

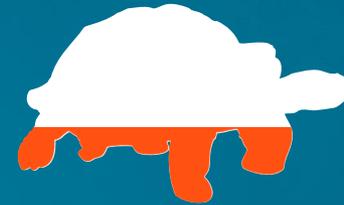


Mission: to prevent extinctions by removing invasive species from islands

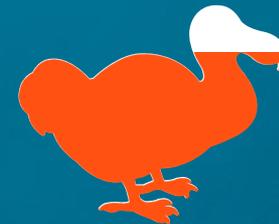
Islands Represent



Less than **5%** of land mass



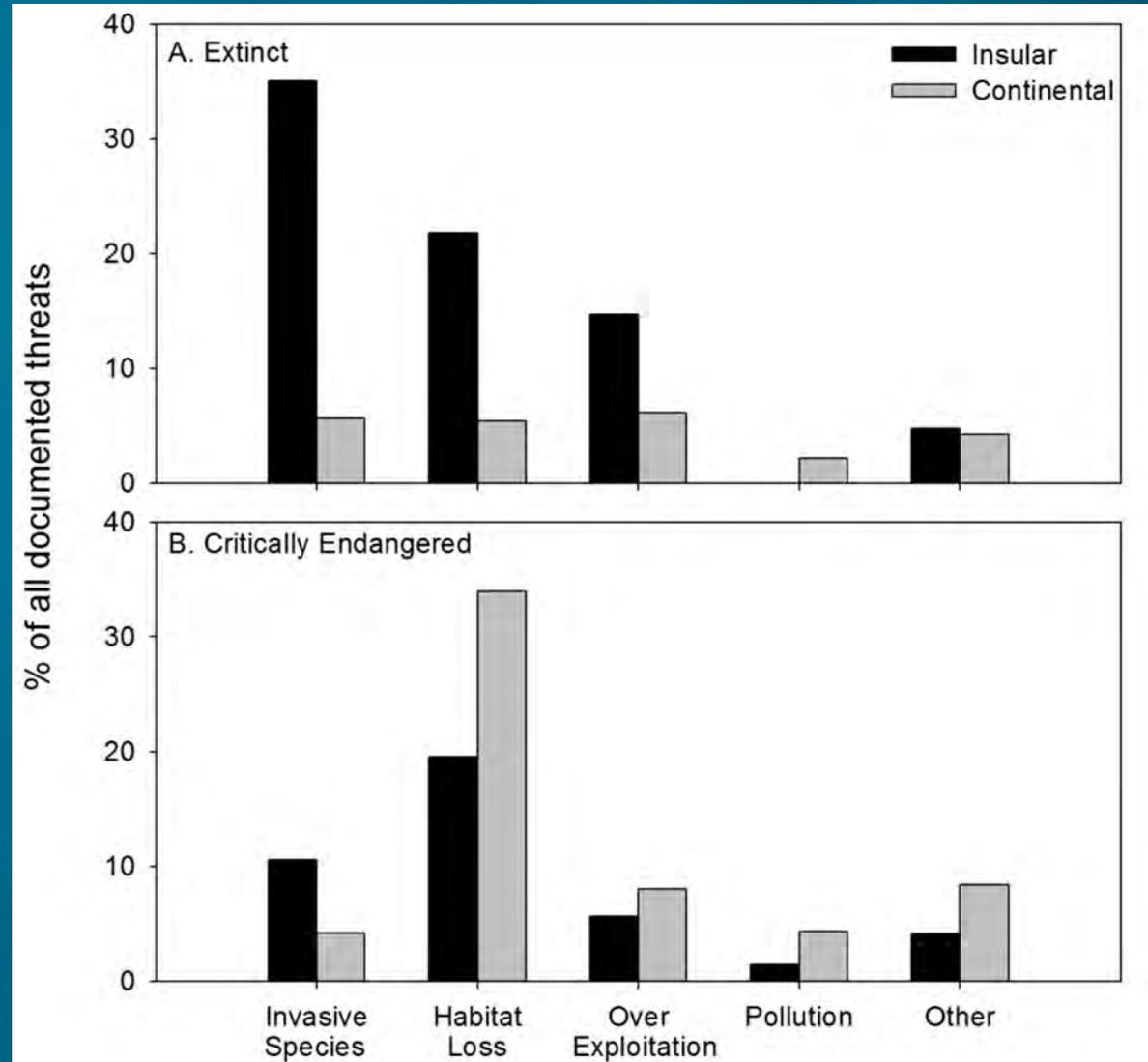
40% of endangered species



80% of extinctions since 1500

Islands as a special conservation need

- Invasive Alien Species (IAS) cause island extinctions
- Remain a key threat to today's CR plants and animals



Invasive Species

Predation

Competition

Disrupt
ecological
function



How do invasives impact island species?

Direct:

- **Predation-** Galapagos Tortoise (Galapagos Conservancy) and Laysan Albatross





How do invasives impact island species?

Direct:

➤ Predation-

➤ **Grazing-** Palm Forests - Hawaii (USFWS) and Rapa Nui (Hunt 2006)



How do invasives impact island species?

No rats

Rats



➤ **Subsidize or Control predators (Kurle et al. 2008)**

Introduced foxes



Seabirds



Marine
Productivity



Predators
(Land birds, Spiders)



Herbivores
(Slugs)



Terrestrial Plants
(Elymus Grass)



Nutrients from
Guano



Introduced foxes



Seabirds



Marine Productivity



Predators
(Land birds, Spiders)



Herbivores
(Slugs)



Terrestrial Plants
(Empetrum Shrub)



Nutrients from
Guano





Invasive Alien Vertebrate Eradications

One of the most
effective ways to:

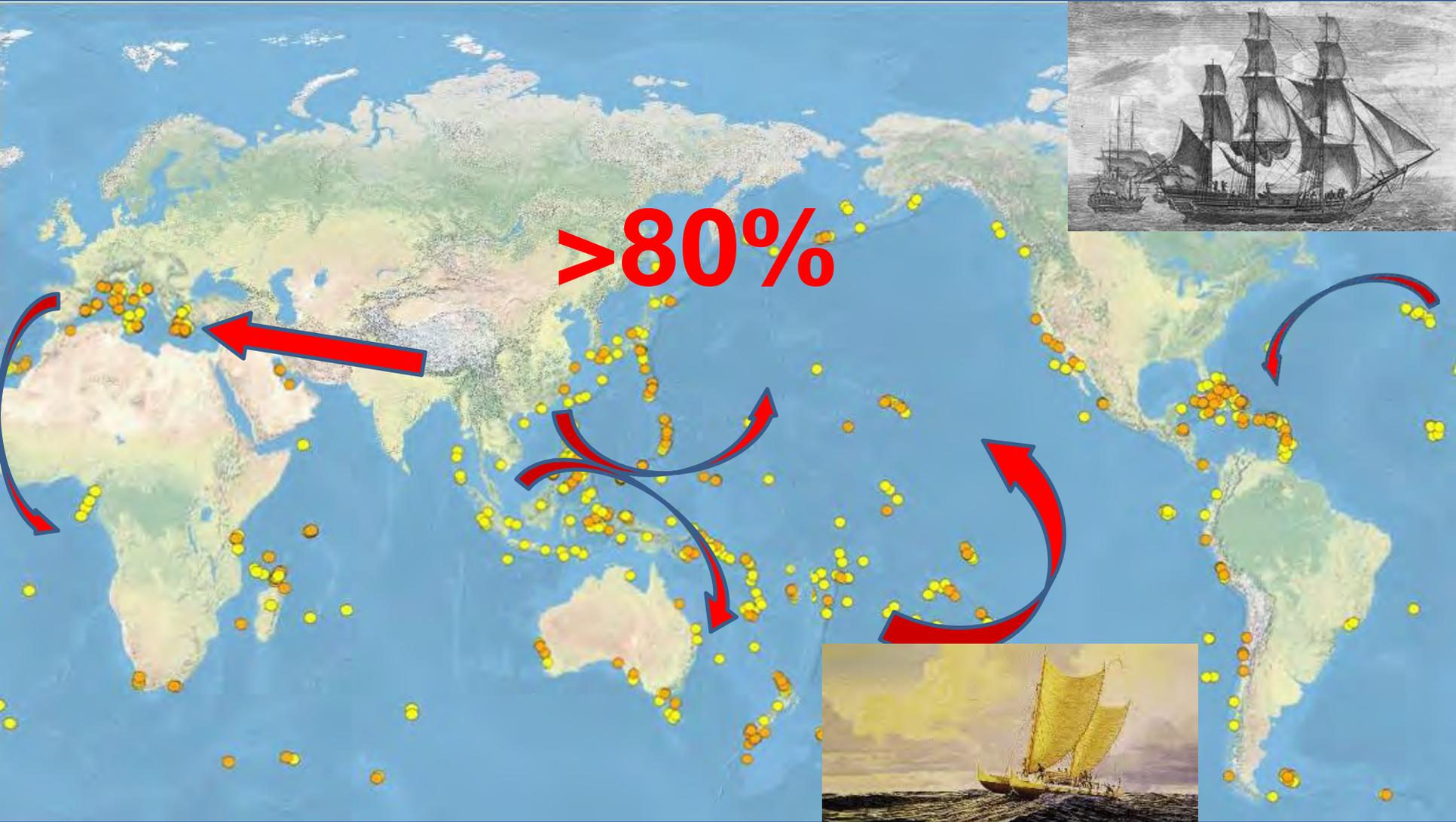
Protect Threatened
Species

Invasive Species on Islands - A Global Problem...



<http://tib.islandconservation.org>

Introduced Rodents: A Conservation Problem (Atkinson 1985)



Rattus rattus

Rattus norvegicus

Rattus exulans

Mus musculus

Stop Rats!

Protect Alaska



Home
Rats and Wildlife
Rats on Boats
Rats in Town
Rat Laws
Order Kits
Contact Us
News



WHERE THE RATS ARE

Legend

- Cities, towns, and villages with known breeding populations of rats.
- Large islands with rats.



Rats are Bad News for People and Wildlife

On ships, boats, planes, barges and trucks, rats have spread over much of the world. With them come disease, economic harm and wildlife destruction. We don't want this to happen in Alaska! Much of Alaska remains rat free, one of the last such places on earth. Our climate and remoteness won't keep Alaska and its wildlife safe forever. As travel, development and shipping increase, so to does the risk of spreading rats.

Rats Could Get on Your Boat

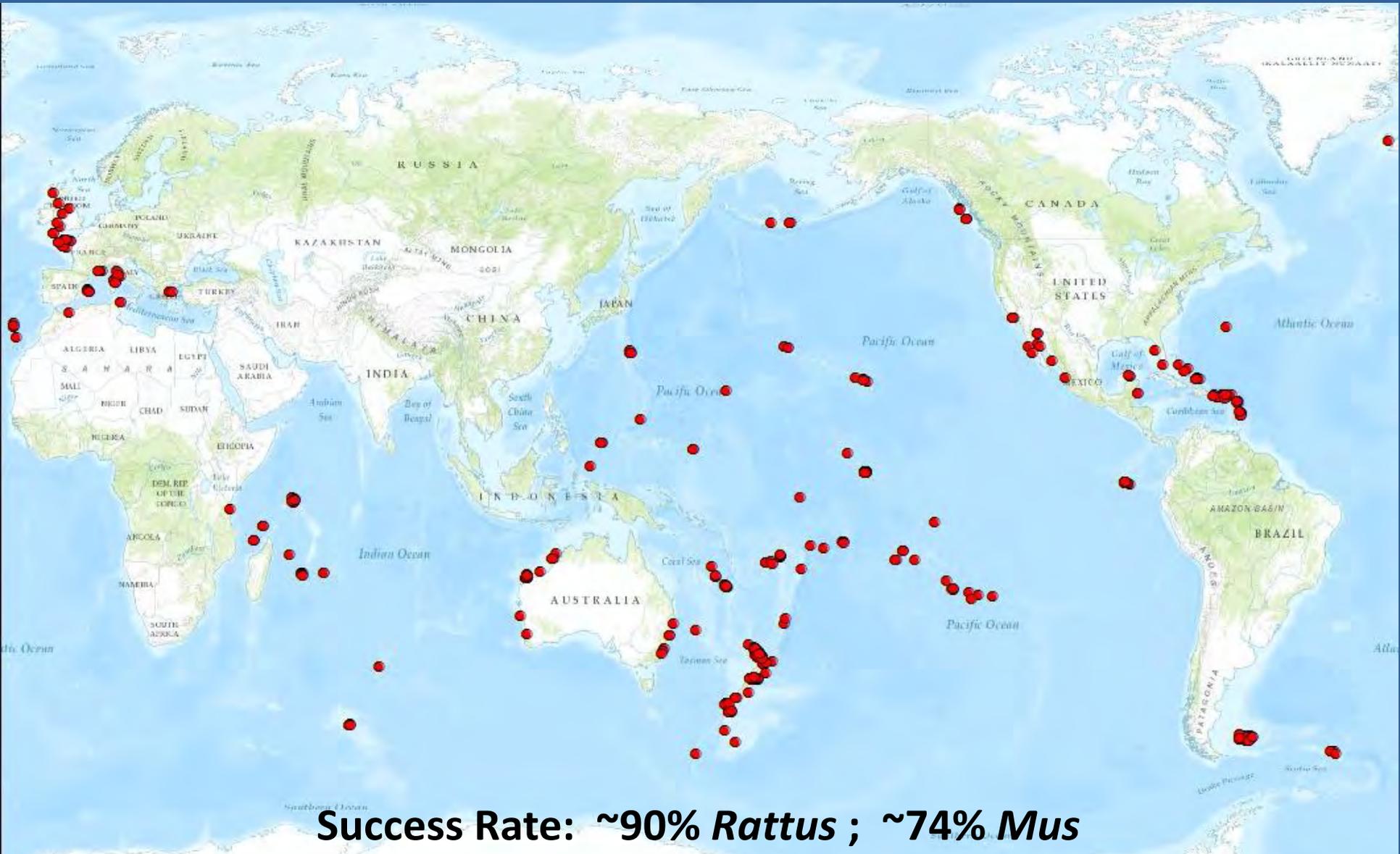
Ever tie up at Dutch, Kodiak, Ketchikan, or Seattle? These ports and many others have rats. Without you even knowing it, rats could have boarded your boat by scurrying up a line or jumping from the dock or another boat. Or you could have craned aboard a rats nest when you loaded cargo, trawl nets or pots. These stowaways can harm you, your boat and Alaska's wildlife. Don't let your boat be the one that accidentally unleashes this plague on our wildlife paradise or a rat-free town. Review the [Rats on Boats](#) page to find



Global Rodent Eradications

~500 Successful

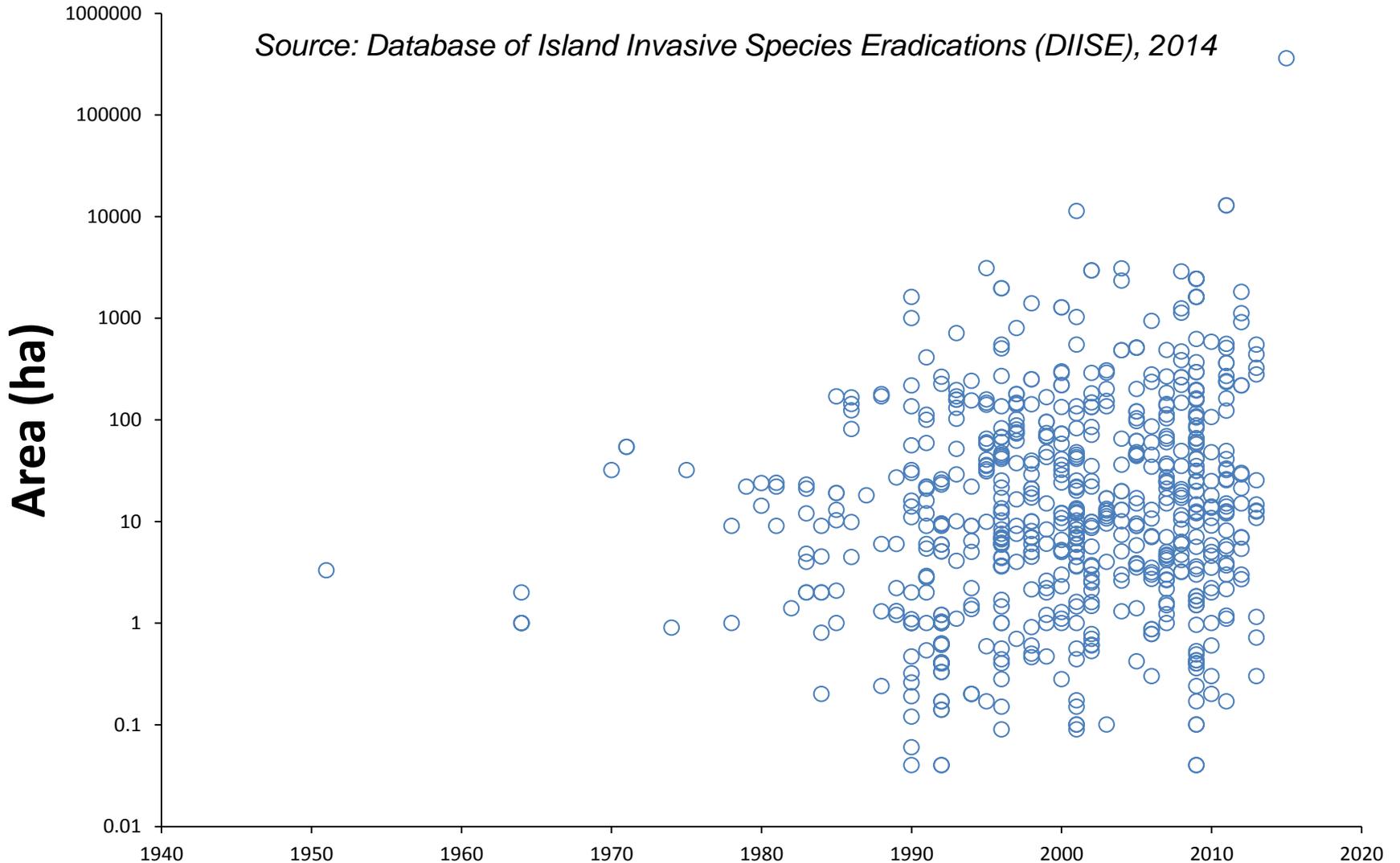
Source: Database of Island Invasive Species Eradications (DIISE), 2014



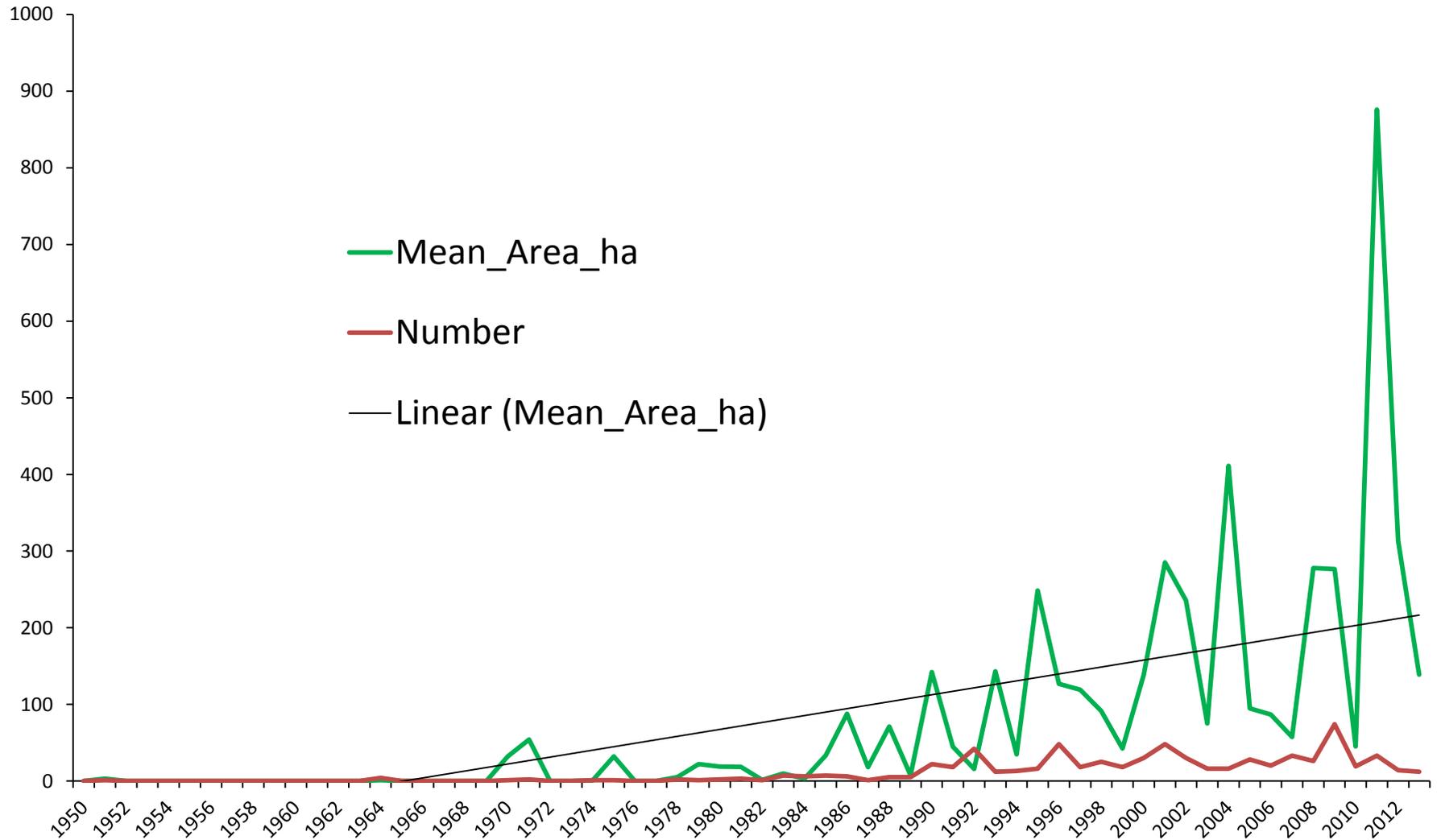
Success Rate: ~90% *Rattus* ; ~74% *Mus*

Successful and In Progress Rodent Eradications

Source: Database of Island Invasive Species Eradications (DIISE), 2014



Mean Area (ha) Cleared of Rodents Per Year

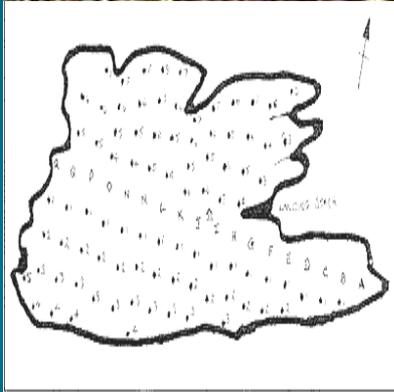




Palmyra Atoll



Rodent Eradication Methods: Rodenticides



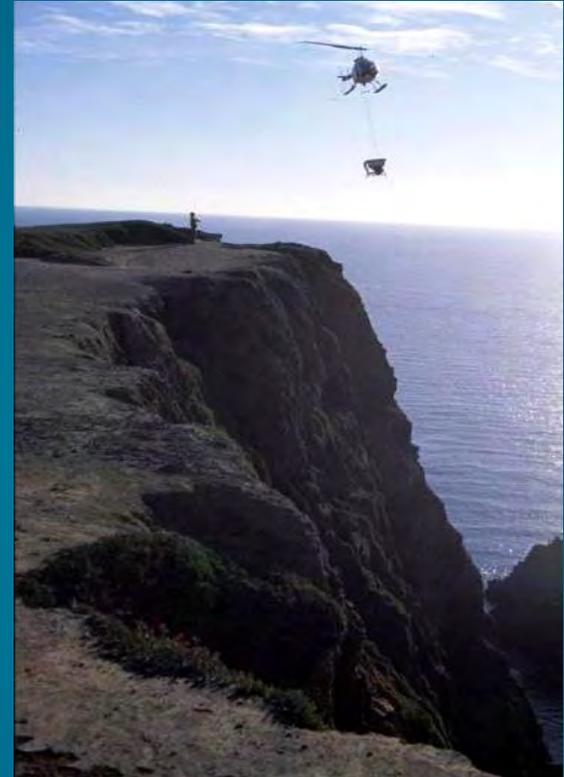
Bait station

34%



Hand broadcast

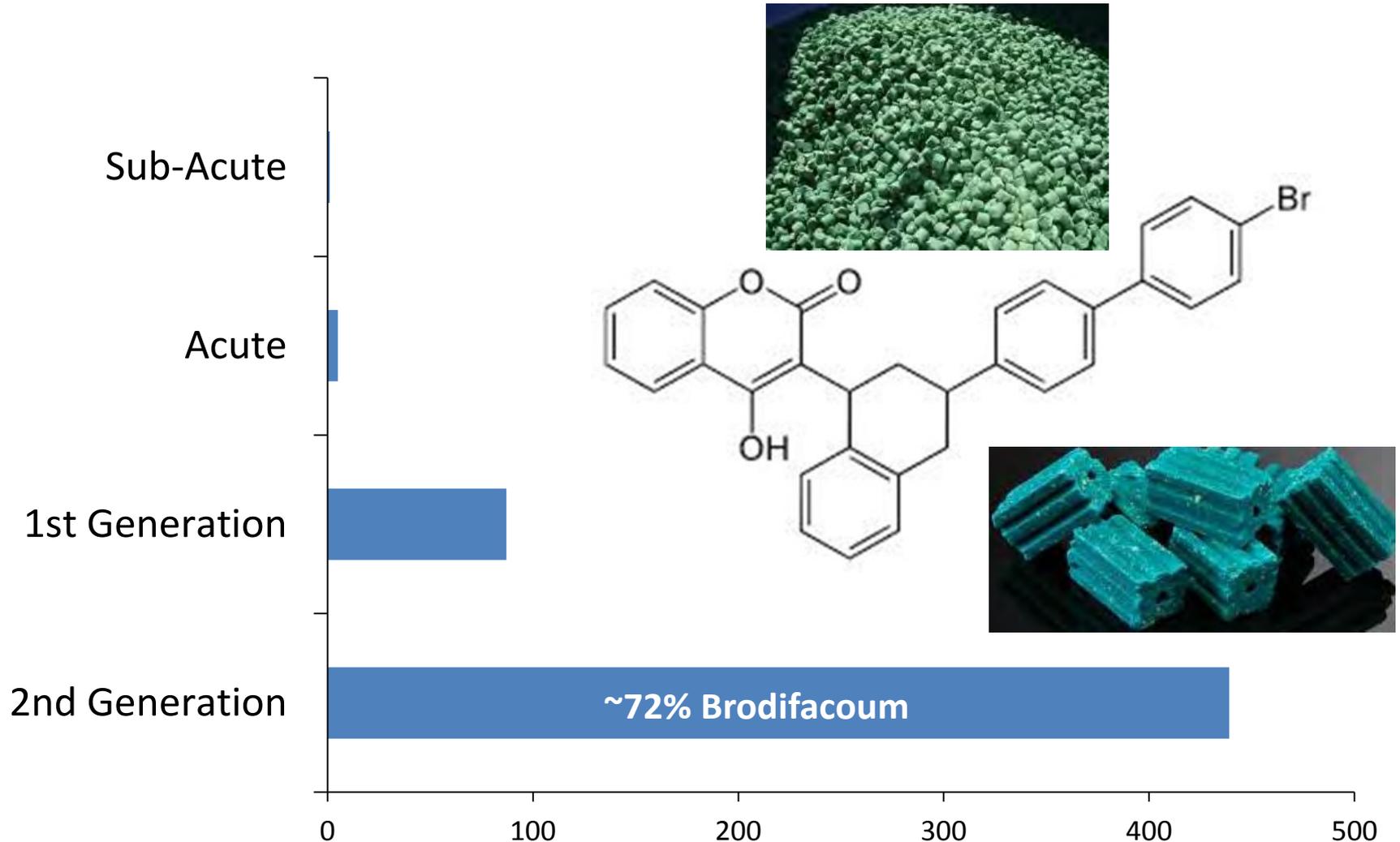
23%



Aerial broadcast

43%

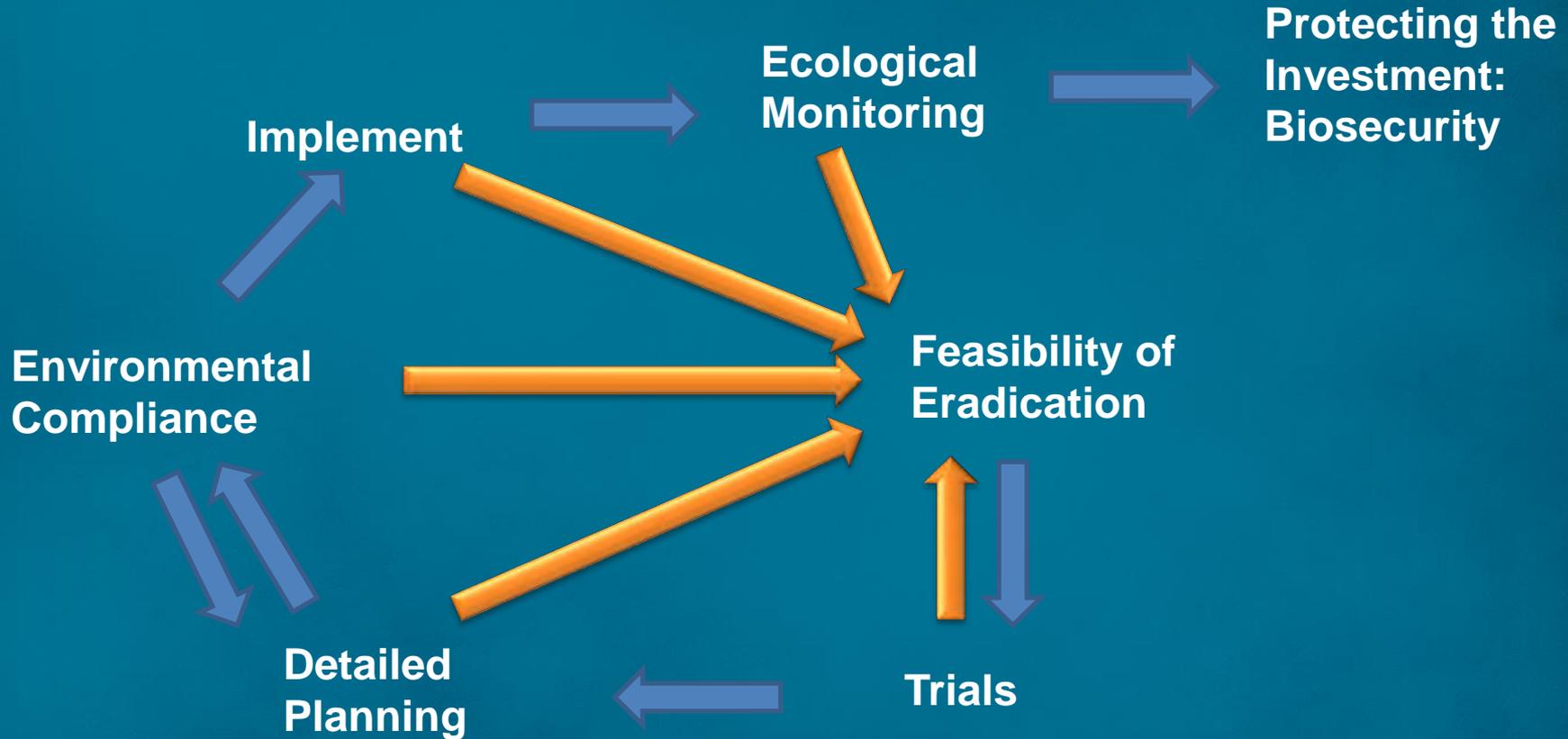
Rodenticide Choice: Balancing Efficacy vs. Risk A Tradeoff



Basic Eradication Project Cycle

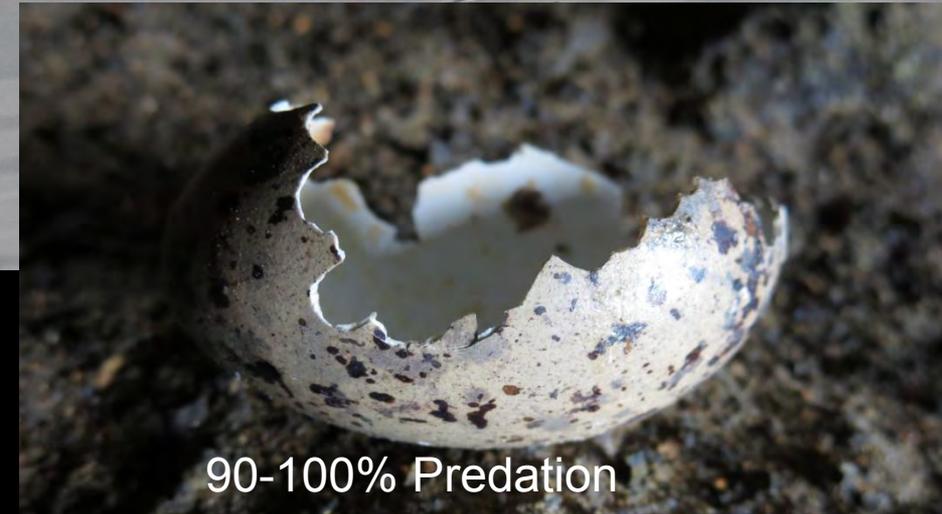


Managing Risk: Adaptive Management





American
Trader
Trustee
Council



90-100% Predation

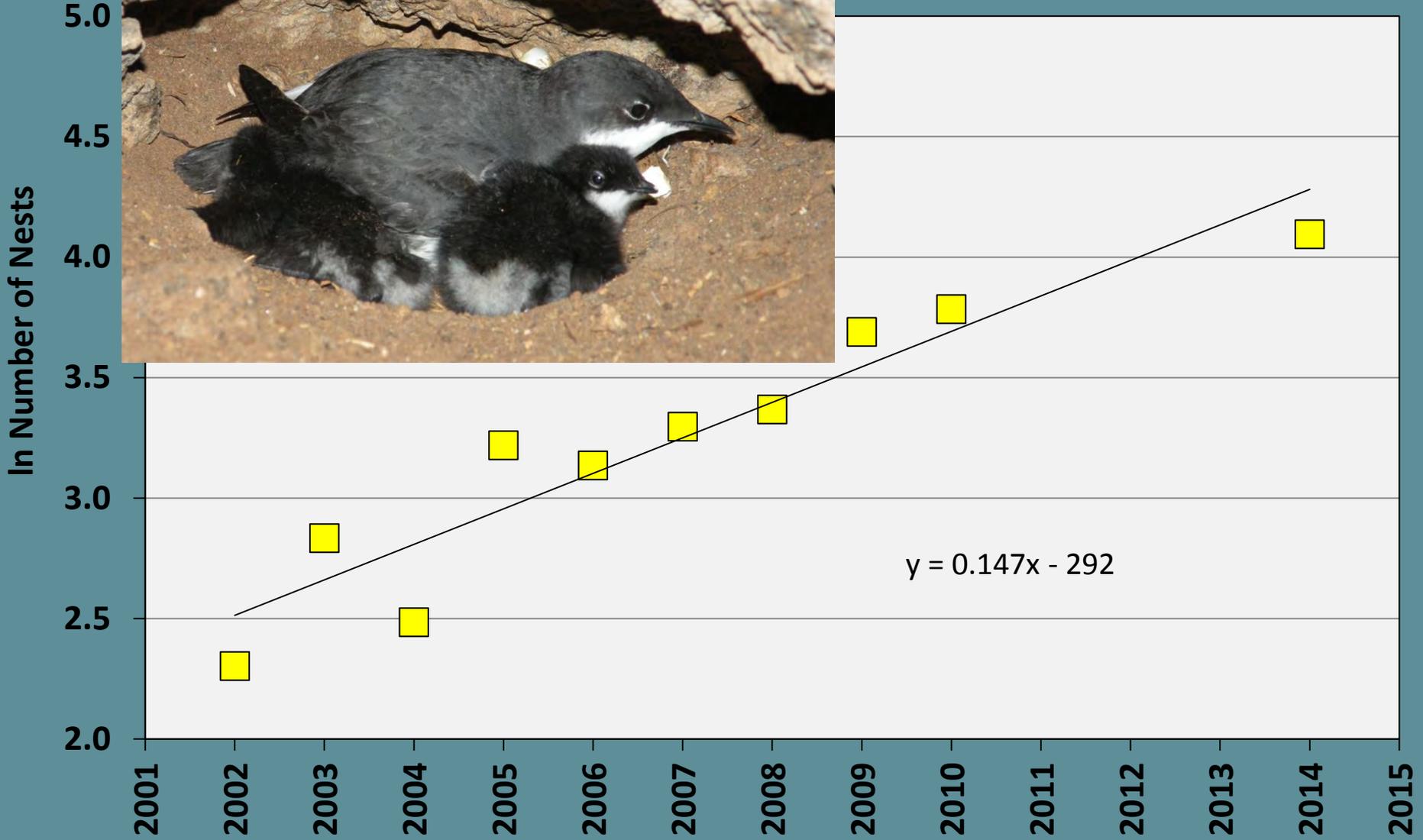
Anacapa Island, California



Per Annum Increase: In Annual Number of Occupied Nests



Whitworth and Carter, 2014





The Nature Conservancy



ISLAND CONSERVATION

Preventing Extinctions



Hawadax (Rat) Island, Alaska

Timing: Balancing efficacy vs. risk

Spring

Summer

Fall

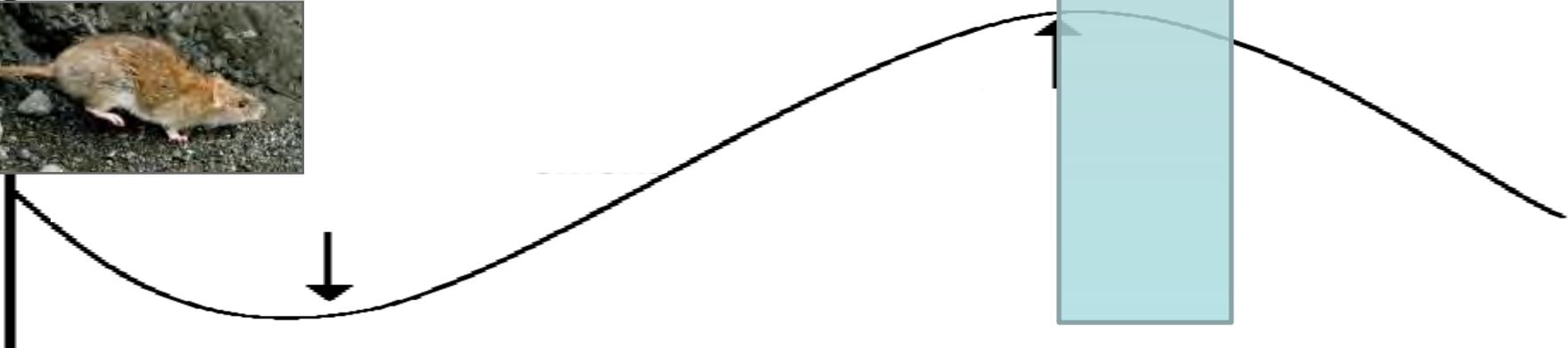
Winter

Weather

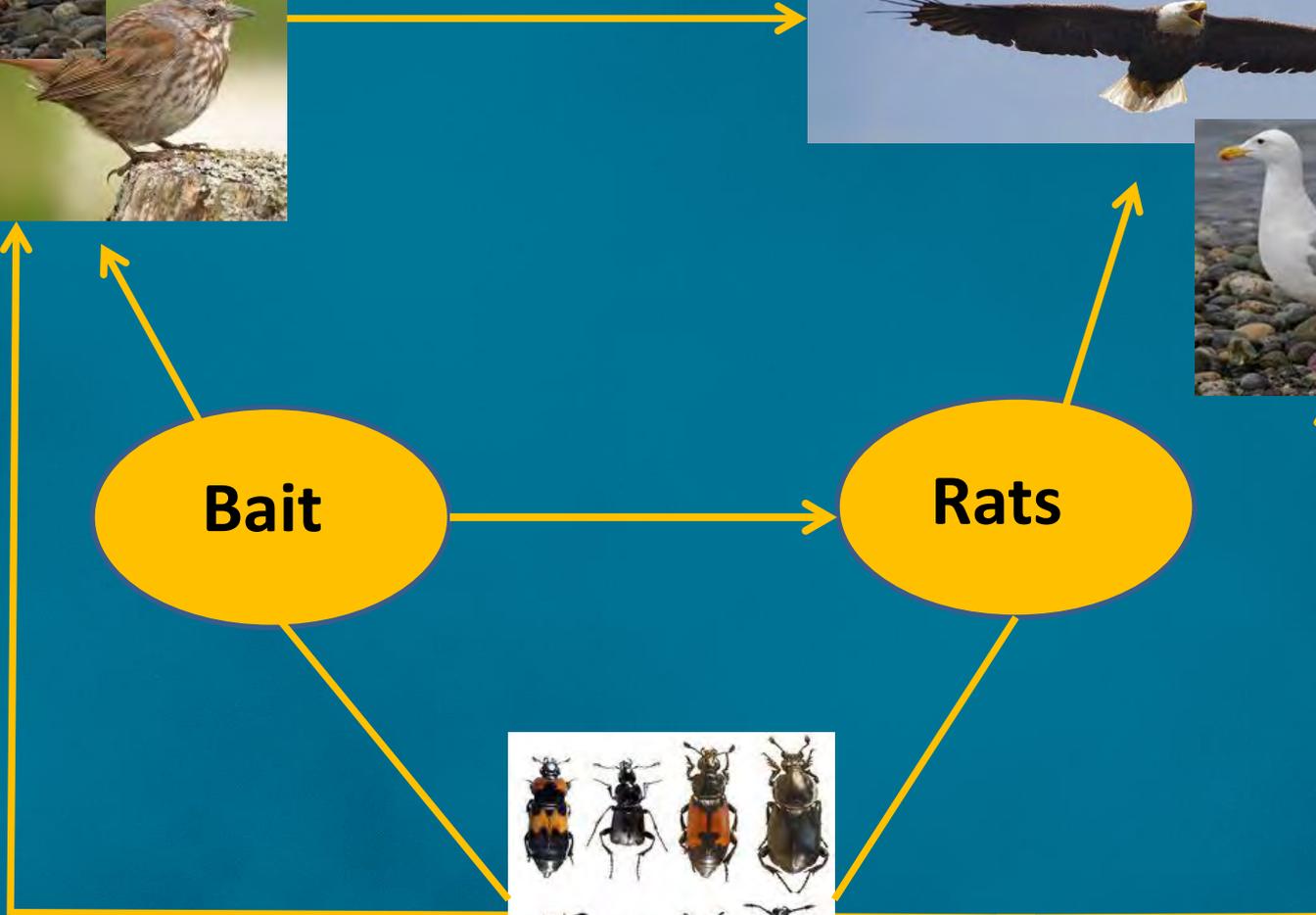
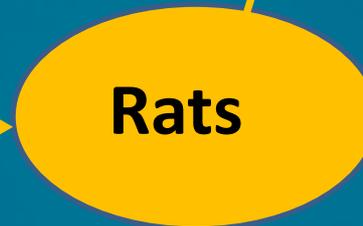


Native Species

ion size



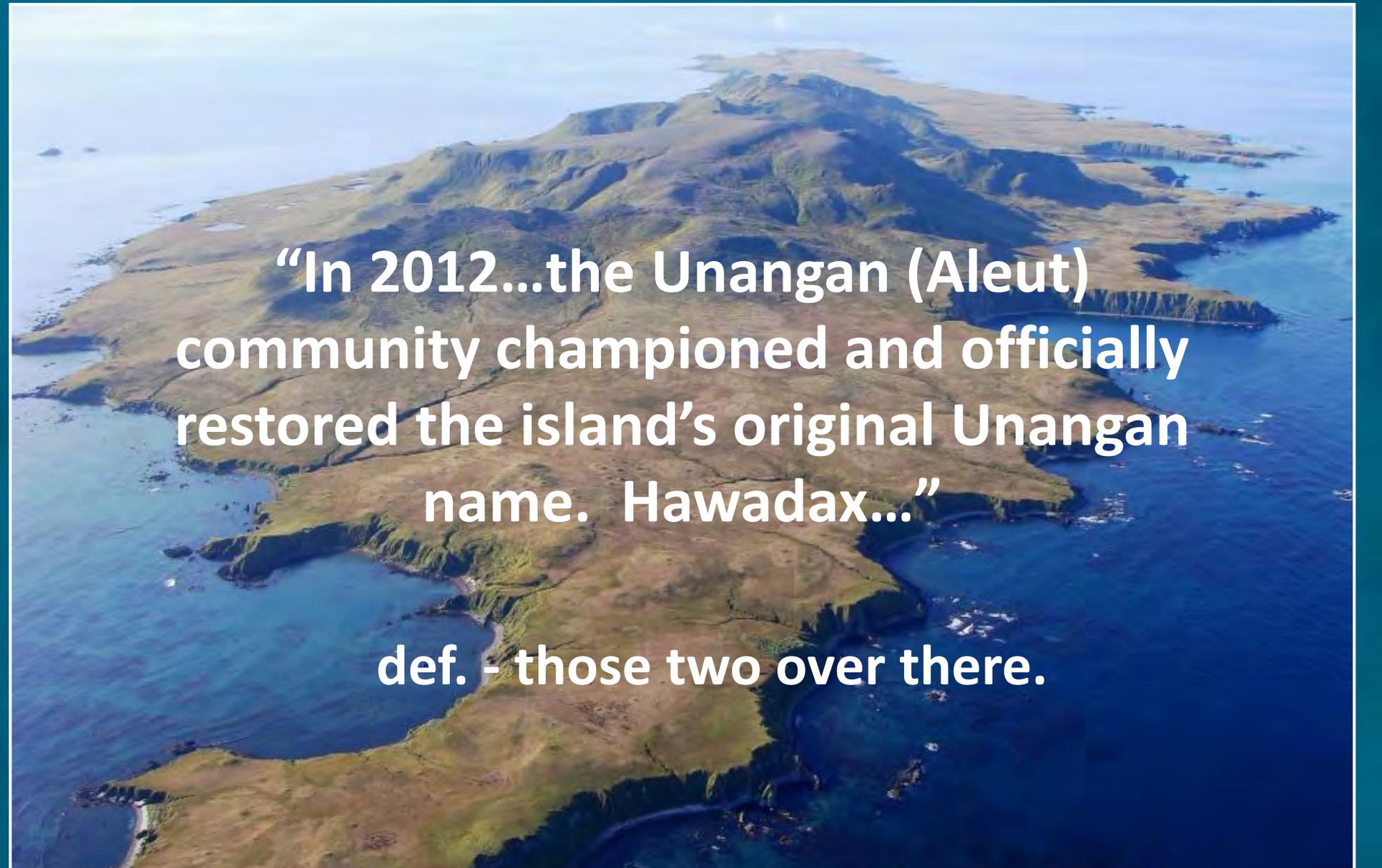
Non-target Risks



Cost vs. Benefit: Is it Worth It?



Beyond the Biodiversity: Rat Island



“In 2012...the Unangan (Aleut) community championed and officially restored the island’s original Unangan name. Hawadax...”

def. - those two over there.

Challenges for the Future

- Reliant on application to every rodent territory
- Not Species Specific
- Humane issues
- Inhabited islands
- Perception of poisons



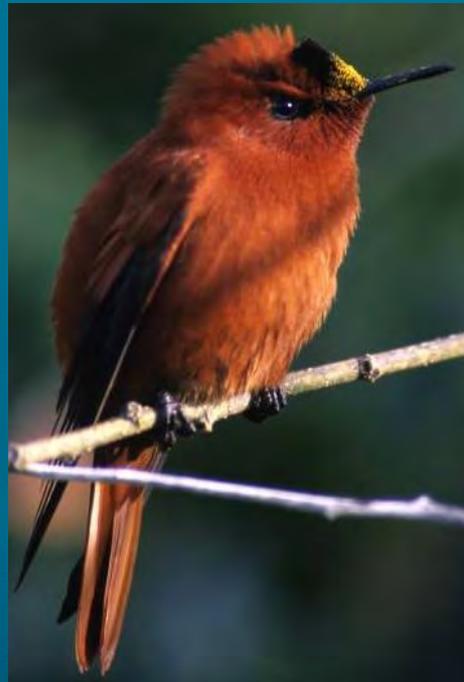
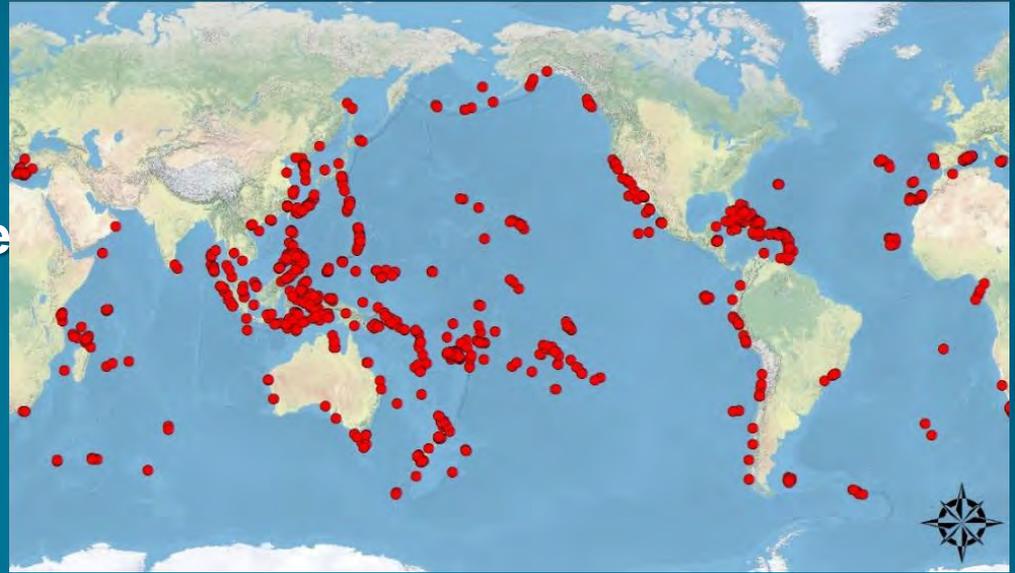
Innovation Strategy

Incremental vs. Transformative

- Eliminate Pesticide Use or Reduce

- Applicable for Large Scale

- How might we catalyze?



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Special Issue Article: Tropical rat eradication

The next generation of rodent eradications: Innovative technologies and tools to improve species specificity and increase their feasibility on islands

Karl J. Campbell^{a,b,*}, Joe Beek^c, Charles T. Eason^{d,e}, Alistair S. Glen^f, John Godwin^g, Fred Gould^h, Nick D. Holmesⁱ, Gregg R. Howald^j, Francine M. Madden^k, Julia B. Ponder^l, David W. Threadgill^m, Alexander S. Wegmannⁿ, Greg S. Baxter^o

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ABSTRACT

Rodents remain one of the most widespread and damaging invasive alien species on islands globally. The current toolbox for insular rodent eradications is reliant on the application of sufficient anticoagulant baits across every potential rodent territory across an island. Despite significant advances in the use of these baits over recent decades, numerous situations remain where eradication is challenging or not yet feasible. These include islands with significant human populations, unacceptably high rodent densities, on-occurrence of livestock and domestic animals, or vulnerability of native species. Developments in drone technology and advances in the medical, pharmaceutical, veterinary pest control, social sciences, technology and detection fields offer potential insight into the next generation of tools to eradicate rodents from islands. However, gaining a structured process whereby current problems are assessed against potential future solutions. We undertake such an exercise to identify the most promising technologies, techniques and approaches that might be applied to rodent eradications from islands. We highlight a future-specific, focused, R&D intervention in species-specific baits, rodenticide research, crab deterrent in baits, prophylactic treatment for protection of non-target species, transgenic rodents, viral vectored immunoneutralization, drone, self-seeding traps and baited applications, detection probability models and improved stakeholder community engagement methods. We present a brief description of each method, and discuss its application to rodent eradication on islands, known edge cases, challenges, whether it is incremental or transformative in nature and any unique potential timeline for availability. We outline how a combination of new tools may render previously intractable rodent eradication problems feasible.

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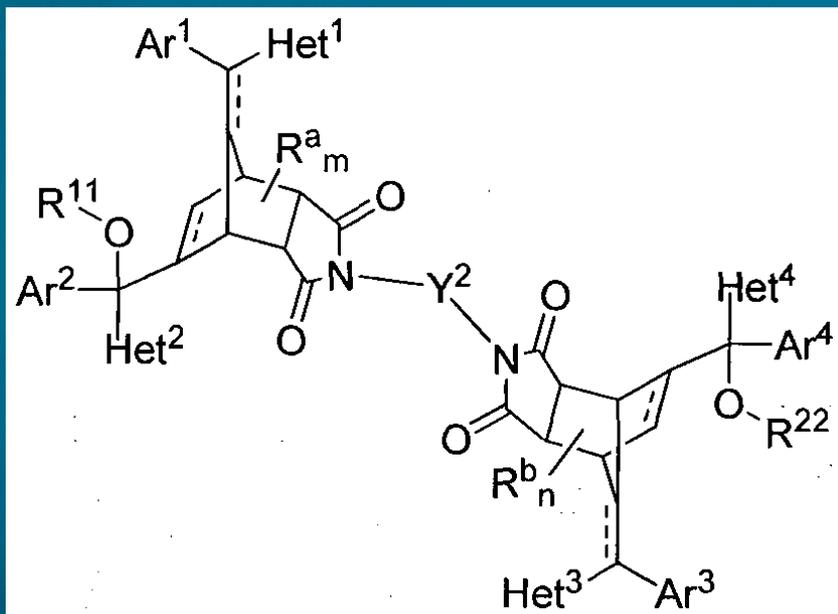
1. Introduction

Insular mammal eradications are powerful conservation tools to protect biodiversity and prevent extinctions on islands (Aguiar-Muller et al., 2009; Bellingham et al., 2010; Campbell et al., 2011). The opportunity to scale-up existing eradication techniques is being realized, with larger and more challenging projects being undertaken (Phillips, 2010; Sutherland et al., 2014). Yet

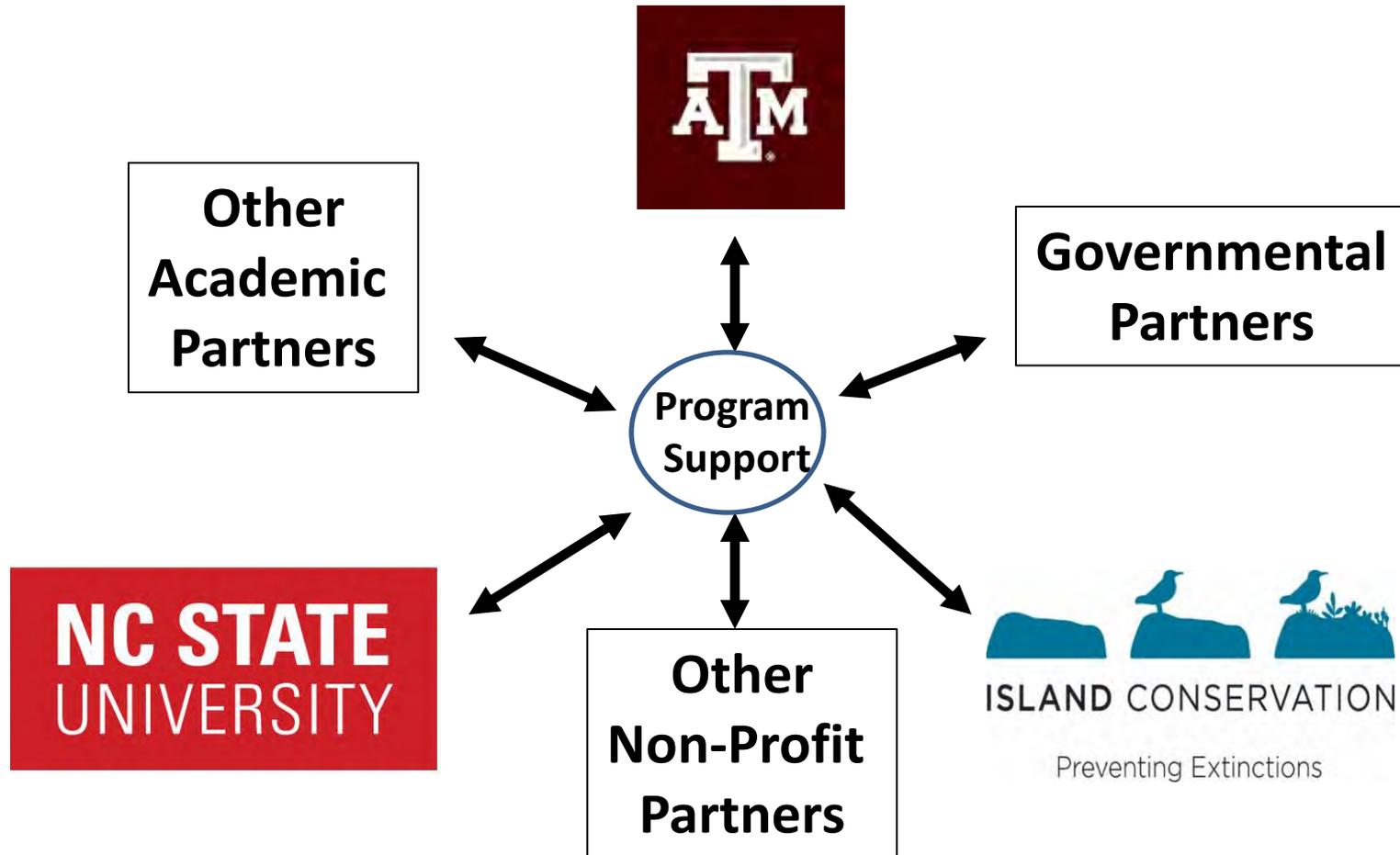
Innovations

Crab Deterrents

Rattus Specific Toxicant (RST)



Genetic Biocontrol of Invasive Rodents Program

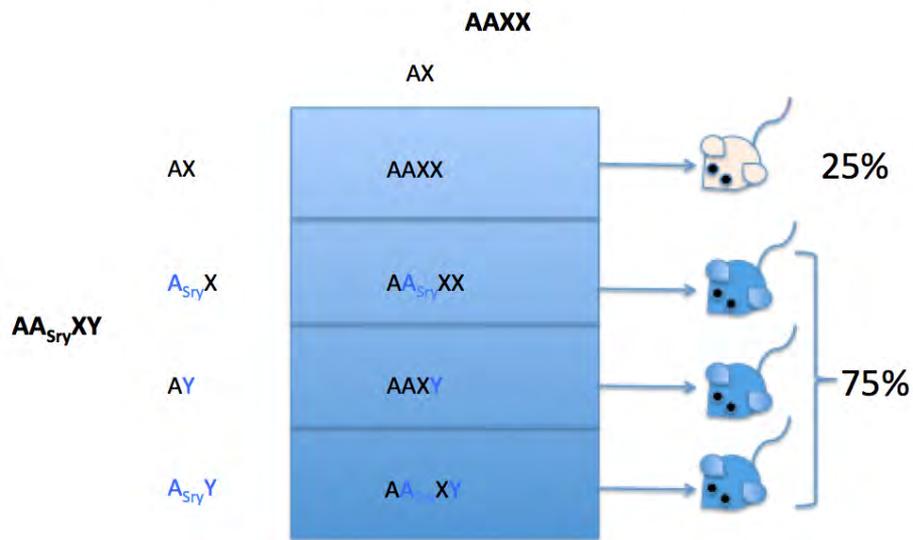


Mouse Genetics

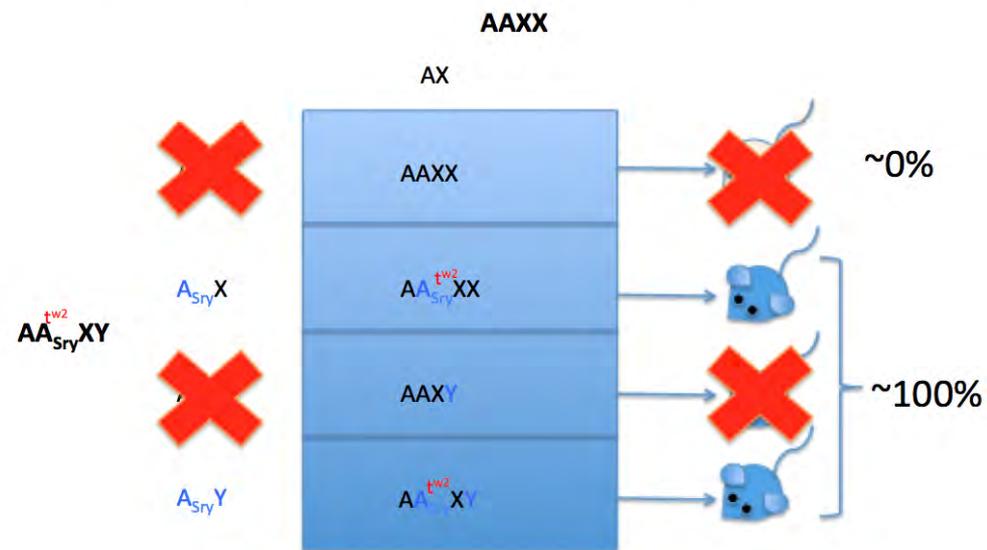
that may contribute to conservation

- **SRY** – Sex Determining Region in the Y-chromosome
- **T-complex** – naturally occurring meiotic drive in *Mus*

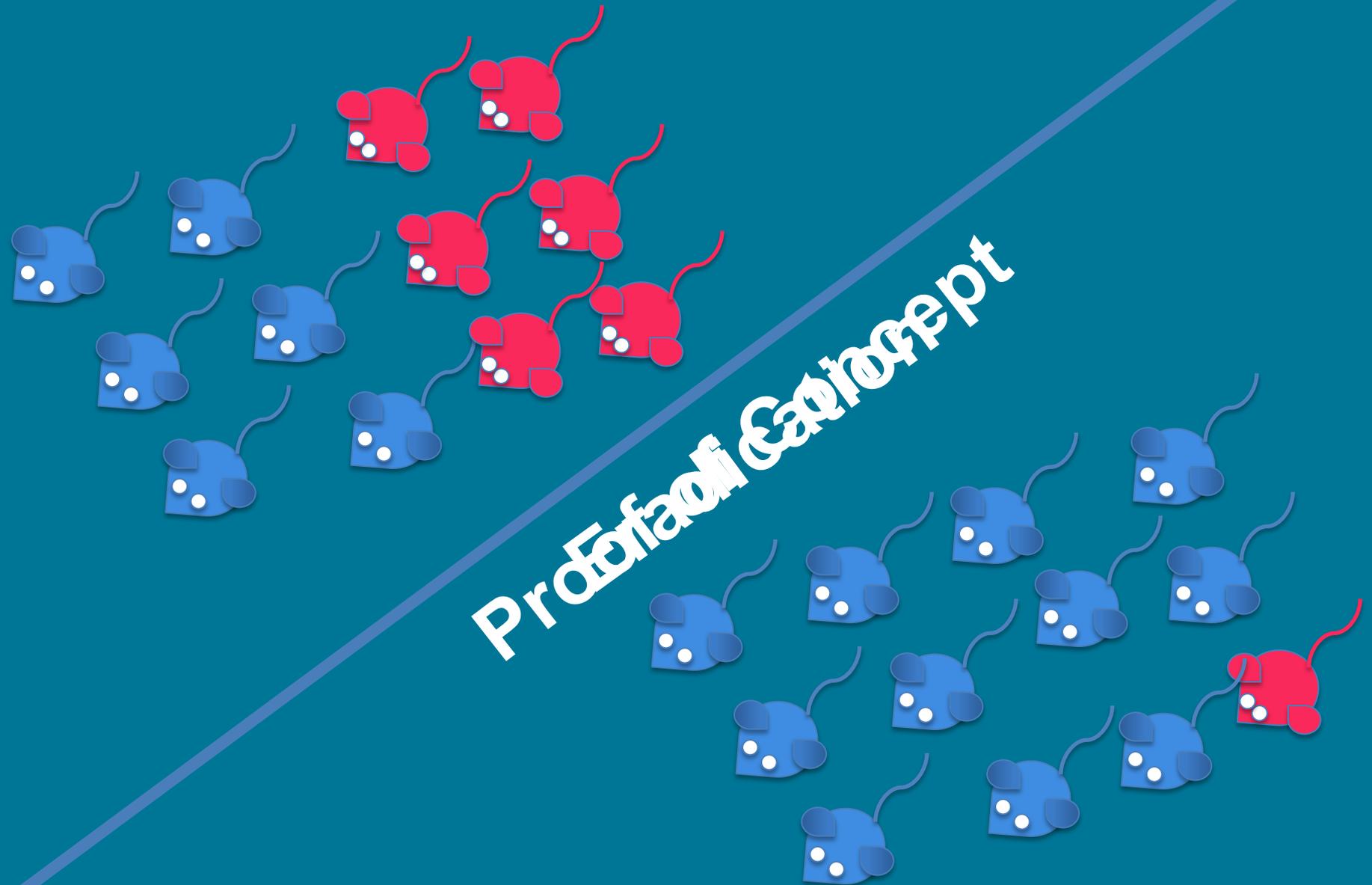
Expected Sex Ratios



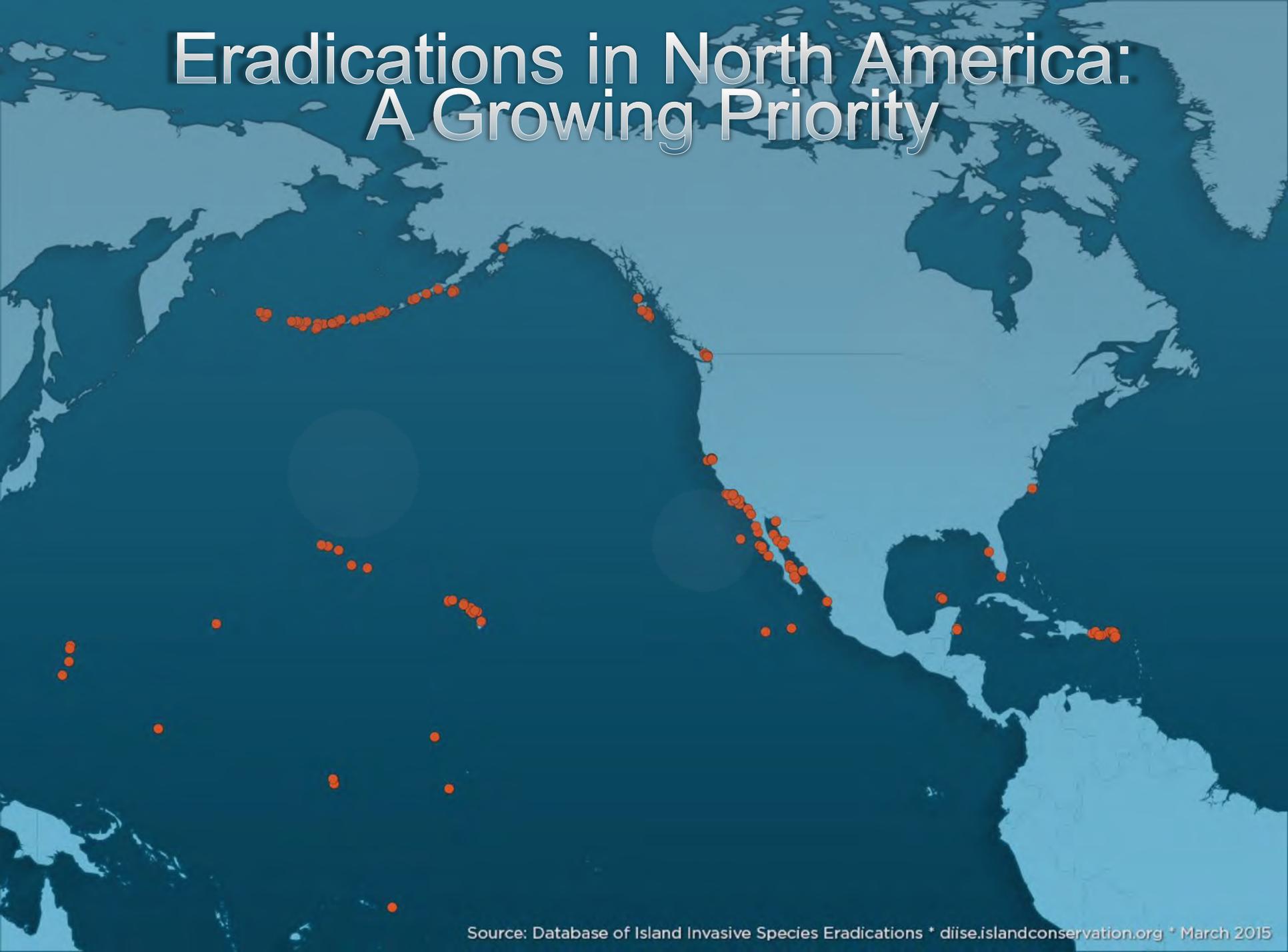
Expected Daughterless Pups



Mendelian inheritance



Eradications in North America: A Growing Priority



Letter of Intent

- Signed at 2014 Trilateral Meeting
- Seeks to strengthen collaboration between Canada, Mexico, and the United States on the conservation and restoration of islands



MEMORANDUM OF UNDERSTANDING U.S. FISH AND WILDLIFE SERVICE



“.. jointly promote an integrated and coordinated approach to these efforts through project implementation, information exchange, education and training, coordination, inventorying and monitoring, and sharing of resources whenever appropriate.”



Innovation Strategy

- Identify point of greatest impact
 - Invasive rodents
- Match technology to the need
 - Horizon scanning
- Select investment targets
 - Incremental
 - Transformative
- How might we catalyze?



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ABSTRACT

Islands remain one of the most widespread and damaging invasion hotspots on earth globally. The current toolbox for smaller rodent eradications is reliant on the application of sufficient anticoagulant toxicants into every potential rodent refuge across an island. Despite significant advances in the use of these tools over recent decades, numerous situations remain where eradication is challenging or not yet feasible. These include islands with significant human populations, complex topography, communities, or occurrence of feral and domestic animals, or vulnerability of native species. Developments in diverse branches of science, particularly the medical, pharmaceutical, veterinary and food, social science, technology and defense fields offer potential insights into the next generation of tools to eradicate rodents from islands. Evidencing a structured process whereby core problems are assessed against potential future solutions. We undertake such an exercise to identify the most promising technologies, techniques and approaches that might be applied to rodent eradication from islands. We highlight a *Rattus*-specific, rickettsial, RNA interference as species-specific, toxicant, independent of mammal, crab, dingo or bait, prophylactic treatment for protection of non-target species, transgenic rodents, virus vectored immunotoxin, drone, self-seeding traps and baiting applications, detection probability models and improved, substrate, on-remote, engagement methods. We present a brief description of each method, and discuss its application to rodent eradication on islands, knowledge gaps, challenges, whether it is incremental or transformative in nature and provide a potential timeline for availability. We outline how a combination of new tools may render previously intractable rodent eradication problems feasible.

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1. Introduction

Invasive mammal eradications are powerful conservation tools to protect biodiversity and prevent extinctions on islands (Aguiar-Molina et al., 2002; Baskett et al., 2010; Campbell et al., 2011). The opportunity to scale up existing eradication techniques to being realistic, with larger and more challenging projects being undertaken (Pillay, 2010; Sutherland et al., 2014), yet

Successful Eradication Attempts Over Time

Source: Database of Island Invasive Species Eradictions (DIISE), 2014

