

# South Farallon Islands

National Wildlife Refuge

Invasive House Mice  
Eradication Project





Location of the Farallon Islands National Wildlife Refuge and specifically the South Farallon Islands where mouse eradication project will occur

Approx. 30 miles west of San Francisco







# About Farallon Island

National Wildlife Refuge

- 120 acres (49 ha)
- 350 feet high (113 m)
- Rugged and remote
- Some islands are designated Wilderness





## Seabirds

- World's largest colonies of Ashy Storm-Petrel, Brandt's Cormorant, and Western Gull.
- Numbers of breeding seabirds are only ~1/3 of what they were before human impacts
- One of the foremost natural laboratories for monitoring changes in the North Pacific Ocean ecosystem.

## 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 (threatened)



Northern Elephant Seal



Northern Fur Seal

## Wildlife

- Islands provide important breeding and resting habitat.
- Pinnipeds were formerly decimated by seal hunters.
- Protection of islands as a National Wildlife Refuge has provided a safe haven and pinniped numbers are recovering.

# Extensive Human History

## Early 19th century:

- Marine mammal hunting

## Late 19th century:

- Commercial egging
- Construction of lighthouse and houses, lighthouse keepers
- North and Middle Farallon Islands and Noonday Rock established as National Wildlife Refuge in 1909 by President Theodore Roosevelt





## Early to mid-20th century:

- Lighthouse keepers
- U.S. Navy Radio Station

## 1969 – present:

- South Farallon Islands added to the Farallon Islands National Wildlife Refuge
- Stewardship, long-term monitoring, and research of island ecosystem





- Breeding seabird populations, demographics, ecology
- Pinniped populations and demographics
- Migrant birds
- Seabird predation monitoring
- Migrant Burrowing owls
- Arboreal salamanders

- Farallon camel crickets
- Vegetation
- Cetaceans
- White sharks
- Intertidal communities

Research  
and  
monitoring  
on the island  
for 50+ years

Today, our long-term  
data sets form  
Baseline Knowledge





# Pre- eradication Studies

Studies conducted  
to inform the  
Southeast Farallon  
Island invasive  
mouse eradication  
project

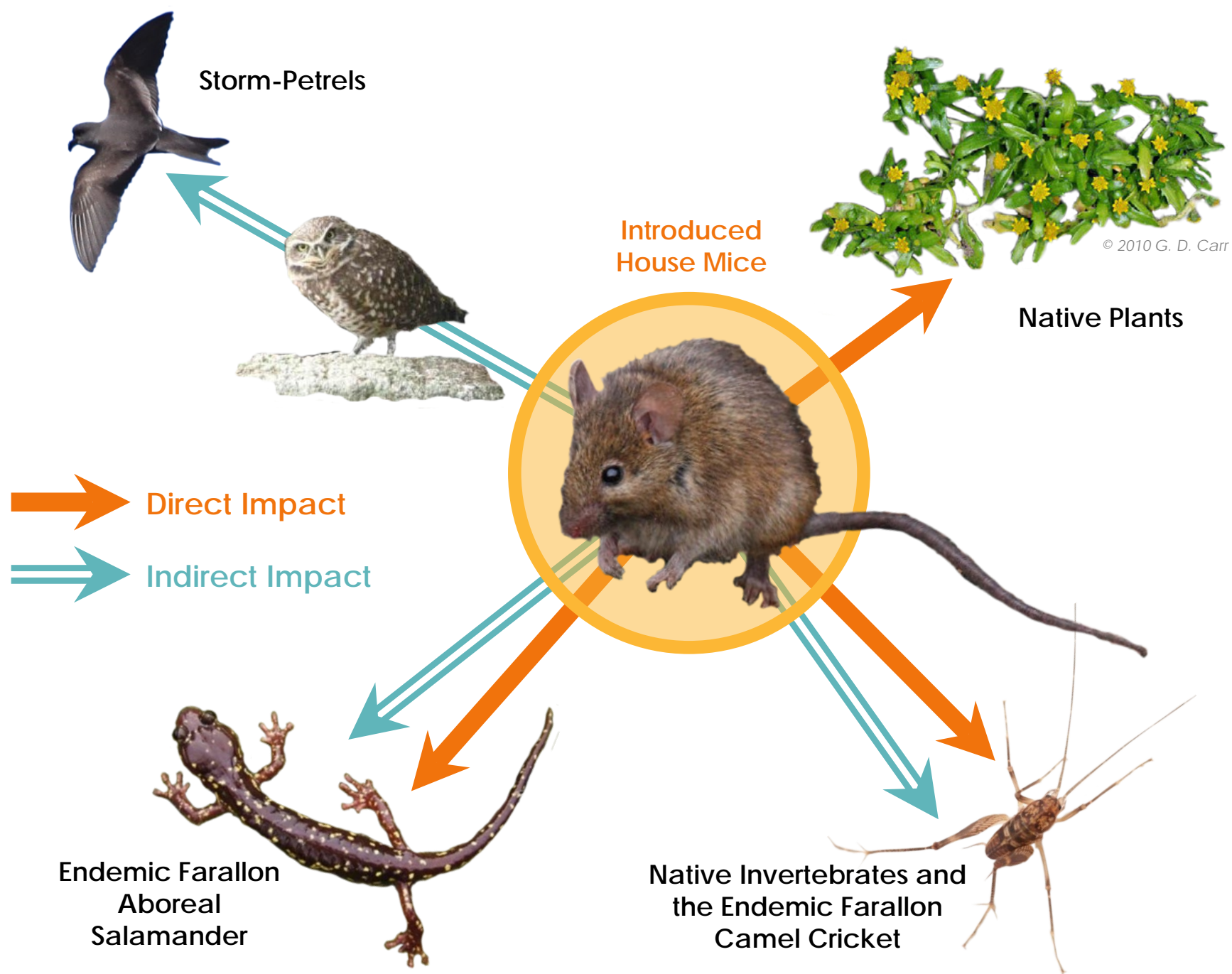
- House mouse density estimate
- Bait palatability and preference trials
- Bait exposure rates (efficacy;)
- Bait station field test
- Mapping of accessible and sensitive areas
- Collection of mouse samples and genetic analysis
- Bait degradation trials
- Gull hazing trials
- Gull risk assessment
- Impacts of mice on Ashy Storm-Petrels
- House mouse diet
- Salamander hazard study
- Conservation measures: Seabird, salamander, cricket, burrowing owl, plant populations
- Black abalone survey



# Impact of Invasive House Mice on Southeast Farallon Island

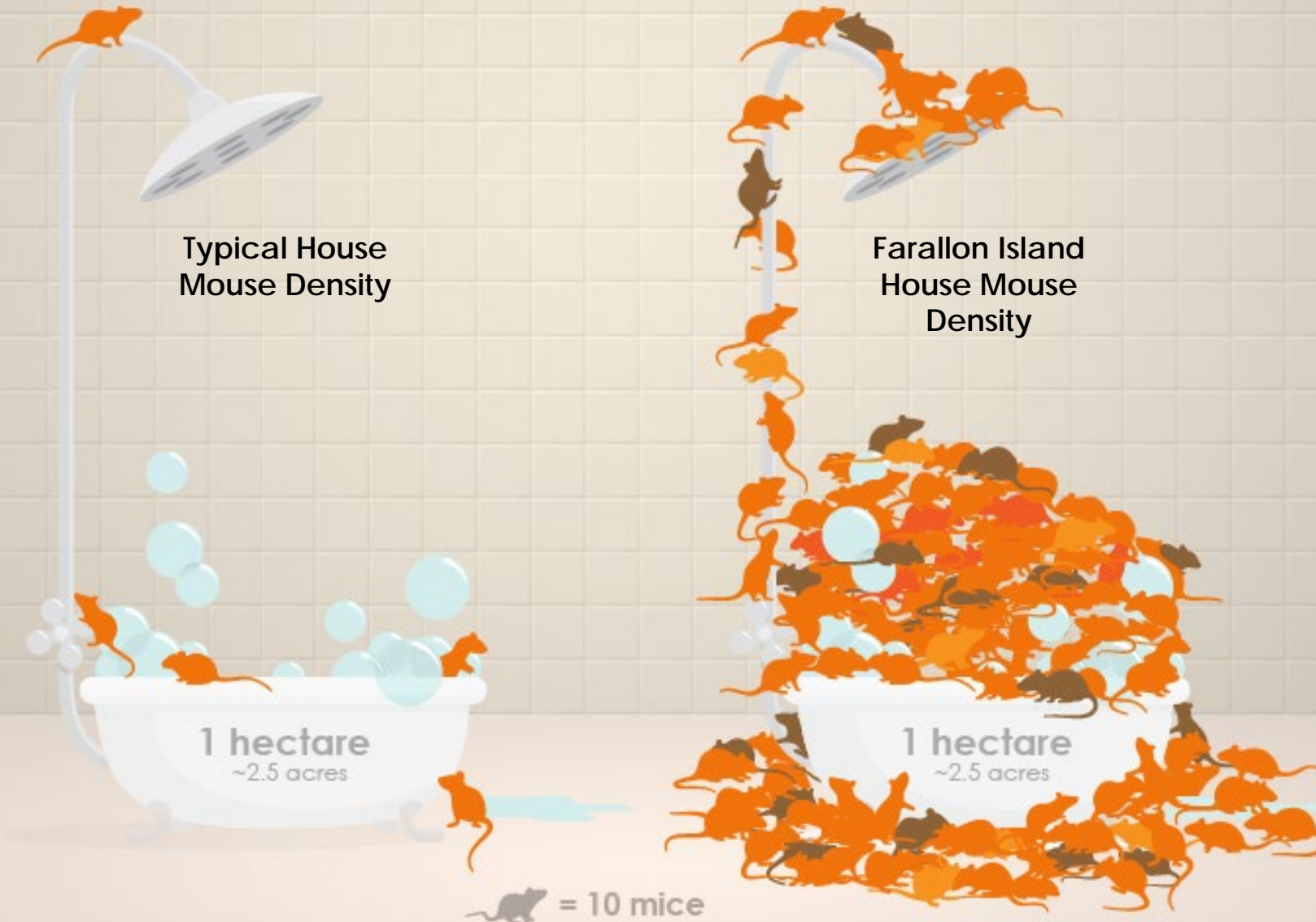


Mouse on Farallon Islands (Matt Brady)



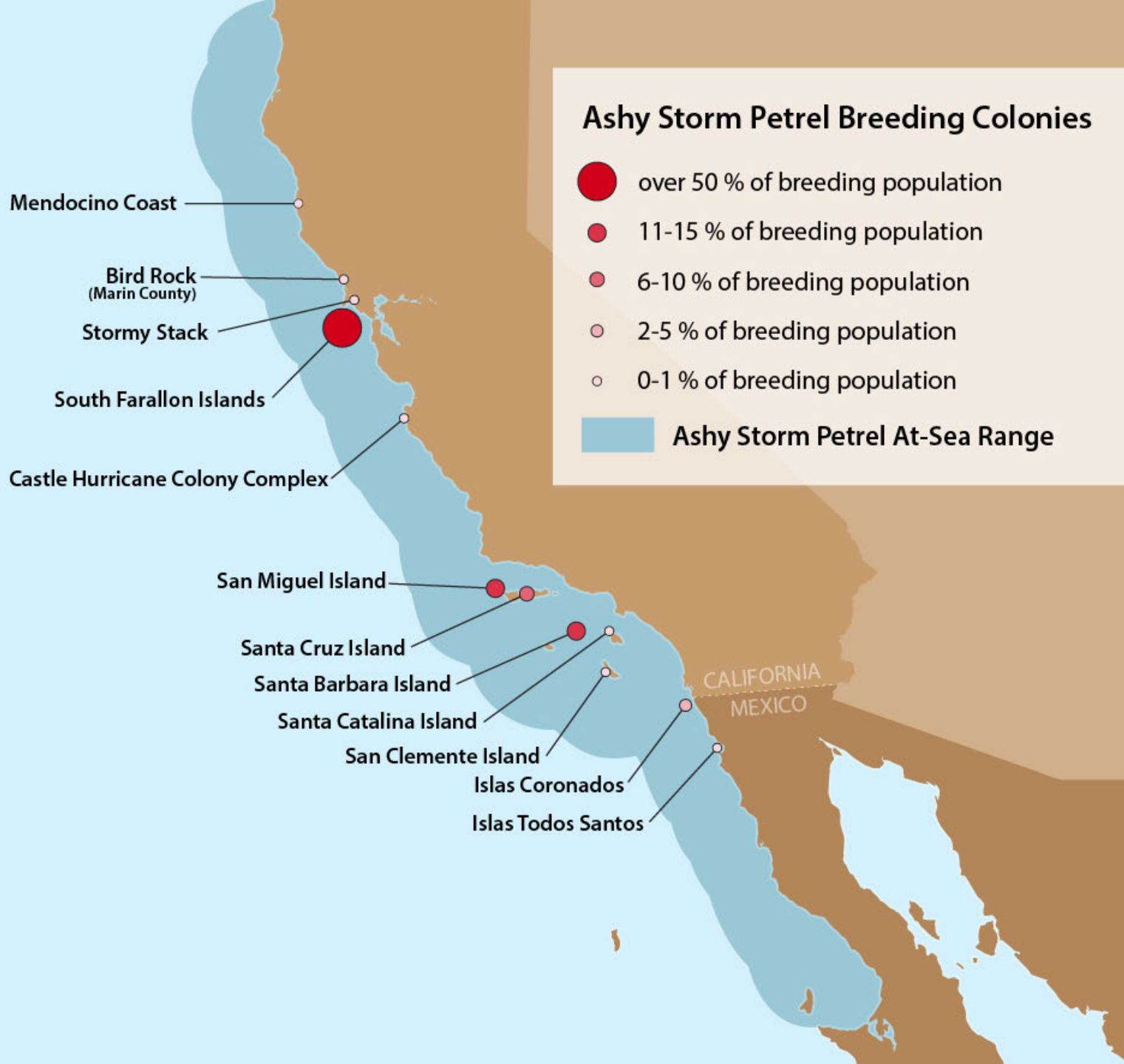


# Highest Reported Density of Invasive House Mice for Any Island in the World



## Density of Invasive House Mice on Southeast Farallon Island

- Density estimate of approximately **1,300** mice per hectare.
- House mouse densities commonly range from **10 to 50** per hectare.



# Distribution of Ashy Storm-Petrel

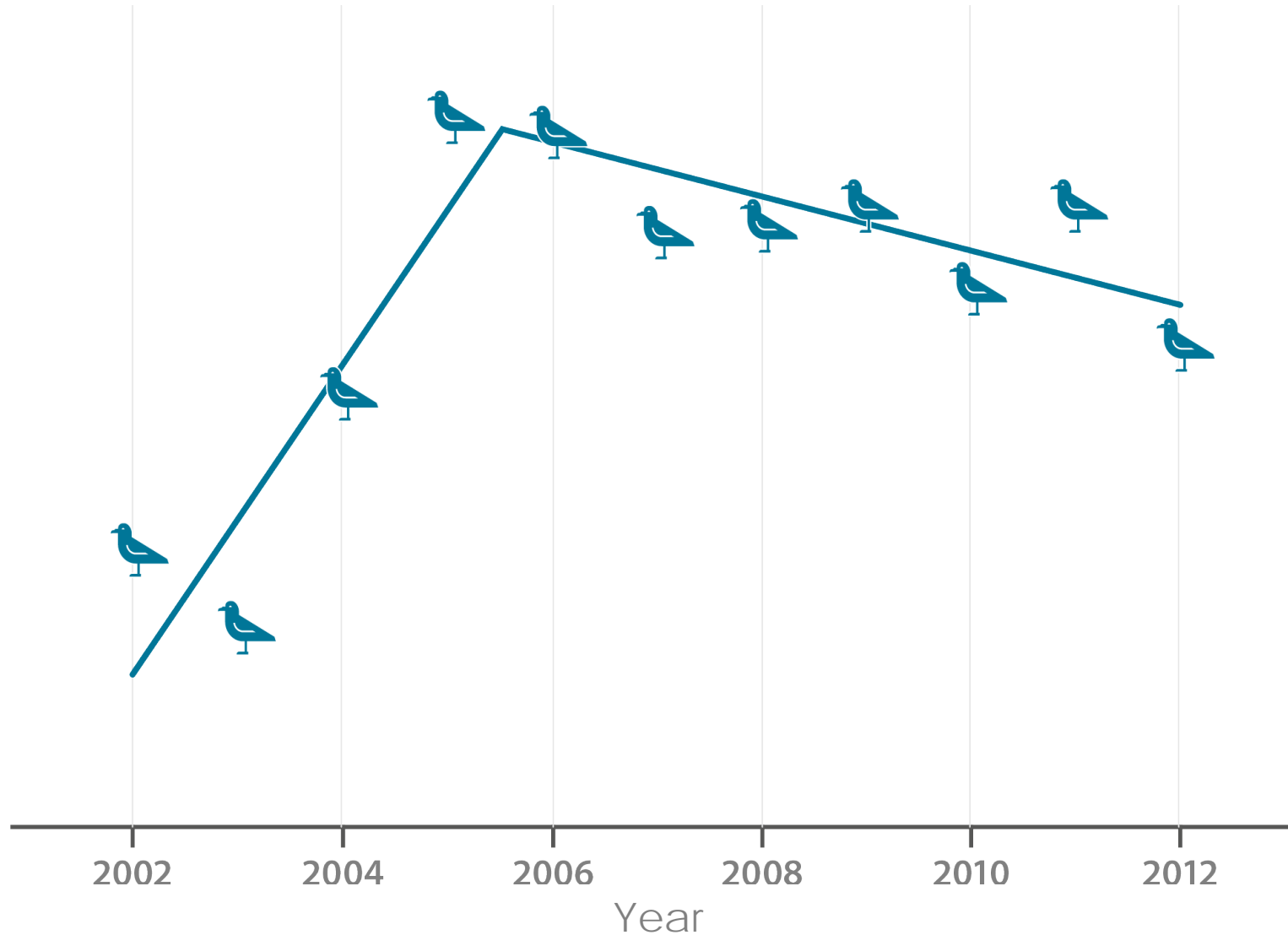
- World population; <10,000 breeding birds





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## Population Index of Ashy Storm-Petrel (compared to Burrowing Owl Predation Index)

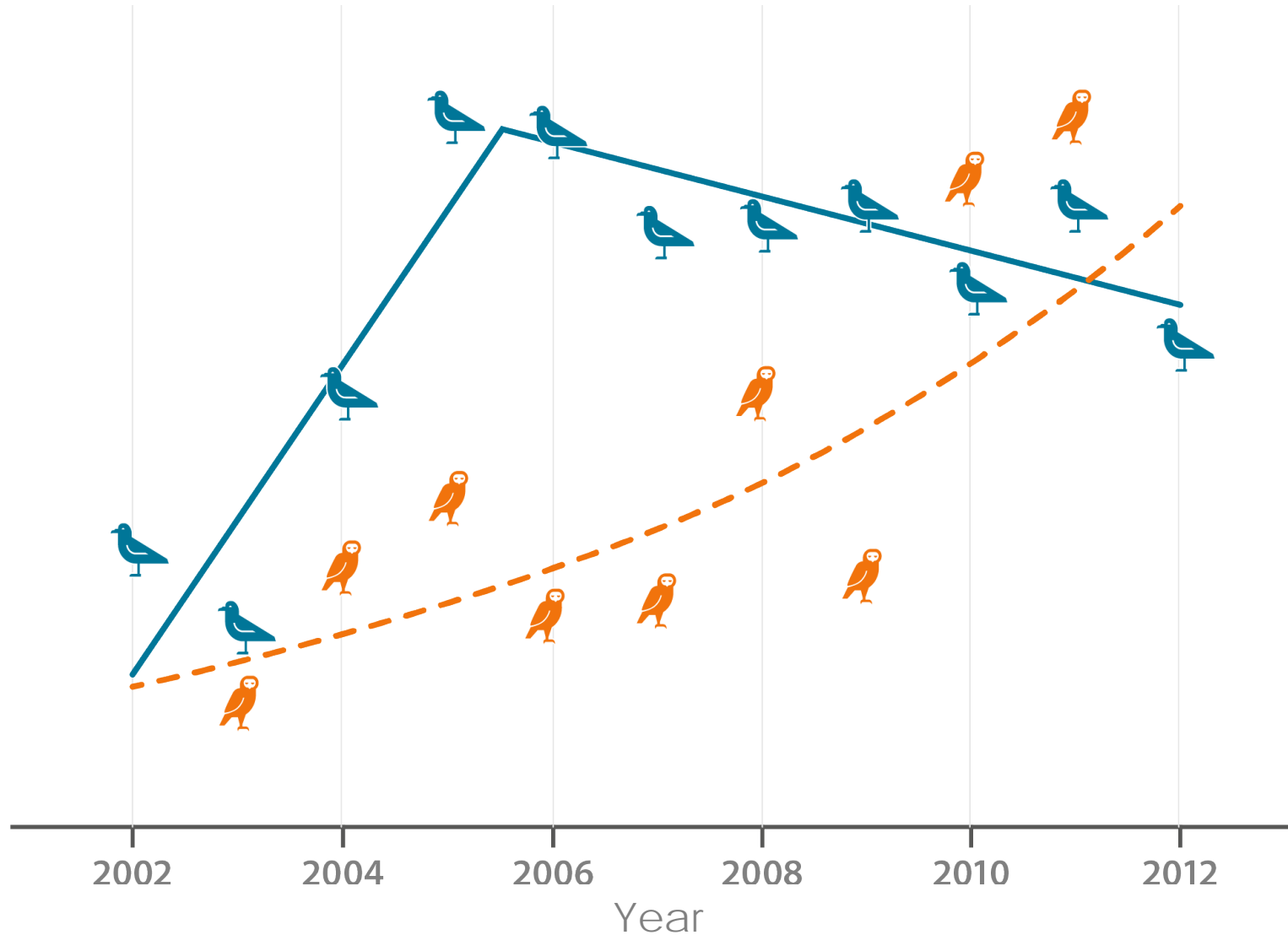


## Population Index of Ashy Storm- Petrel





## Population Index of Ashy Storm-Petrel (compared to Burrowing Owl Predation Index)



## Population Index of Ashy Storm-Petrel



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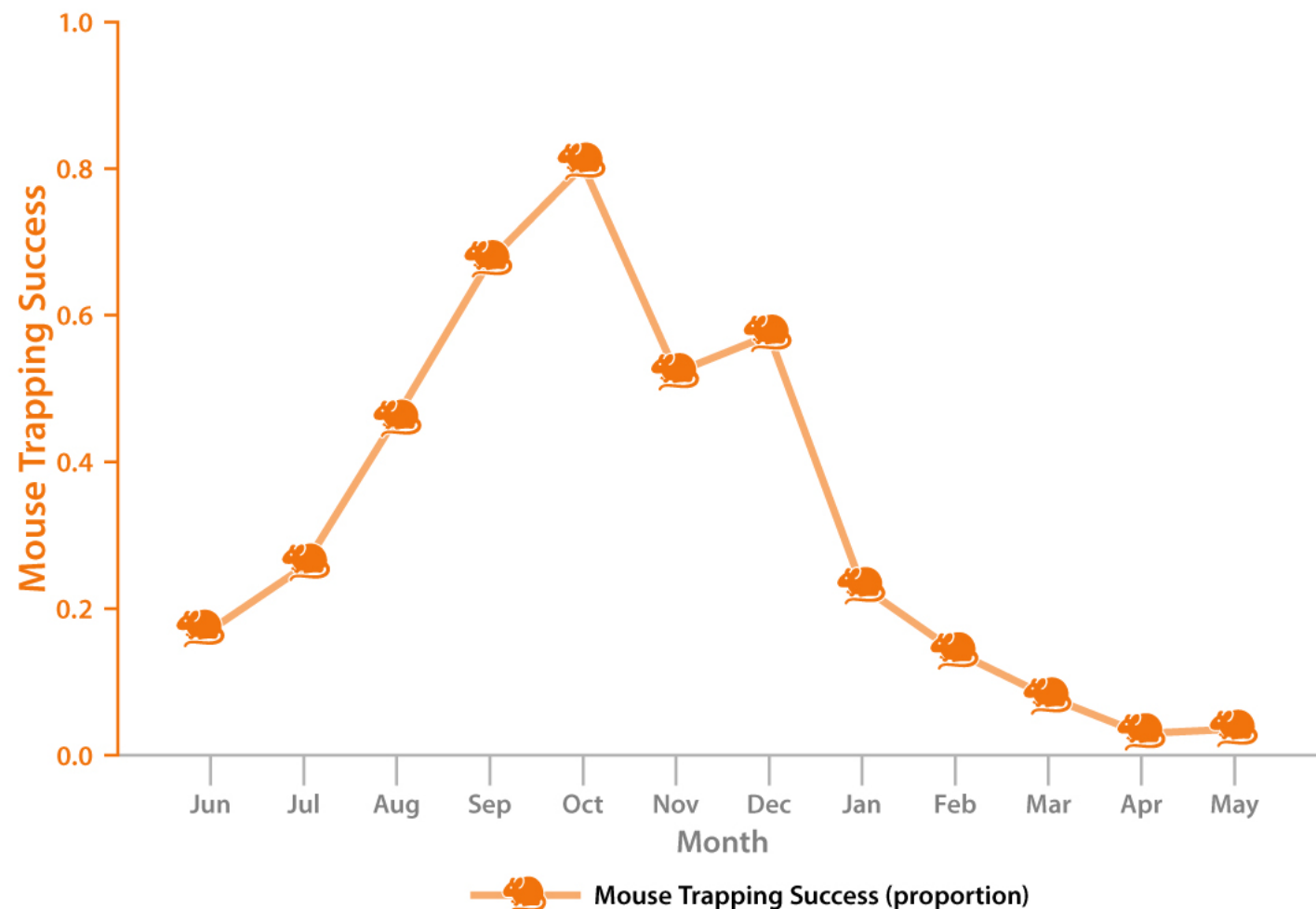


# Relationship of Mouse and Owl Abundance with Storm-Petrel Predation

Mouse Trapping Success

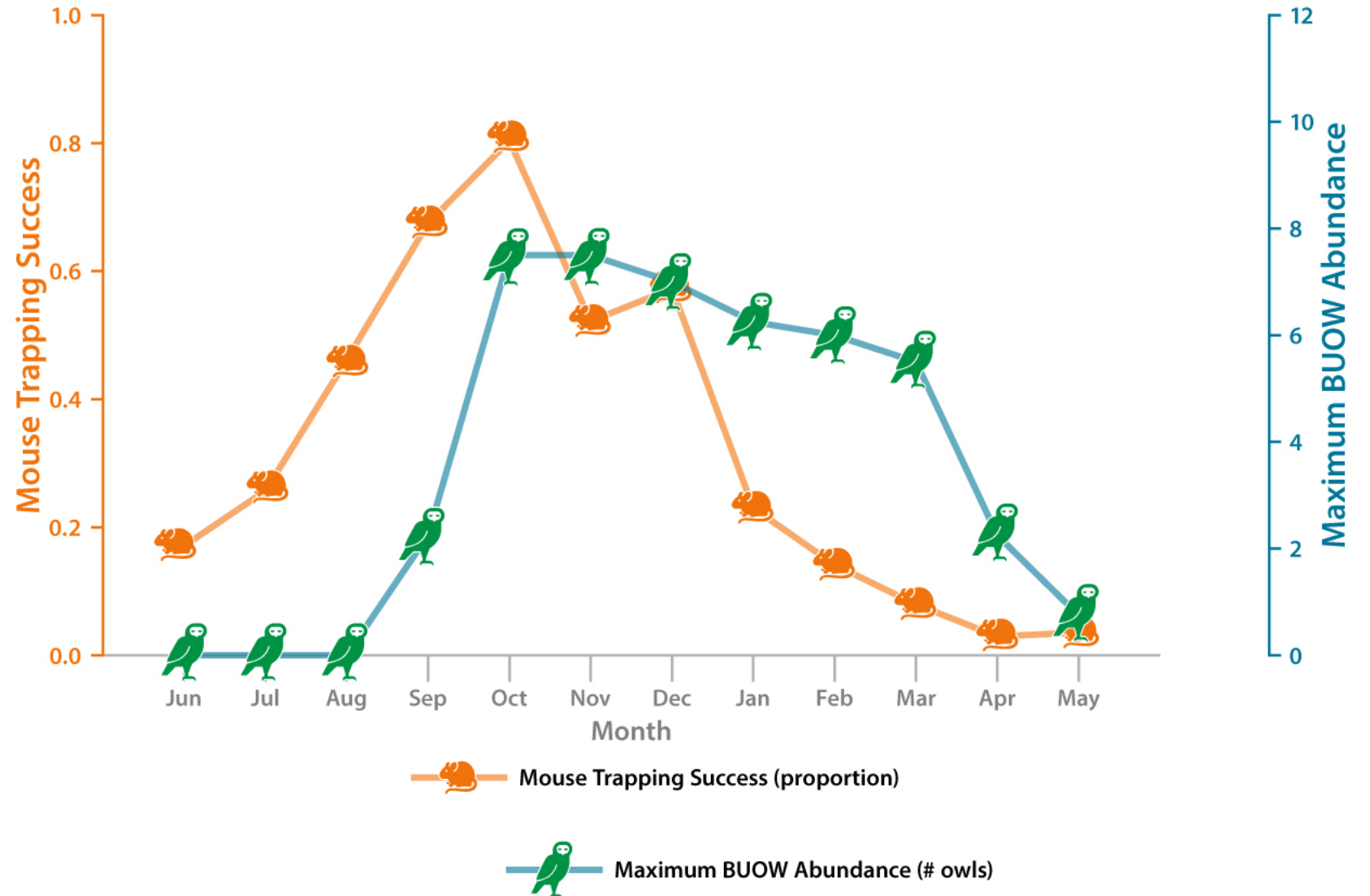


Mouse on Farallon Islands (Matt Brady)



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

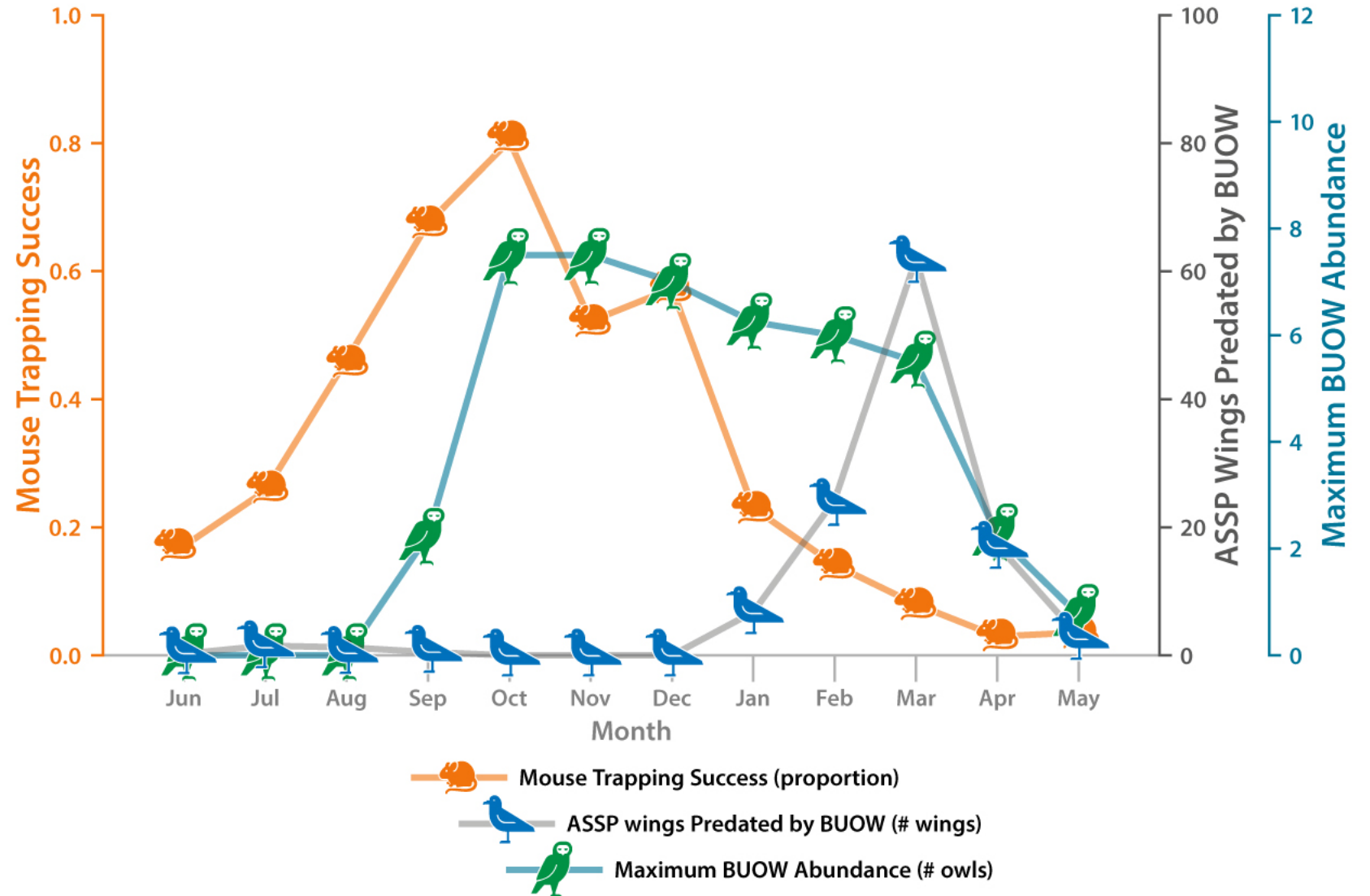
Maximum Burrowing Owl Abundance





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

Storm-Petrel Wings predated by Burrowing Owls

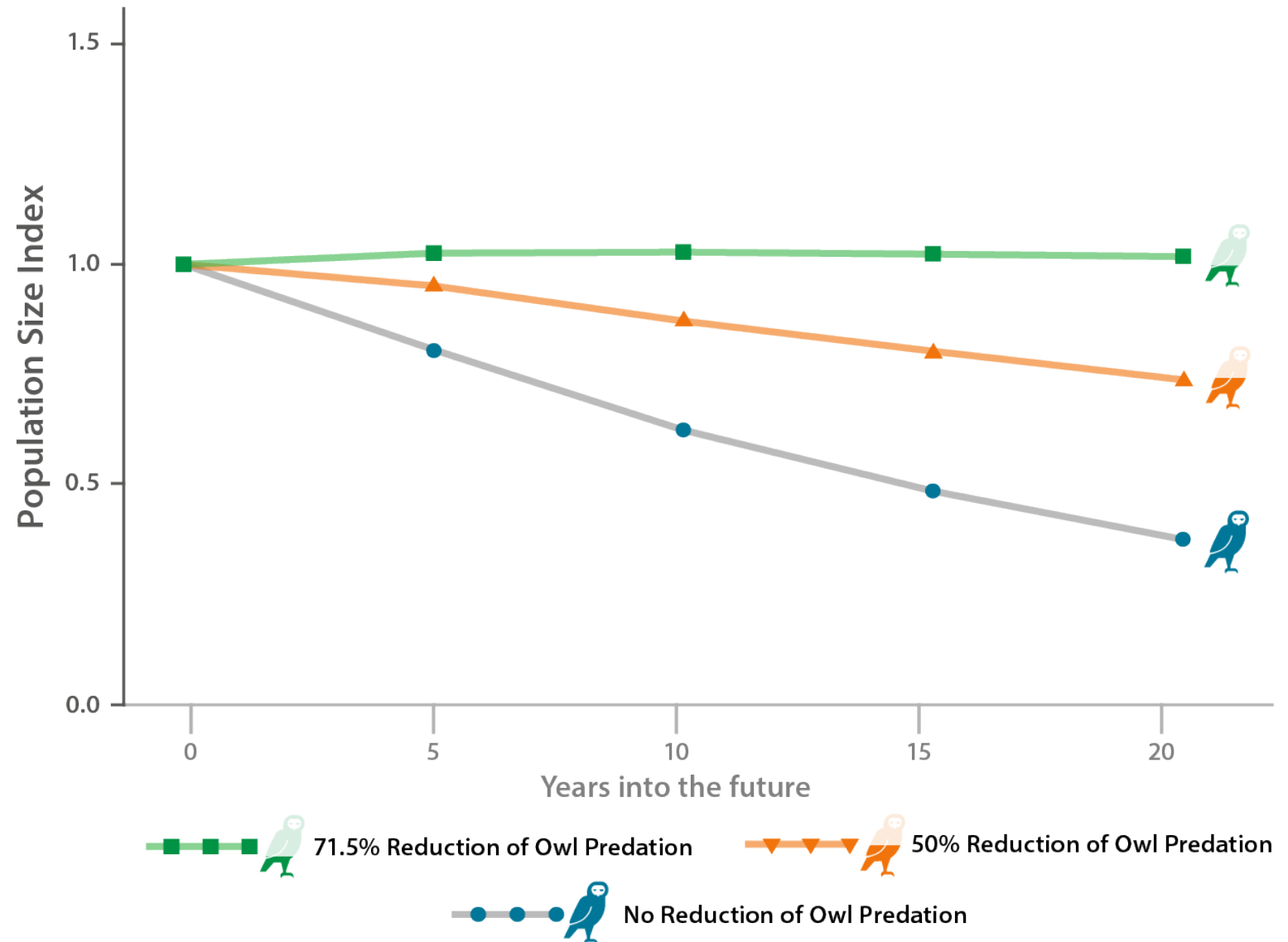


# Ashy Storm-Petrel Trends With and Without Owl Predation Reduction Model

"Moderate Decline" scenario



Ashy storm-petrel remains beneath burrowing owl roost. Photo by P. Pyle.



Source: Ecosphere ESA Journal, Nur et al. (2019)



## Decreases in:

- Owl predation on storm-petrels
- Predation on invertebrates
- Competition with salamanders
- Herbivory of native plants

## Increases in:


- Ashy Storm-Petrels
- Native plants
- Endemic Salamanders
- Endemic Camel Crickets
- Other Invertebrates
- Native ecosystem function



# Expected Benefits of Eradicating (Removing) Mice




# Lessons Learned


Recommendations implemented from the Ornithological Council review of non-target mortality with the Rat (Hawadak) island, AK project.

- a) Developed a detailed plan (EIS) to assess the expected impacts and allow for adaptive management during implementation. 


- b) Prepare contingency plans as part of the operational planning phase 
- c) Obtain required permits. 


- d) Working with the USDA/ APHIS in consultation with EPA, obtain a supplemental bait label if deemed necessary.


- 
- e) Conduct pre-eradication trials to determine appropriate application rates. 

- f) Mitigation measures, including gull hazing, evaluated and included in in action alternatives to minimize impacts to non-targeted resources. 

- g) Monitor bait availability during implementation. 

- 
- h) Ensure that the eradication operation is fully staffed for the duration of the implementation. 

- i) Allow the operational team the opportunity to fully review the operational plan. 

- j) Develop a detailed and clearly laid out command structure to be utilized during the operation. 



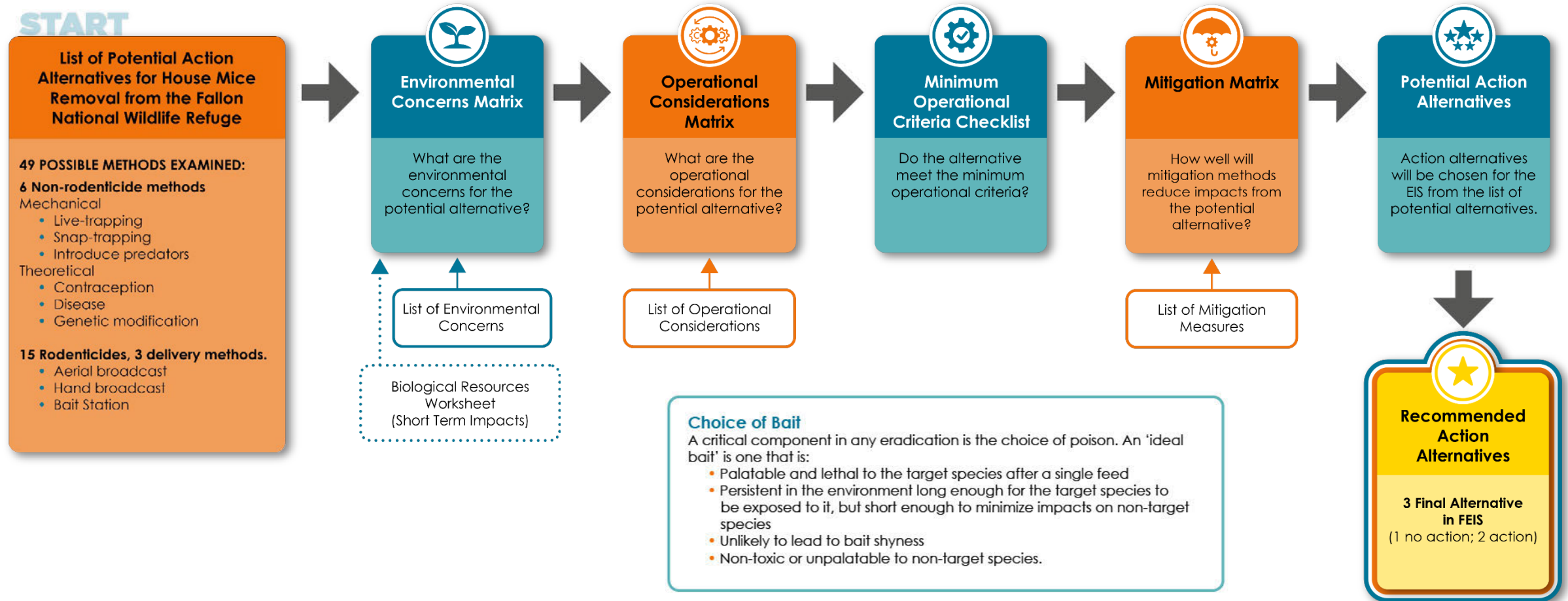


# Comparison of Rodent Control on Mainland vs Eradication on Islands

	Eradication on Islands	Control on Mainland
Goal ▶	Restoration of an island ecosystem by complete removal of the target invasive species.	Local reduction of the rodent population to benefit agriculture, human health, or native species
Outcome ▶	100% removal of all individuals is required, as failure to remove an individual from an island could result in repopulation. Biosecurity measures can prevent recolonization of islands.	Generally, complete removal on the mainland is impossible because rodents can recolonize from adjacent areas. Unless active control is sustained indefinitely, rodent populations will return to pre-control levels within a short period of time.
Length of Operation ▶	One-time operations that usually are completed in a few weeks.	Sustained for long periods or revisited periodically in perpetuity.
Extent of Positive Impact ▶	Permanent; ecosystem-wide; often measurable within 1-2 years.	Highly limited in extent, degree, and duration
Extent of Negative Impact ▶	Limited short-term impacts to non-target resources	Long-term rodenticide use leads to chronic non-target impacts.
Extent of Regulatory Oversight ▶	In the U.S., certain rodenticides including Brodifacoum-25D Conservation are registered with the EPA for conservation use, such as island eradications NEPA and various federal, state, and local authorizations also are required.	2 <sup>nd</sup> generation coagulants require pesticide applicator license to apply. Typically, no other authorizations required.

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# Alternative Selection





# Alternative Selection

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

### 49 POSSIBLE METHODS EXAMINED:

#### 6 Non-rodenticide methods

##### Mechanical

- Live-trapping
- Snap-trapping
- Introduce predators

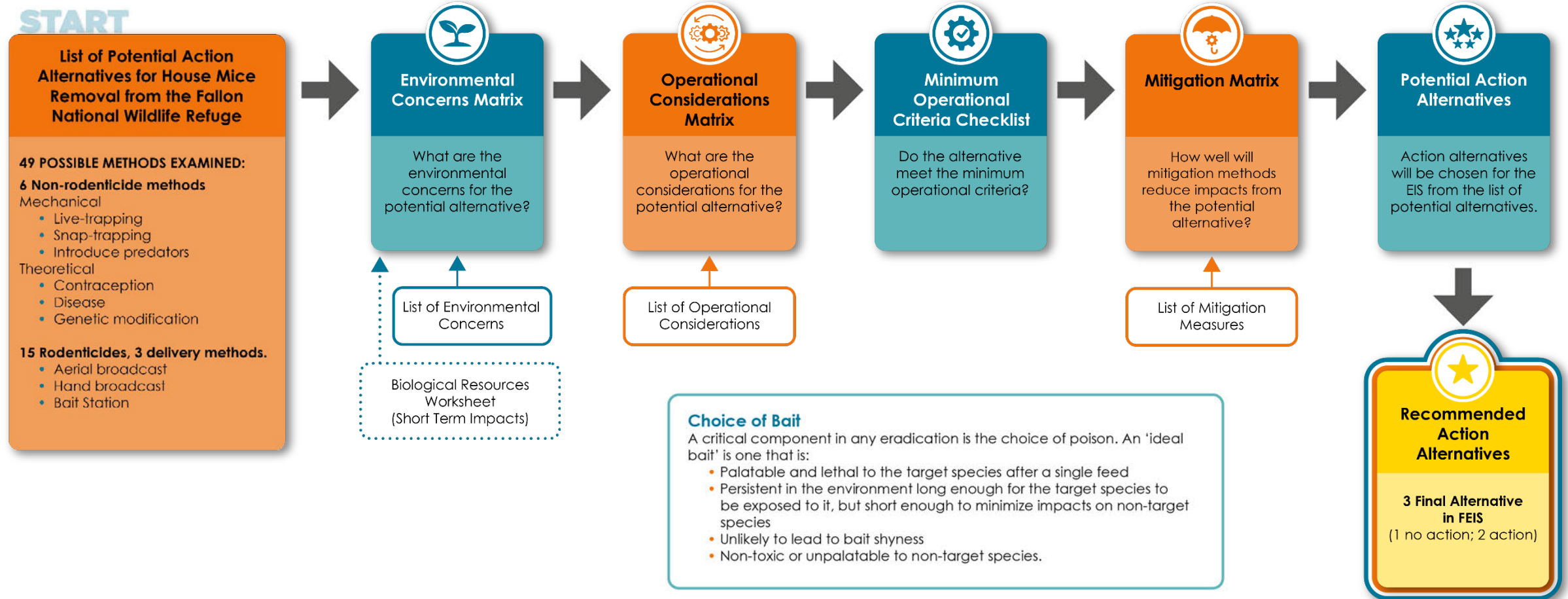
##### Theoretical

- Contraception
- Disease
- Genetic modification

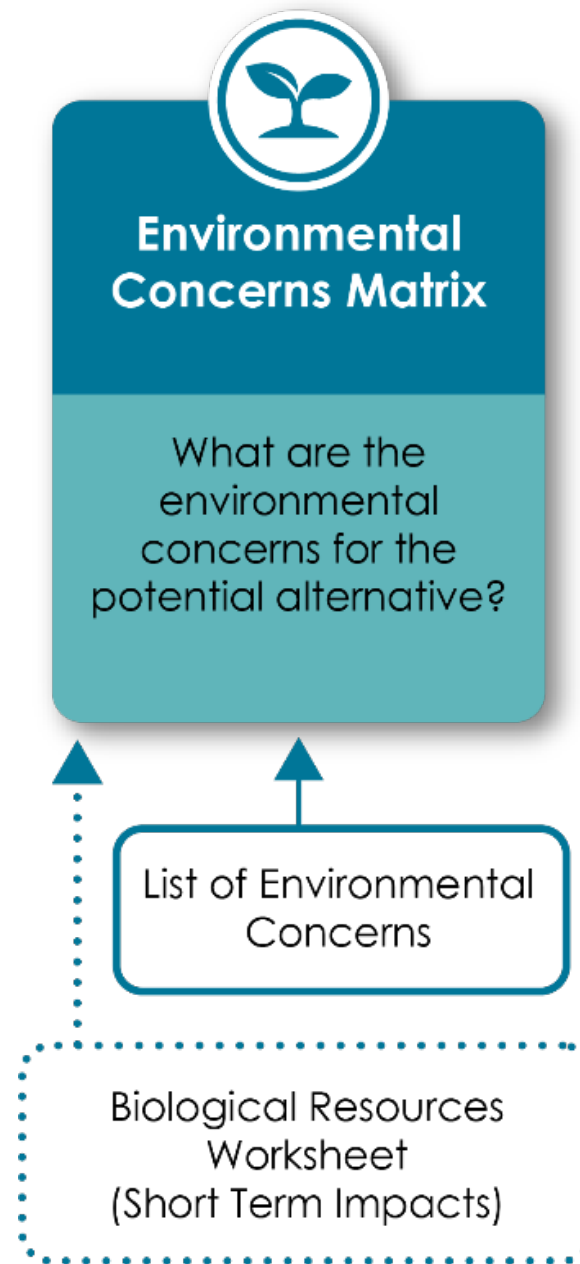
#### 15 Rodenticides, 3 delivery methods.

- Aerial broadcast
- Hand broadcast
- Bait Station

# Alternative Selection

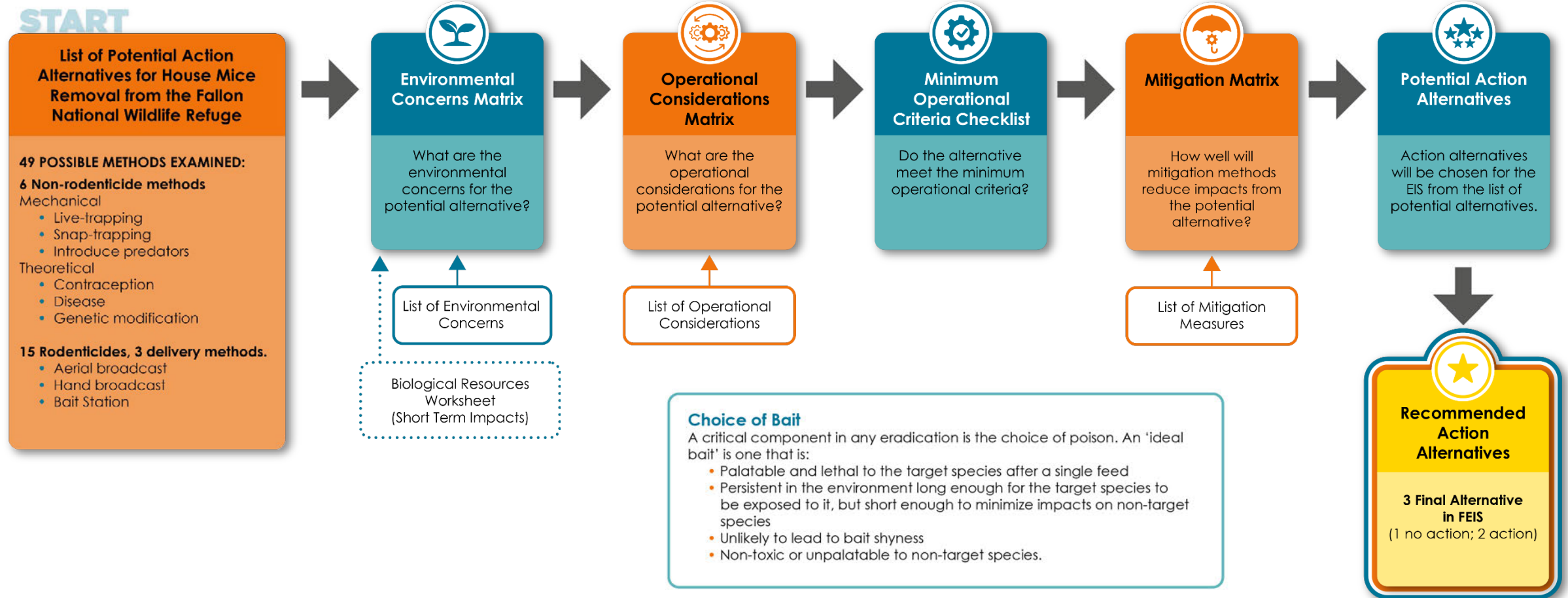


# Alternative Selection

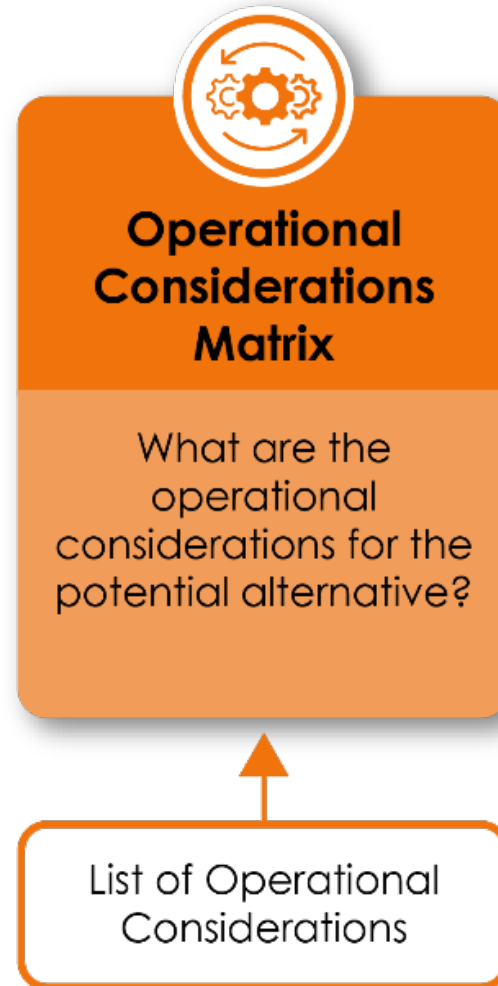




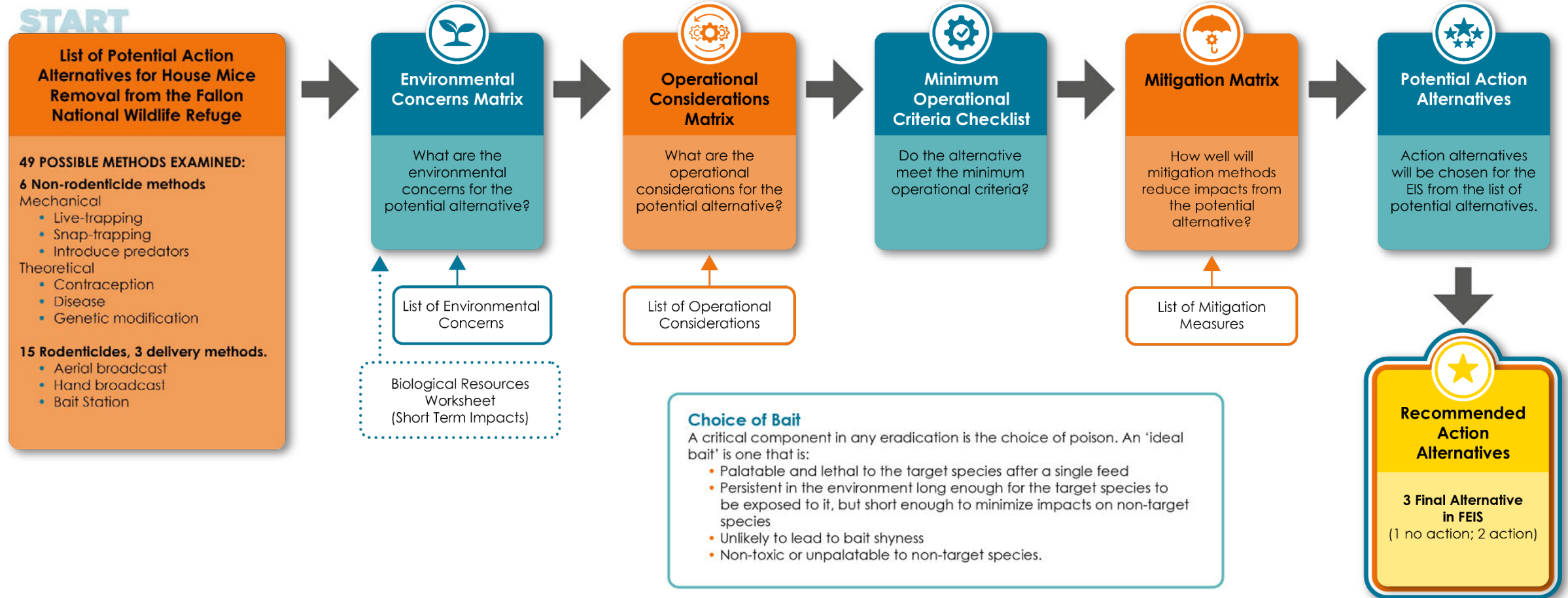
# Alternative Selection



# Alternative Selection



# Alternative Selection





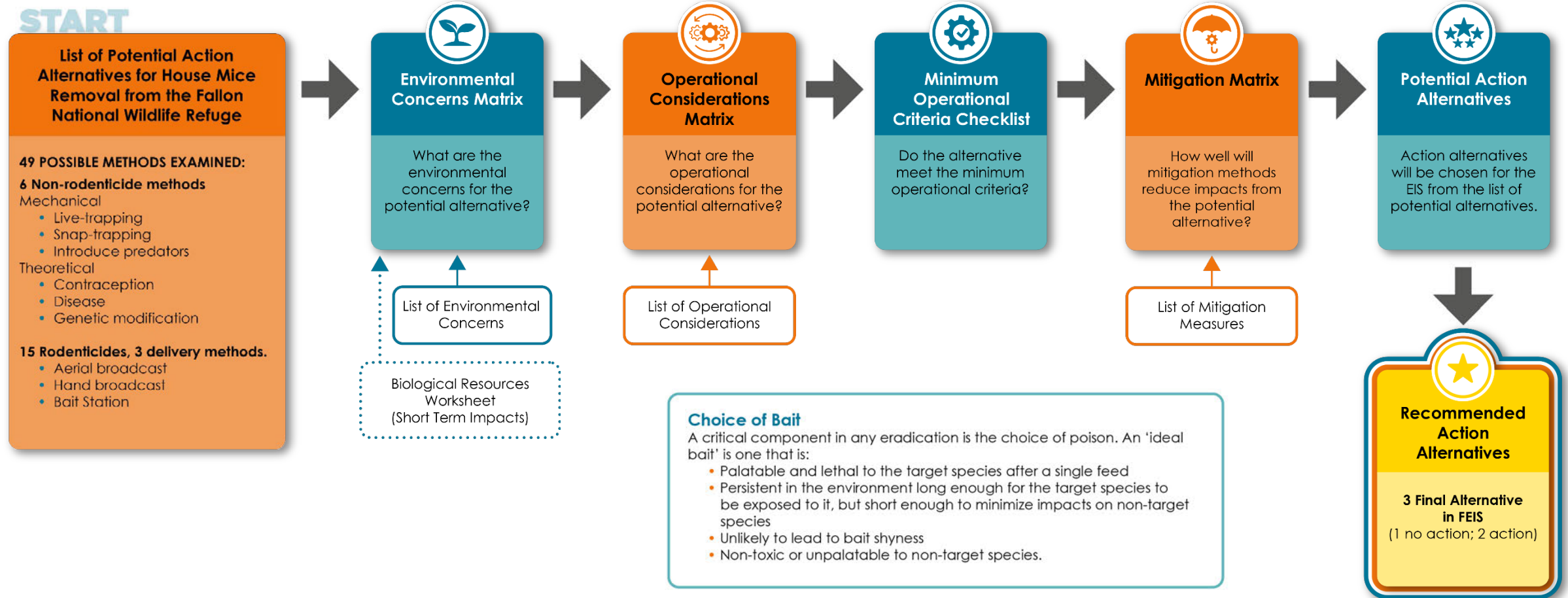
# Alternative Selection



## Minimum Operational Criteria Checklist

Do the alternative  
meet the minimum  
operational criteria?

# Alternative Selection

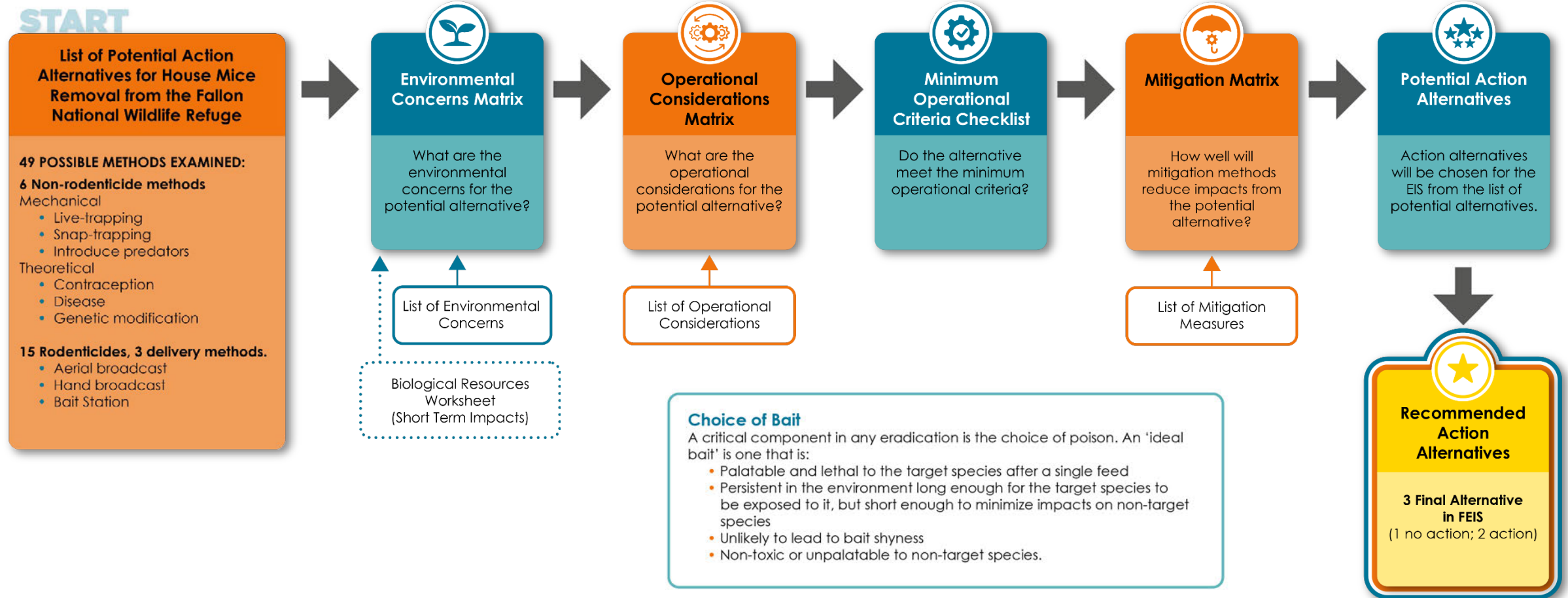


# Alternative Selection





# Alternative Selection



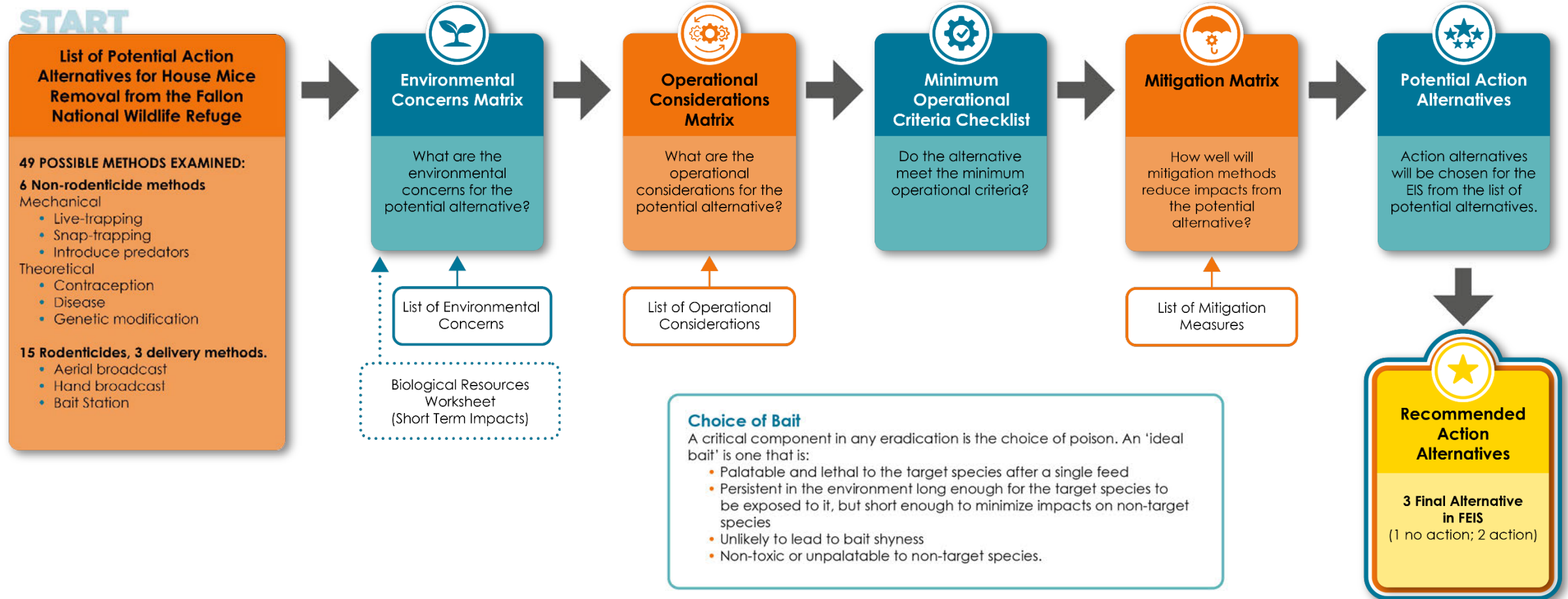
# Alternative Selection



## Potential Action Alternatives

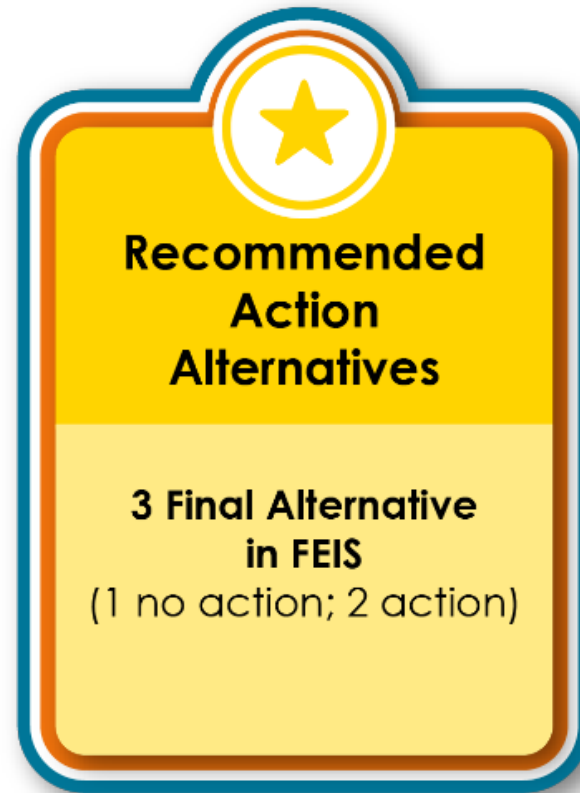
Action alternatives will be chosen for the EIS from the list of potential alternatives.

# Alternative Selection

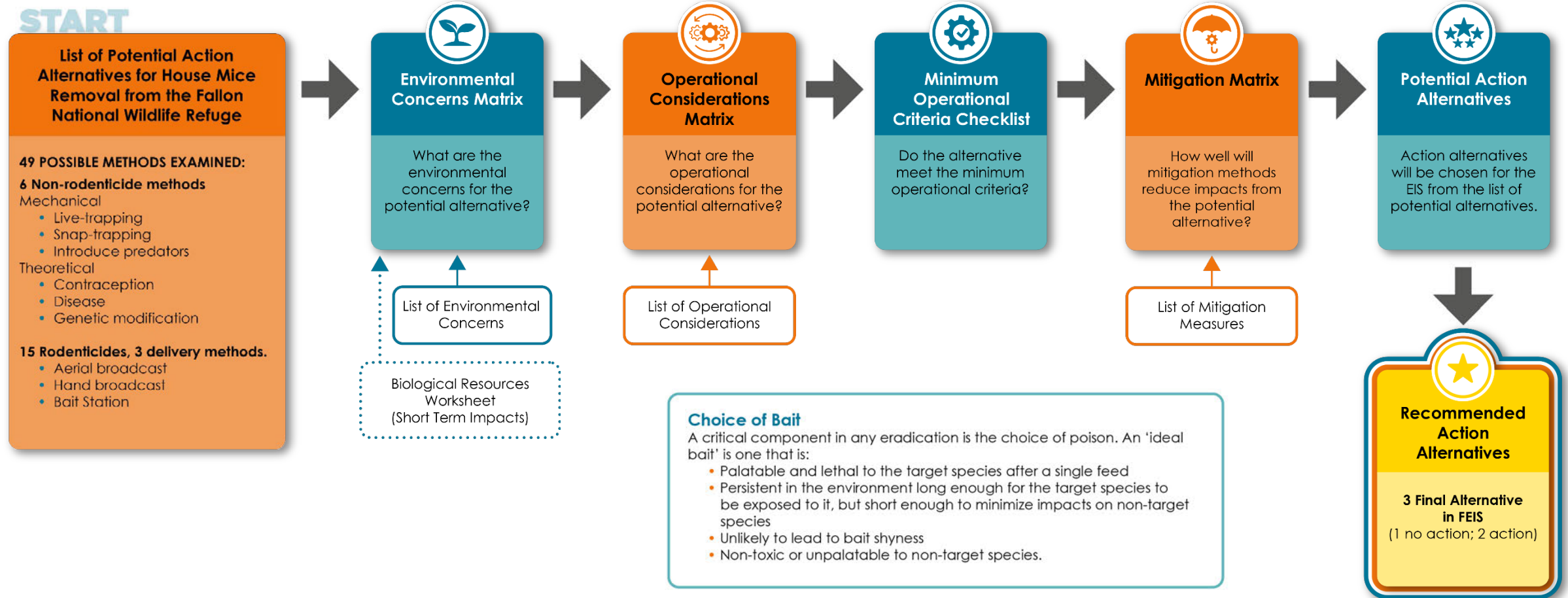




# Alternative Selection



# Alternative Selection



# 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.





## LEGISLATIVE COUNSEL'S DIGEST

AB 1788, as amended, Bloom. Pesticides: use of anticoagulants.

### ~~Existing~~

*(1) Existing* law regulates the use of pesticides and authorizes the Director of Pesticide Regulation to adopt regulations to govern the possession, sale, or use of any pesticide, as prescribed. Existing law prohibits the use of any pesticide that contains one or more of specified anticoagulants in wildlife habitat areas, as defined. Existing law exempts from this prohibition the use of these pesticides for agricultural activities, as defined. Existing law requires the director, and each county agricultural commissioner under the direction and supervision of the director, to enforce the provisions regulating the use of pesticides. A violation of these provisions is a misdemeanor.

This bill would create the California Ecosystems Protection Act of 2019 and expand this prohibition against the use of a pesticide containing specified anticoagulants in wildlife habitat areas to the entire state. The bill would expand the exemption for agricultural activities to include activities conducted in certain locations and would also exempt from its provisions the use of pesticides by any governmental agency employee who uses pesticides for public health ~~activities and a~~ *activities, a* mosquito or vector control district that uses pesticides to protect the public ~~health.~~ *health, and the use of any pesticide or rodenticide used for the eradication of nonnative invasive species inhabiting or found to be present on offshore islands in a manner that is consistent with all otherwise applicable federal and state laws and regulations.*

*(2) Existing law provides that the above-described provisions do not preempt or supersede any federal statute or the authority of any federal agency.*

*This bill would additionally provide that these provisions do not preempt or supersede special local need or emergency exemptions for the use of pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act.*

# State Bill Exemption for Island Eradication Projects

An act to amend Section 12978.7 of, and to add Section 12978.8 to, the Food and Agricultural Code, relating to pesticides.



# Operational Attributes

Action Attribute	Proposed Action
Toxicant Type/Product	▶ Brodifacoun-25D Conservation (Bell Labs)
Primary bait delivery method (~90%)	▶ Aerial Broadcast
Supplementary bait delivery method (~10%)	▶ Hand Broadcast, Bait Station
Timing: Start of application	▶ Fall
Environmental conditions	▶ Long-term weather forecast that predicts less than 25 knots of wind and five fine days (four fine nights) with no significant rainfall (less than 6mm)
Number of aerial application	▶ 2
Time between applications	▶ 10-21 days
Minimum length of exposure required to ensure eradication	▶ 4 days following each application
Anticipated bait pellet application rates	▶ 24 lb/acre (16 lb/acre +8lb/acre) 27 kg/ha (18 kg/ha +9 kg/ha)
Anticipated total amount of rodent bait that would be applied	▶ 2,917 lb (1,323 kg)
Concentration of rodenticide within rodent bait	▶ 0.0025%

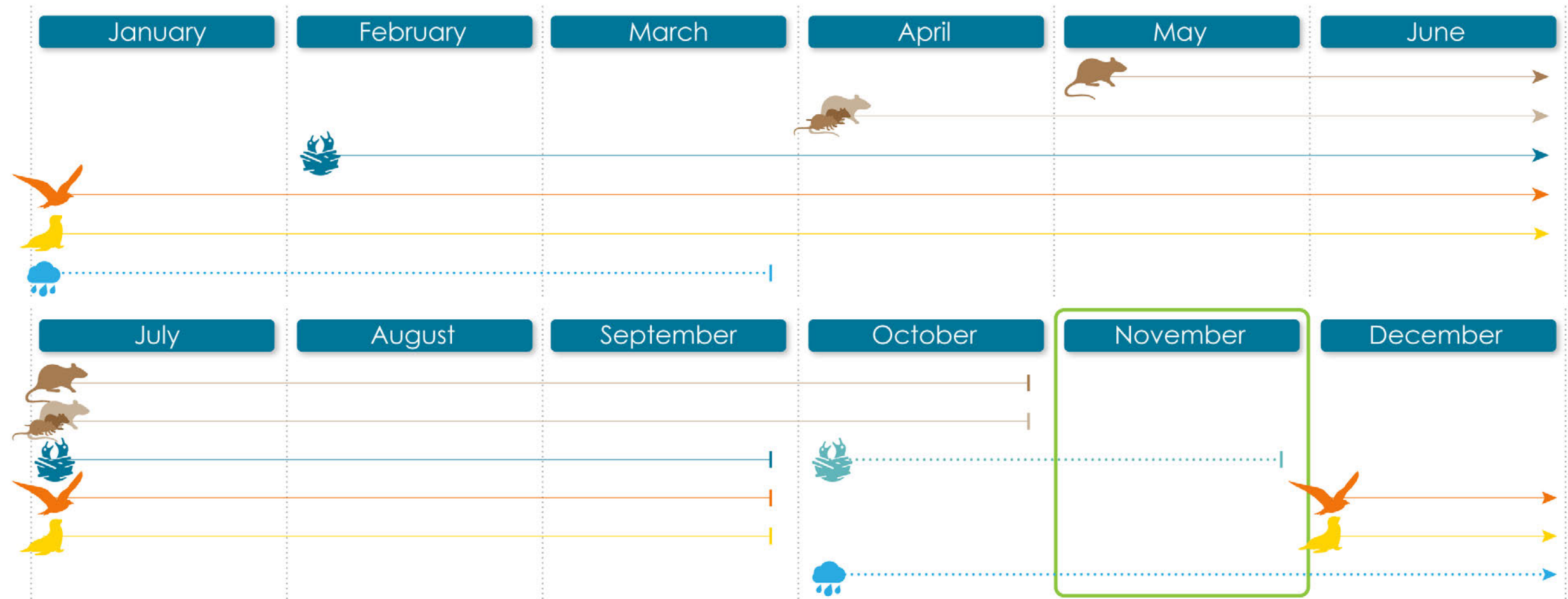


# Operational Attributes (Continued)

Action Attribute	Proposed Action
Anticipated total amount of rodenticide to be applied	▶ 33g
Anticipated hours of flight time required for aerial bait application actions	▶ About 11 hours (~5.5 hours x 2)
Total helicopter time over island for bait application	▶ About 6 hours (~3 hours x 2)
Total operational days	▶ Up to 21 days (2 drops 10-21 days apart)
Projected bait availability and palatability to gulls	▶ Up to 5 weeks
Anticipated hours of flight time required for gull hazing	▶ Up to 70 hours (2 hours daily for 5 weeks)
Actions to minimize risk to non-target species	▶ Timing of operation, gull hazing, raptor capture, calamander capture, carcass removal, use of bait stations
Actions to minimize bait drift	▶ Baiting of areas above MHWS only, flying only in wind speeds of less than 30 kts, use of deflector and dribble buckets.



# Baseline Data Informs Project Timing



Mouse numbers ↑    Likelihood of mouse breeding ↑    >5,000 Gulls present (avg)    Pinnipeds breeding    Average rainfall >2m    Seabirds breeding    Only ashy storm-petrel breeding\*  
Because ashy storm-petrels nest underground in small rock crevices and are nocturnal, they would be nearly unaffected by proposed eradication activities.



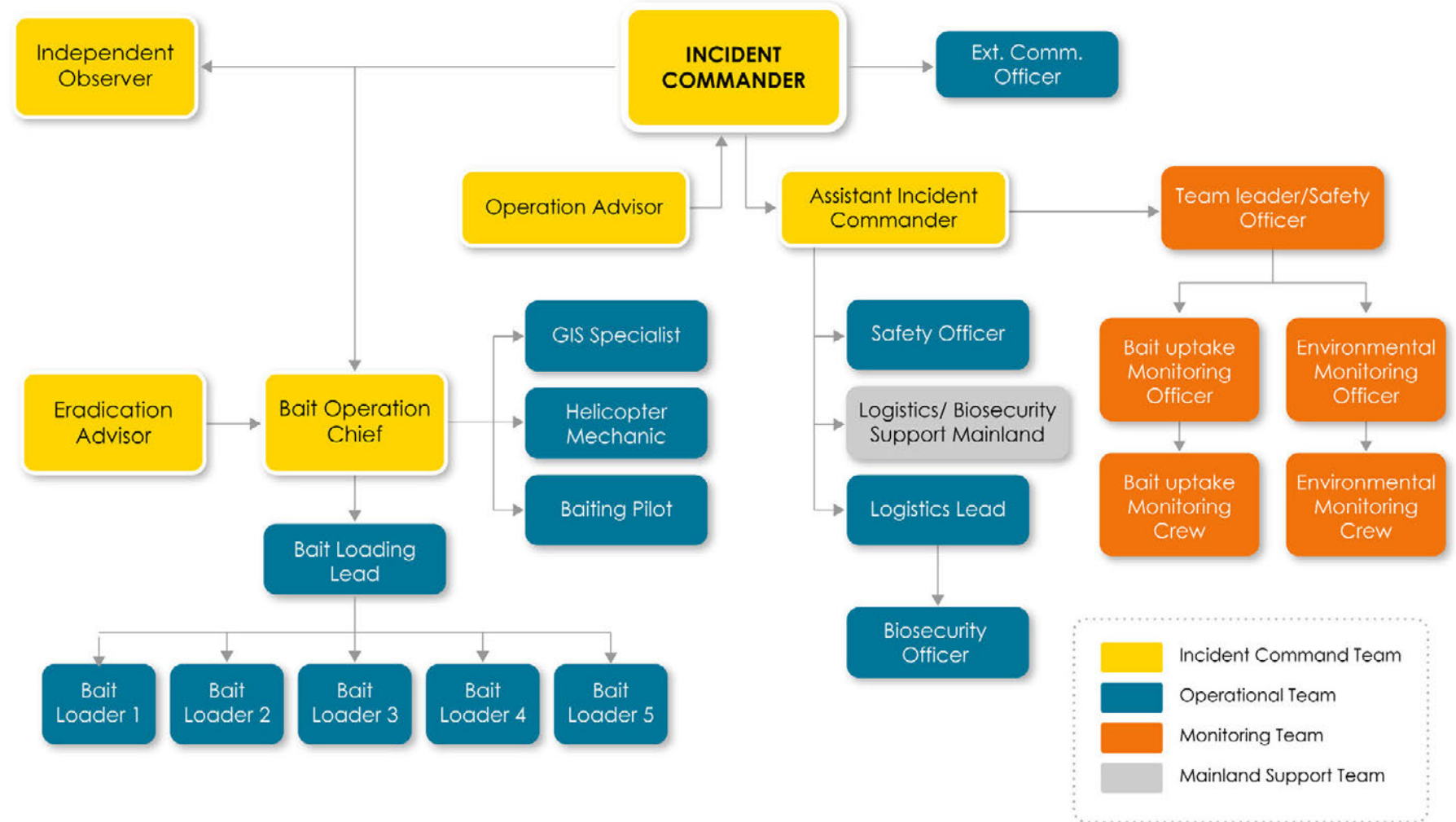
# Pre- Application Activities

A number of operational activities need to be completed prior to bait application

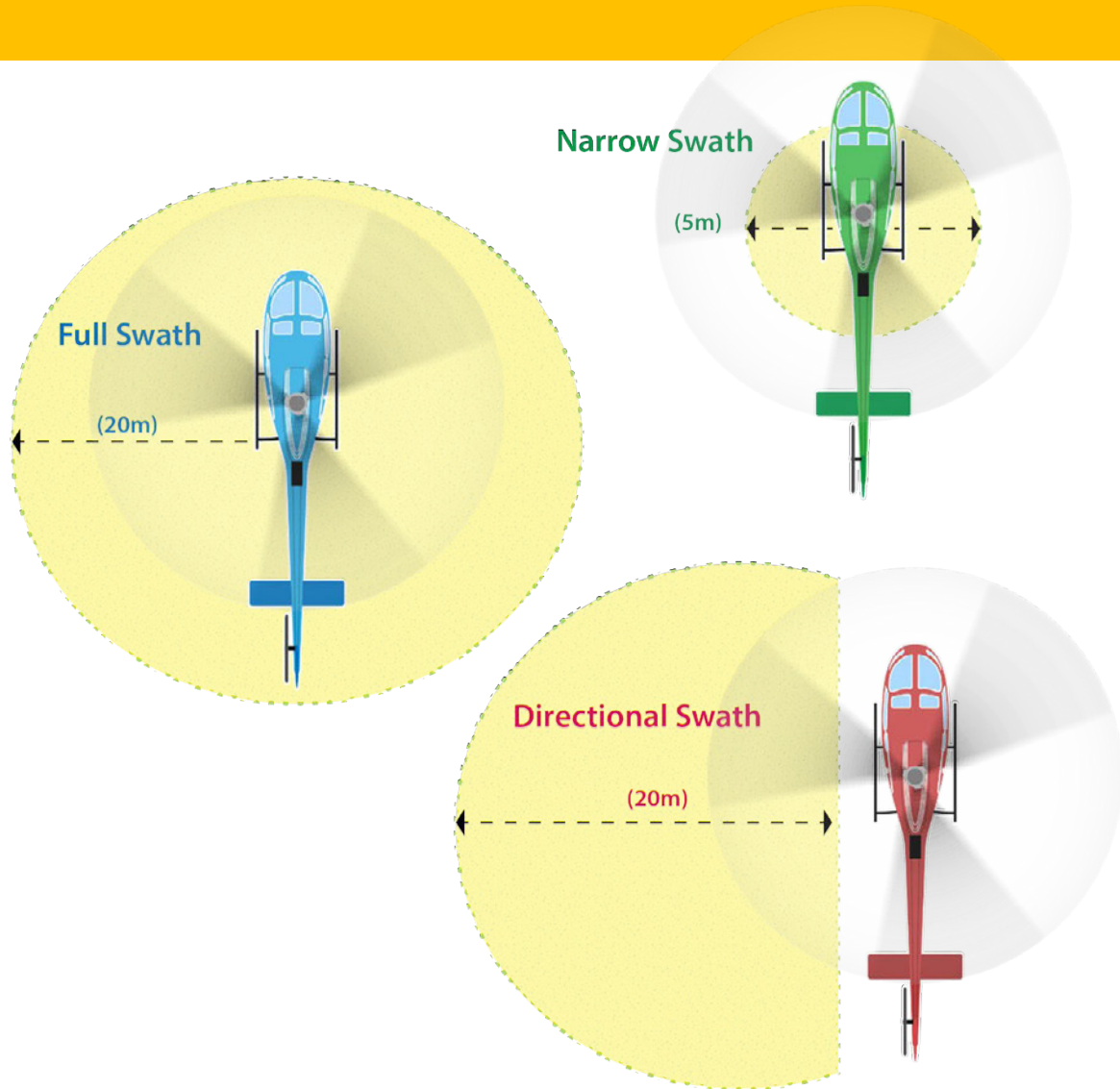
- Purchasing bait and materials
- Preparing contracts/agreements for all operational aspects, including appropriate helicopter support, aviculturist and veterinarian
- Constructing aviaries (e.g. burrowing owl, peregrine falcon) and on-island capture-and-hold trials
- Mapping of helicopter lines
- Improving island bio-security quarantine procedures
- Establishing all pre- and post-application monitoring programs protocols



# Example Incident Command Structure



# Operations



- 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 assure complete coverage.
- Variable swaths allow effective baiting on different terrains without baiting marine environment.





# Operations

- Operations
- Timing
- Gull hazing
- Capture birds of prey
- Capture salamanders
- Carcass removal
- Monitoring and adaptive management



## Protecting wildlife and habitats during operations





# Operations

Gull Hazing will use various bird deterrent techniques

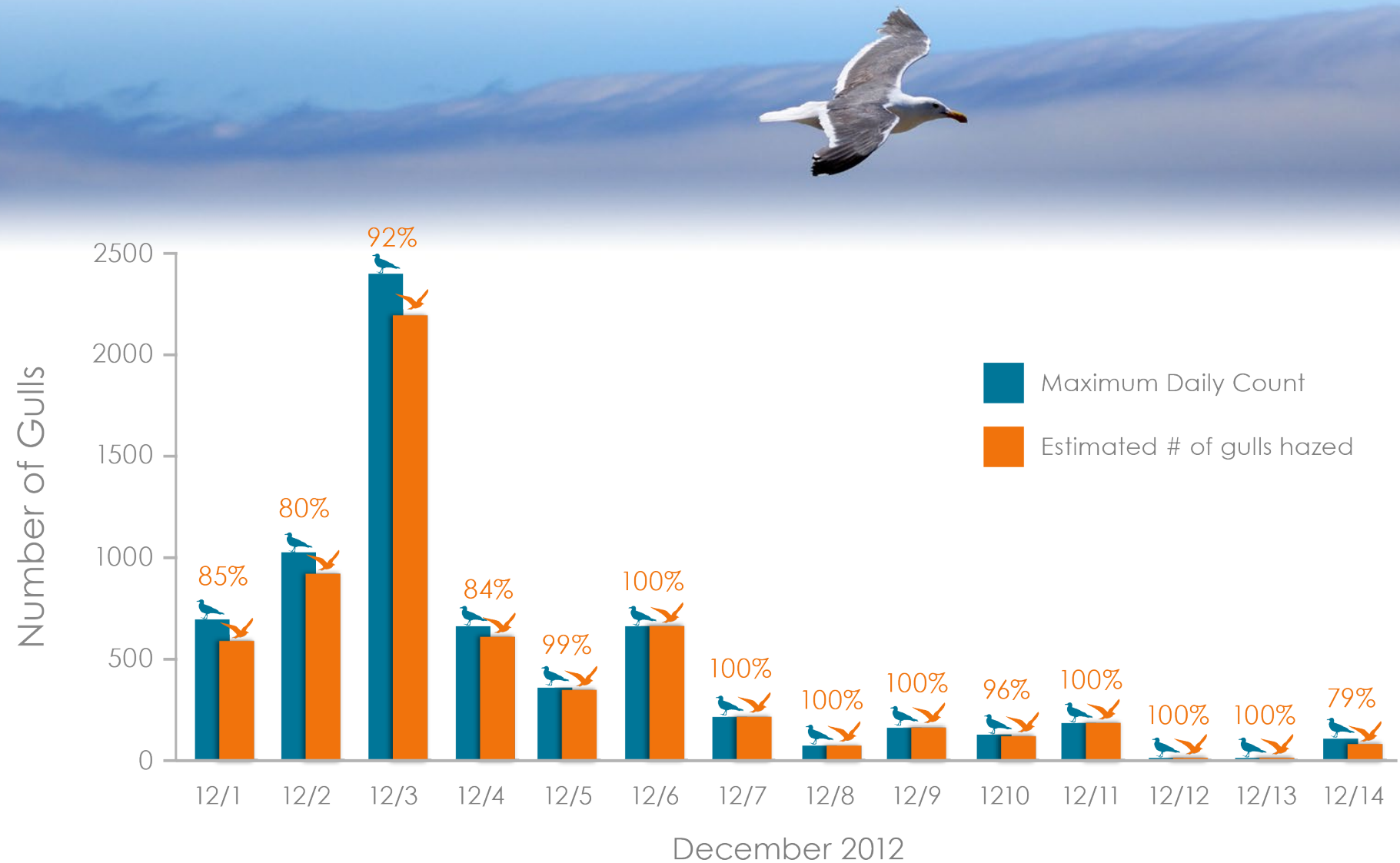
Treatment Type	Product Examples
Biosonic	bird distress calls; varying sound patterns
Pyrotechnic	cracker shell, screamer rocket, cannon
Laser	penlight laser, avian dissuader laser
Mechanical	human, helicopter
Passive visual cues	gull effigy, owl decoy, mylar tape



# Operations

## Gull Hazing Data – Effectiveness of gull hazing based on trials

The maximum number of gulls present at any given time (based on ½ hourly gull counts) and estimated number that were successfully hazed during the gull hazing trial. Percentages represent the daily hazing effectiveness. Hazing efforts were reduced on December 14 due to staff departure.





Late Fall / Early Winter  
major gull roosting  
areas on Southeast  
Farallon Island



# Operations

**Monitoring**  
operations will  
include:

- Bait application rates
- Mouse uptake/exposure
- Birds
- Salamander and camel cricket
- Vegetation
- Intertidal (Water Invertebrates)
- Subtidal (Water, Fish, Crabs)
- Soil





# Contingency Plans

## Key Items of a Spill Response Plan

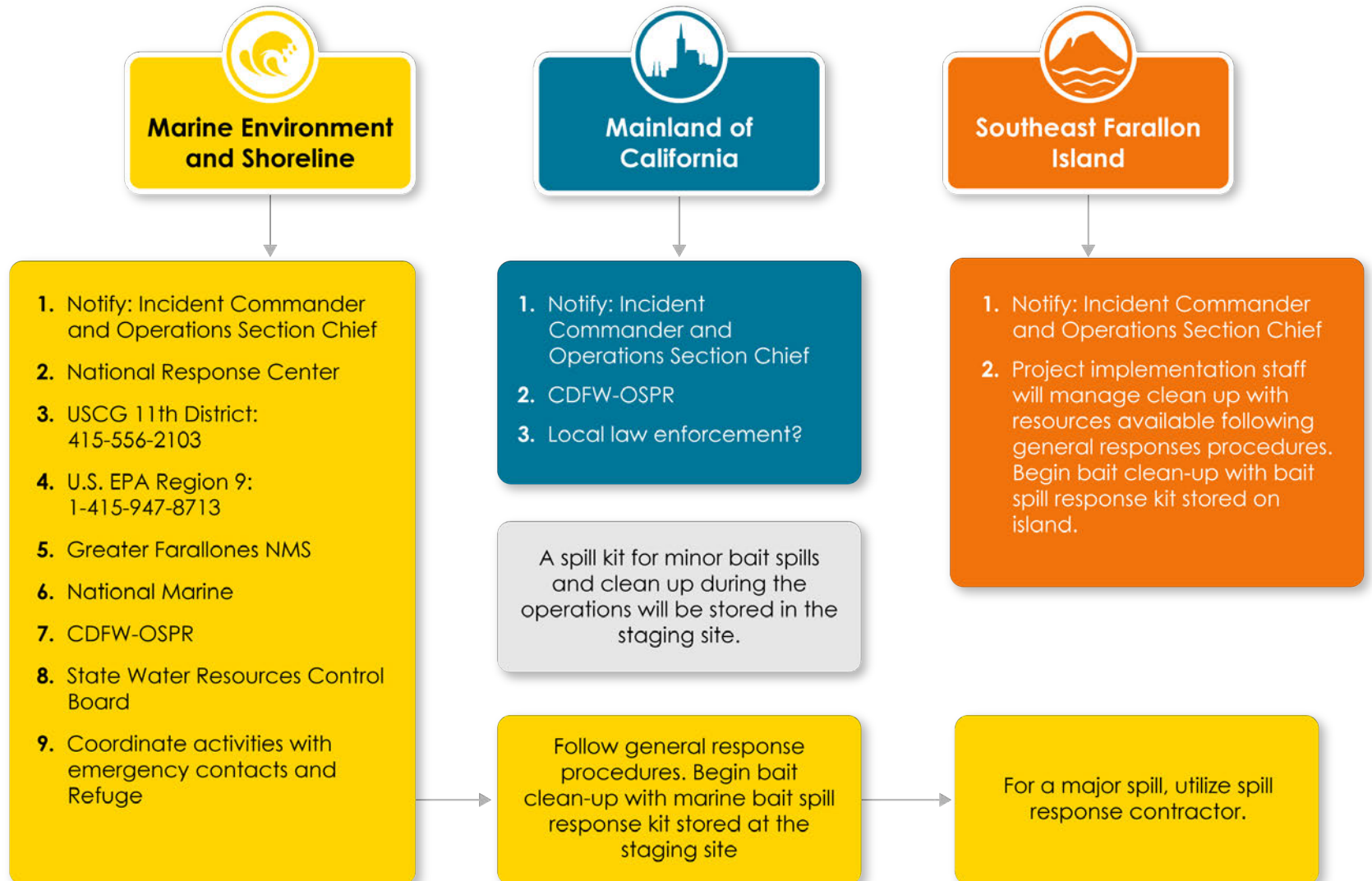
- Precautions and Response
- Description of responsibilities
- Precautions
- Response activities
- Notifications

## Response Resource and Preparedness Activities

- Equipment, Supplies, Services, and Personnel
- Communications and Control
- Preparedness Activities



## Bait Spill



# Contingency Plans



## Bait Spill

SCENARIO	PRECAUTIONS	RESPONSE
<b>Bait Enters Marine Environment</b>	<ul style="list-style-type: none"> <li>Bait in secure water-resistant containers</li> <li>Shipping only when sea conditions are suitable</li> <li>Helo off-loading only when conditions are suitable</li> <li>Only one bait container airlifted at a time</li> <li>Container attached by at least 2 straps that individually exceed limits of load</li> <li>Aviation, maritime and shipping regulations followed</li> <li>Flight log maintained</li> </ul>	<ul style="list-style-type: none"> <li>National Response Center and other federal and state authorities notified immediately</li> <li>All attempts to determine a safe and feasible way to recover the bait container(s)</li> <li>USFWS staff document the coordinates of spill and support response authorities to recover lost container(s)</li> <li>Spill kits carried on-board vessels transporting bait</li> </ul>
<b>Bait Spreading Bucket Lost Into Marine Environment</b>	<ul style="list-style-type: none"> <li>Spreader bucket not loaded over capacity</li> <li>Helo not loaded over capacity</li> <li>Aerial bait spread only when conditions are suitable</li> <li>Experienced pilot</li> <li>Helo remains within 200m of land</li> <li>Bucket attached by at least 2 straps that individually exceed limits of load</li> <li>Aviation regulations followed</li> <li>Flight log maintained</li> </ul>	<ul style="list-style-type: none"> <li>National Response Center and other federal and state authorities notified immediately</li> <li>USFWS staff document the coordinates of spill and support response authorities to recover lost bucket and any uncontained bait</li> <li>Spill kits carried on-board vessels transporting bait</li> </ul>
<b>Bait Spreading Bucket Spilled Into Terrestrial Environment</b>	<ul style="list-style-type: none"> <li>Spreader bucket not loaded over capacity</li> <li>Helo not loaded over capacity</li> <li>Containers placed on stable, flat surfaces</li> <li>Sufficient number of personnel used</li> <li>Aerial bait spread only when conditions are suitable</li> <li>Experienced pilot</li> <li>Bucket attached by at least 2 straps that individually exceed limits of load</li> <li>Aviation regulations followed</li> <li>Flight log maintained</li> </ul>	<ul style="list-style-type: none"> <li>USFWS staff document spill location and initiate bait recovery</li> <li>Spill kit available on Southeast Farallon Island</li> </ul>

# Contingency Plans

## Non-target impacts to terrestrial or marine biota

Outline the triggers the Service will use to identify the need for response action and the contingency responses that will be put in place to minimize the consequences of eradication activities to non-target biota.

- Potential deficiencies in gull hazing program and
- Monitoring results indicate that significant impacts to a species' population or exceedance of allowable take by permit appear likely to occur under current conditions.
- Will follow Incident Command structure.
- Will include list of action options.





# Contingency Plans

## Non-Target Impact Scenarios



## Scenario 1

Hazing not effective prior to broadcasting bait

### Potential triggers

Daily hazing effectiveness less than XX %

Greater than XX # of gulls present on the island for a significant period of time e.g. more than 30 minutes

### Potential Response

- ▶ • Increase hazing effort or modify methods.
- ▶ • Delay broadcast until sufficient hazing success is achieved.

Last resort action: Cancel rodenticide bait application and re-evaluate project.

## Scenario 2

Hazing effectiveness declines after bait application (either 1<sup>st</sup> or 2<sup>nd</sup> application)

### Potential triggers

XX # of gulls observed consuming bait pellets or roosting in baited areas

Discovery of XX # fresh gull carcasses showing signs of rodenticide poisoning

### Potential Response

- ▶ • Increase hazing effort or modify methods (i.e. more pyros, deploy more effigies, more human presence).
- ▶ • Reduce bait exposure by manually collecting or destroying pellets in difficult to haze areas.

Last resort action: manually collect or destroy pellets across all accessible areas.  
Cancel second bait drop if Scenario 2 occur between 1st and 2nd bait application.



# Contingency Plans

## Non-Target Impact Scenarios



## Scenario 3

Sick, dying, or dead gulls suspected of being poisoned, observed in tourist areas

### Potential triggers

Greater than five dead or dying gulls are reported within a five-day period from one location



Greater than ten dead or dying gulls are reported within a five-day period from one location within the City of San Francisco other than a beach.



Greater than 25 dead or dying gulls are reported within a five-day period from one location within the City of San Francisco other than a beach.



Dead or dying gulls are being reported in several areas.



### Potential Response

- Staff or trained volunteer(s) is dispatched to collect the birds (if possible) and conduct a survey of the area for additional birds, which also would be collected. Birds would be taken to a previously identified facility for necropsy and collection of tissue samples for analysis of anticoagulant rodenticide. Carcasses would then be incinerated.

- Surveys of other nearby tourist areas are conducted for the presence of dead or dying gulls suspected of anticoagulant rodenticide poisoning.

- Facility is notified to report any other dead or dying birds suspected of anticoagulant rodenticide poisoning.

- Standardized surveys are designed and conducted within popular tourist areas for the presence of dead or dying gulls suspected of anticoagulant rodenticide poisoning.

- Press release that dead or dying gulls have been observed at certain tourist areas. Include information about what to do if a dead or dying gull is found, including keeping pets away from potentially poisoned wildlife

# Contingency Plans

## Non-Target Impact Scenarios



## Scenario 4

Hazing results in pinniped take that is likely to exceed allowable numbers

### Potential triggers

Pinniped take (especially flushing) is significantly higher than expected.

Stampeding behavior is observed.

Pinniped take limits for one or more of the five species may be met.

ANY pinniped mortality observed.

### Potential Response

- ▶ • Modify hazing methods (i.e. use fewer pyros).
- ▶ • Reduce hazing in the areas that are most sensitive to pinniped take.
- ▶ • Consult with NOAA and the Marine Mammal Laboratory to increase take limits.
- ▶ • Eliminate hazing near major pinniped haul-outs areas.

Last resort action: cease all hazing activity.

Note: this may be required if any pinniped mortality is observed.

# Contingency Plans

## Non-Target Impact Scenarios



## Scenario 5

Bait application operations results in high pinniped take that is likely to exceed allowable numbers

### Potential triggers

Pinniped take (especially flushing) is significantly higher than expected.

Stampeding behavior is observed.

Greater than 25 dead or dying gulls are reported within a five-day period from one location within the City of San Francisco other than a beach.

ANY pinniped mortality observed.

### Potential Response

- ▶ • Modify rodenticide bait application methods.
- ▶ • Increase altitude of helicopter for aerial applications.
- ▶ • Facility is notified to report any other dead or dying birds suspected of anticoagulant rodenticide poisoning.
- Restrict helicopter activity to areas without high concentrations of pinnipeds. Hand bait those areas if accessible.
- Reduce hazing in the areas that are most sensitive to pinniped take.
- Consult with NOAA and the Marine Mammal Laboratory to increase take limits.
- Eliminate baiting near major pinniped haul-out areas.

Last resort action: cease all bait application activity.  
Note: this may be required if any pinniped mortality is observed.

# Contingency Plans

## Non-Target Impact Scenarios



## Scenario 6

Sick, dying or dead marine fish suspected of being poisoned

### Potential triggers

An individual crab or fish sample tests positive for anticoagulant rodenticide between first and second bait applications or following the second bait application.

Five or more crabs or fish test positive for anticoagulant rodenticide between first and second bait applications or following the second bait application.

### Potential Response

- Immediate notification of USFWS, CDFW, and NOAA personnel.
- Consider implementing protocol to collect additional samples for immediate analysis of anticoagulant rodenticide; and
- Eradication team meets to discuss improved baiting strategy to further minimize bait drift.
- Consult with CDFW and NOAA to determine communication with fishing community.
- If warranted, meet with federal, state, and local agencies and fishing community to discuss potential fishery action.
- Consider implementing protocol to collect additional samples for immediate analysis of anticoagulant rodenticide; consider expanding geographic scope or diversity of marine species within sampling program.
- Consider cancelling second bait drop



# CASE STUDY

## Ancapa Islands

### Benefits Achieved:

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# CASE STUDY

## Rat/Hawadak Island

### Benefits Achieved:

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# Worldwide Mouse Eradication

- **57** successful mouse eradications worldwide since 1971
- **>600** successful rodent (rats or mice) eradications worldwide
- **Near 100%** successful 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)
  - Hawadak/Rat Island (Alaska Maritime NWR, AK)
  - Desecheo NWR (Puerto Rico)







# 100% eradication with extensive safeguards,

backed by respected conservation  
and birding organizations,  
to restore one of the most  
ecologically important areas  
in the world.

