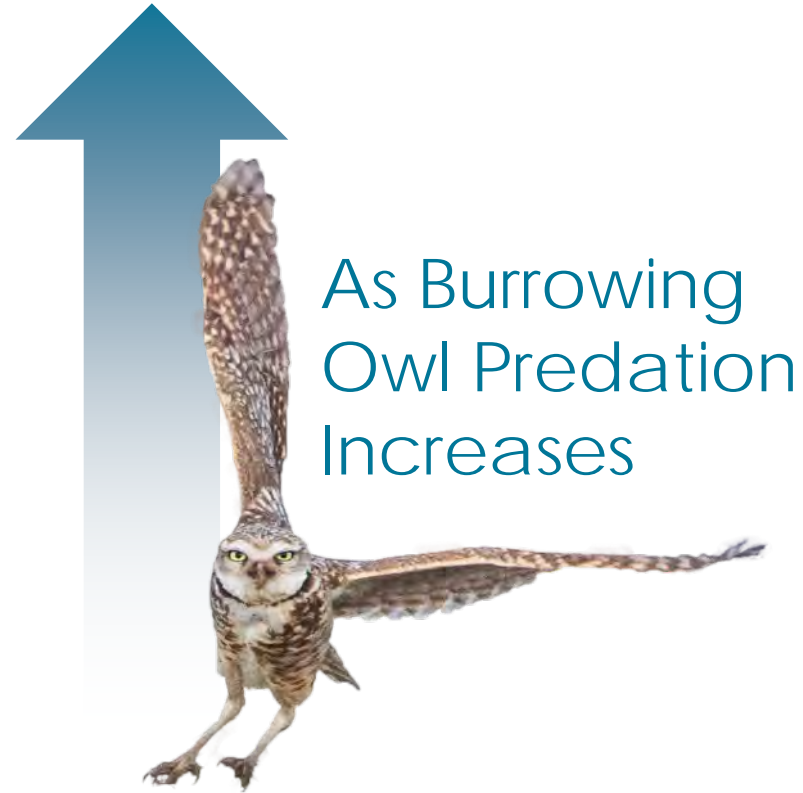
Ashy Storm-Petrel Wings Predated by Burrowing Owls



Source: Nur et al. 2019



# Ashy Storm-Petrels and Burrowing Owls



Nur et al. 2019. Evaluating population impacts of predation by owls on storm petrels in relation to proposed island mouse eradication. *Ecosphere*.



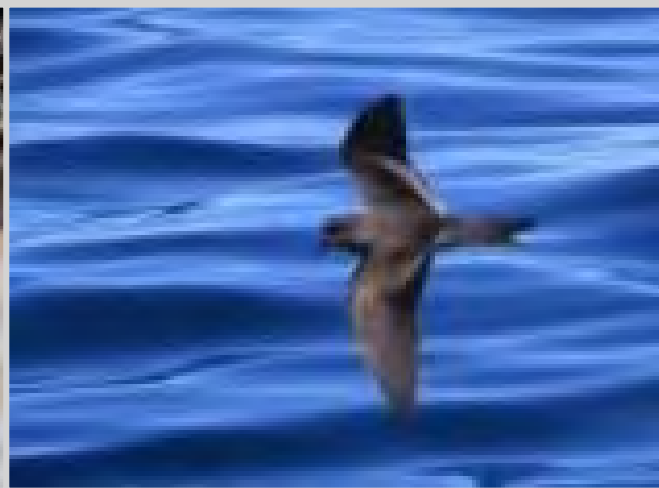
# Expected Benefits of Eradicating Mice

## Decreases in

- Mouse impacts on ashy storm-petrel
- Mouse impacts on crickets & other invertebrates
- Mouse impacts on salamanders
- Mouse impacts on native plants

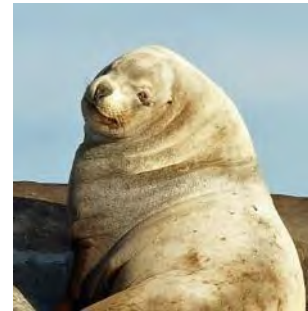
## Increases in

- Ashy storm-petrels
- Native plants
- Endemic salamanders
- Endemic camel crickets
- Other invertebrates
- Native ecosystem function



# Finding a Solution

Developing action plans and evaluating alternatives





# Environmental Planning Process

- **Feasibility Study: 2004**
- **EA Public Scoping: 2006**
- **Comprehensive Conservation Plan: 2009**
- **EIS Pubic Scoping: 2011**
- **Draft EIS and public comments: 2013**
  - **553 public and agency correspondences received**
- **Final EIS published: March 2019**
- **Section 7 ESA (black abalone) and Essential Fish Habitat concurrences obtained: April 2019**

# Alternative Selection

## List of Potential Action Alternatives for House Mice Removal from the Farallon National Wildlife Refuge

### 49 POSSIBLE METHODS EXAMINED:

#### 6 nonrodenticide methods

##### Mechanical

- Live-trapping
- Snap-trapping
- Predator introduction

##### Theoretical

- Contraception
- Disease
- Genetic modification

#### 15 rodenticides, 3 delivery methods

- Aerial broadcast
- Hand broadcast
- Bait station



# Alternative Selection



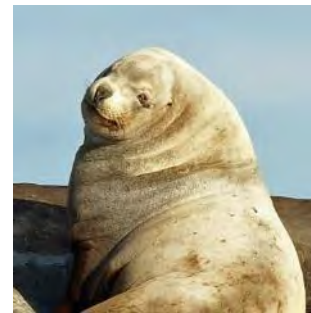
# Contraceptives:

## Dismissed from further analysis

- Currently available only for rat control
- Not currently feasible for eradication
- Future availability for eradication uncertain

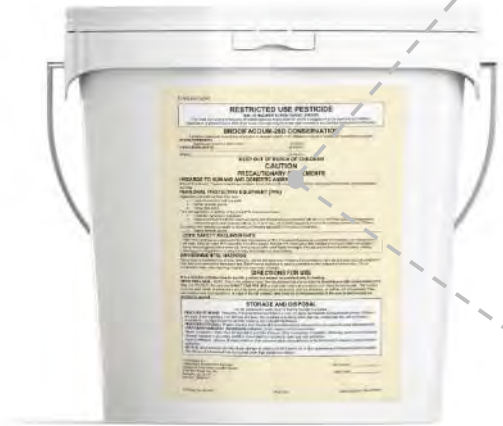
# Brodifacoum-25D Conservation

Preferred Alternative in Final Environmental  
Impact Statement





# Key Pesticide Label Items



## BRODIFACOUM-25D CONSERVATION

- ▶ A pelleted rodenticide for control or **eradication** of invasive rodents in dry climates **on islands** or vessels for **conservation**.
- ▶ This product is to be used for the protection of State or Federally listed Threatened or Endangered Species or other species determined to require special protection.
- ▶ **RESTRICTED USE PESTICIDE:** For retail sale **only** to employees of Federal agencies responsible for wildlife management, to be used **only** by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.
- ▶ It is a violation of Federal law to use this product in a manner inconsistent with its labeling.



# Brodifacoum Soil and Water Impacts

## Risk to Soil

- Disintegrates within 6 months
- Pellets break down within 5 weeks
- Becomes biologically unavailable once the pellet breaks down.

## Risk to Water

- Not soluble in water
- Pellets break apart within a few hours
- Toxicant settles to the bottom making it virtually inaccessible to nontarget species.



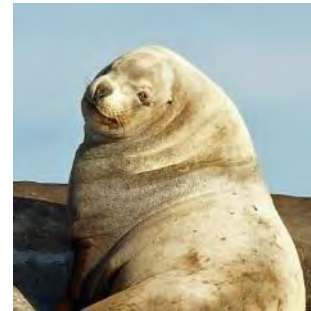
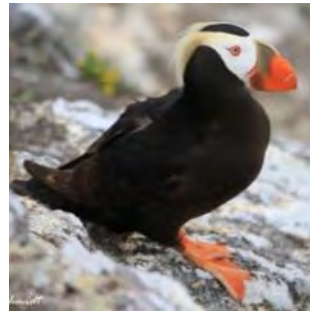
# Brodifacoum Risks to Fish & Wildlife

- Highly toxic to small mammals and birds
- Toxic to some fish
- Not toxic to most invertebrates
- Does not bio-accumulate
- Impacts are short-term





# Operations



# Operational Details

Action Attribute	Proposed Action
Primary bait delivery method (~90%)	▶ Aerial broadcast
Supplementary bait delivery method (~10%)	▶ Hand broadcast, bait station
Timing: Start of application	▶ Fall months
Number of applications	▶ 2
Time between applications	▶ 10-21 days
Anticipated bait pellet application rates	▶ 24 lb/acre (16 lb/acre + 8 lb/acre)
Anticipated total amount of rodent bait that would be applied	▶ 2,917 lb
Concentration of rodenticide within rodent bait	▶ 0.0025% (2.5 parts per million)
Total amount of rodenticide to be applied	▶ 2.9 1.6 oz (33 g)
Total Operational Period	▶ ~5 weeks



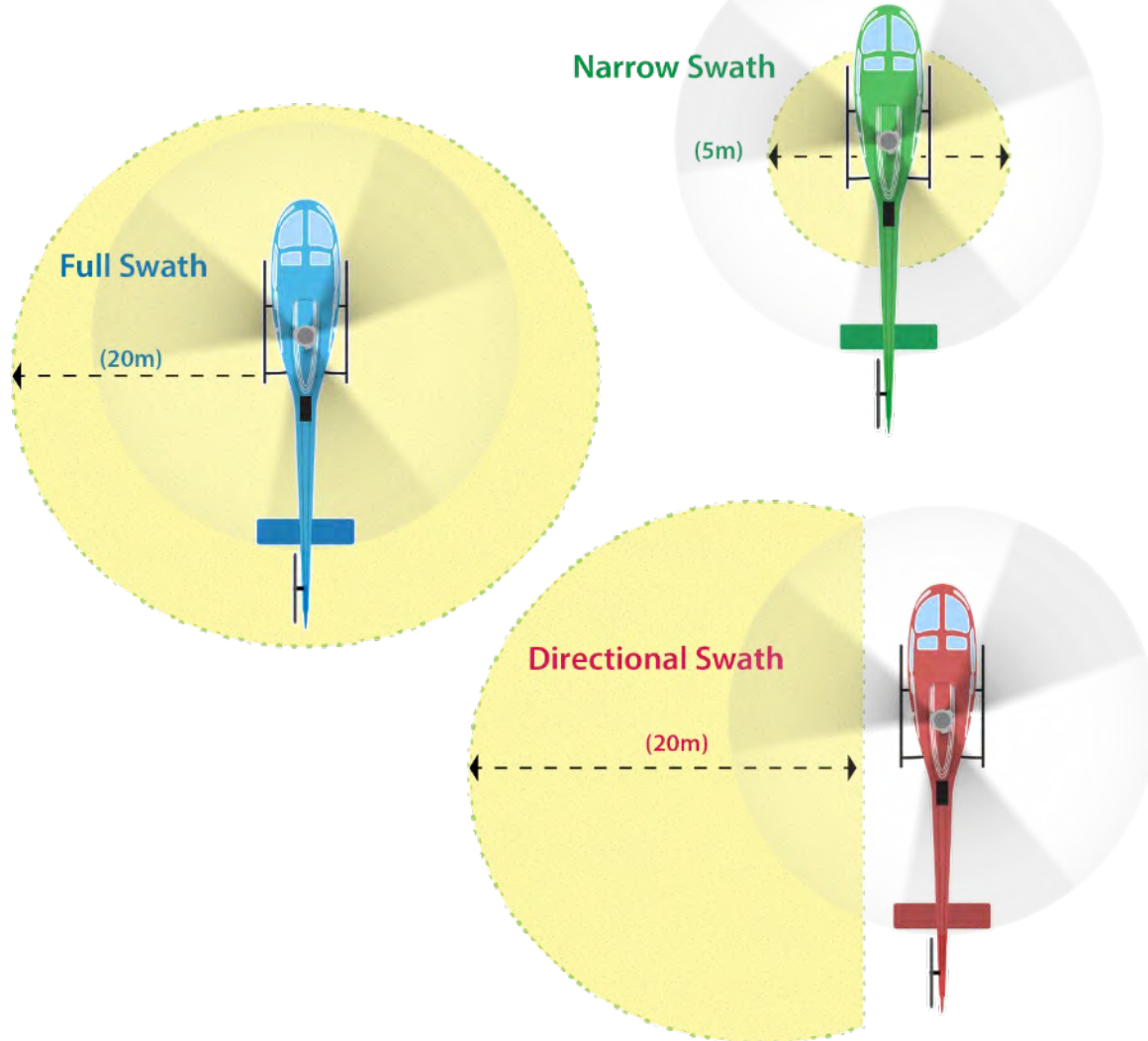
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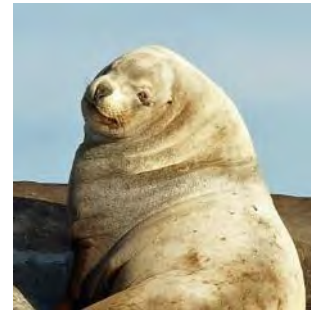
# Bait Application



- Dose rate, bait direction and swath width can all be controlled within set limits.
- Differential GPS to guide the helicopter along a set of pre-determined flight transects.
- Plots of the actual path flown will be inspected in real time to ensure complete coverage.
- Variable swaths allow effective baiting on different terrains without baiting marine environment.

# Protective Measures

Ensuring minimal impact on terrestrial and marine environment





# Protective Measures

- Operations
- Timing
- Gull hazing
- Capture of birds of prey
- Capture of salamanders
- Carcass removal

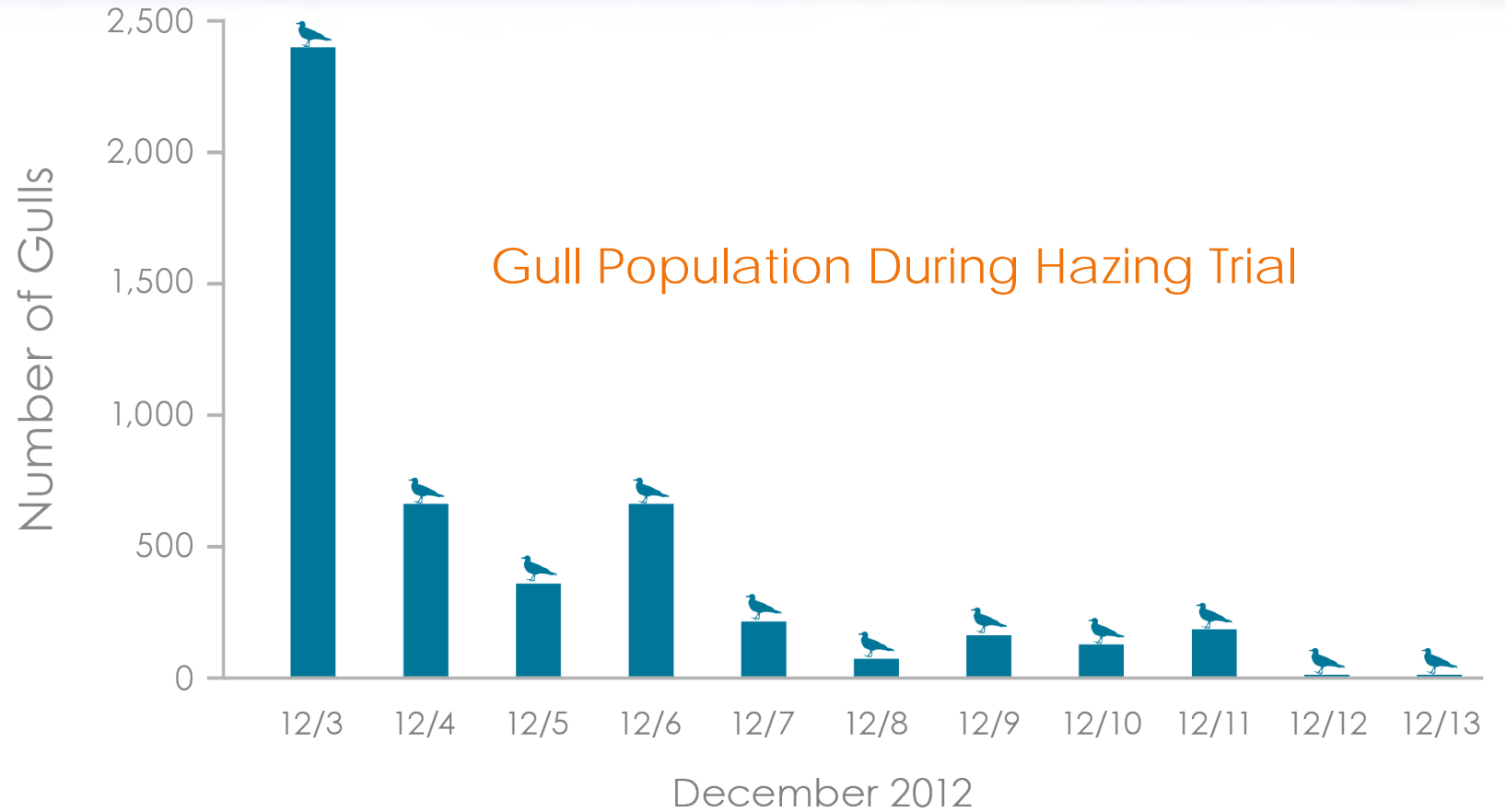
## Protecting wildlife and habitats during operations





# Gull Hazing Success

During hazing trials, gull numbers declined from as high as 2,500 gulls to ~0, and nearly all those gulls were successfully hazed from the islands.



# Eradication Monitoring

Monitoring operations will include the following:

- Bait application rates
- Bait uptake by mice
- Birds
- Salamanders and camel crickets
- Intertidal invertebrates
- Subtidal fish, invertebrates
- Water
- Soil
- GFNMS Beach Watch



Preparing for  
the  
unexpected

## Contingency Plans

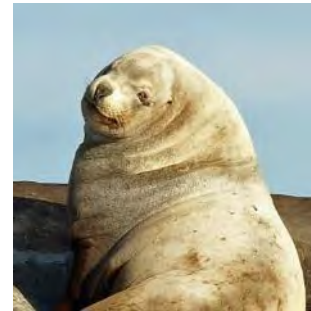
- **Bait spill**
- **Significant non-target impacts**
- **Fisheries exposure**





# Success Stories

Past successes for rodent eradication on islands



# Worldwide Rodent Eradication

- **>600** successful rodent (rats or mice) eradications worldwide
- **57** successful mouse eradications worldwide since 1971
- **Nearly 100%** successful mouse eradications since 2007 (at least 28 of 32 attempts)
- **5** eradications in U.S. (all rats):
  - Anacapa Island (Channel Islands NP, CA)
  - Midway Atoll & Palmyra Atoll NWRs (U.S. Pacific Islands)
  - Hawadax/Rat Island (Alaska Maritime NWR, AK)
  - Desecheo NWR (Puerto Rico)



## Mouse Eradications





# SUCCESS STORY

## Anacapa Island

### Benefits Achieved:

- Rats eradicated using brodifacoum
- No negative impacts to gulls, seawater, marine invertebrates, or marine fish
- Successful mitigation measures
- Seabird populations recovering: Scripps's Murrelet, Ashy Storm-Petrel, Cassin's Auklet
- Increases in intertidal invertebrates.

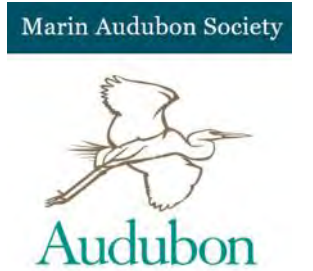


Howald et al. (2009)  
Newton et al. (2016)





# Partners and Other Supporters



Farallon Islands Foundation







**Restore & safeguard**  
 one of the most ecologically  
 important island  
 ecosystems in  
 the world.

