Rodenticide Use for Mouse Eradication on the Farallones: Food for Thought

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Pesticide Research Institute

- **Our Philosophy**

At PRI, we empower individuals, governments and organizations to make informed decisions about pesticides by:

- Seeking out and providing the best available information on pesticides for use in risk assessments, IPM programs and research
- Providing quantitative tools for predicting pesticide exposure and risk
- Facilitating the understanding of issues surrounding pesticide use
- Providing resources to determine the lowest-impact pest control methods for a particular pest problem

Overview

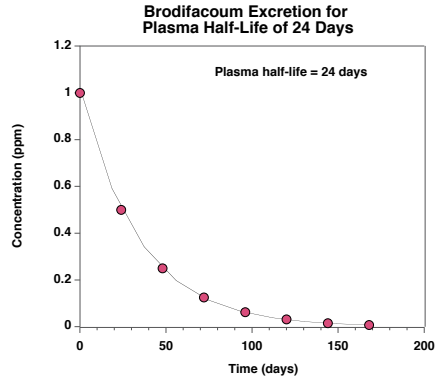
- Rodenticide properties
- Assessment of exposure potential
- Likely outcomes for the preferred alternatives
- Assessment of need for the project
- Re-consideration of alternatives

Properties of Brodifacoum: Solubility

- Solubility in water (DPR data)
  - Governs runoff potential
  - Water solubility = 0.0038 mg/L → very low
  - Pellet washoff potential → very high, due to steep terrain in the islands
- Solubility in fat tissue (EU Footprint data)
  - Octanol-water partition coefficient, K_{ow}
    - K_{ow} = 316,227,766, log K_{ow} = 8.5
    - Bioaccumulation potential → very high

Properties of Brodifacoum: Persistence

- Half-life: The time required for half of the substance to degrade
- Dry pellets: Stable for years
- In soil and water (DPR data)
  - Soil half-life: 84–157 days
  - Water half-life: >30 days (dissipation dominant)
- In biological systems (US EPA data)
  - Long plasma half-life
    - Average: 24 days
    - Rat: 7 days
    - Dog: 120 days
    - Humans: 49 days



Properties of Brodifacoum: Toxicity

- LD_{50}: The dose that kills 50% of a test population
  - Lower LD_{50} → more toxic
  - Higher LD_{50} → less toxic
  - Typically acquired on a test species. Variation in sensitivity among species is common.
- LD_{50} < 1 mg/kg
- Bioaccumulation in the liver

Second Generation Rodenticides

- Brodifacoum, bromadiolone, difethialone, difenacoum
  - Anticoagulant effects
  - Very low LD_{50} (< 1 mg/kg for most species)
  - Single dose poison
  - Excretion is not rapid—bioaccumulation occurs
  - Effects are not immediate—mouse or bird may take several weeks to die, providing a dose of rodenticide to any predator that consumes the animal
  - High risk of secondary poisonings

Federal Restrictions for Second Generation Anticoagulant Rodenticides

- 2008: US EPA imposed restrictions on all rodenticides sold to consumers
  - No loose bait
  - Tamper-proof bait stations
  - Package size, sales/distribution/use restrictions
- The reason: High rates of both primary and secondary poisonings of children, pets and wildlife
- Reckitt-Benckiser (D-Con brand) refused to comply
- EPA initiated cancellation proceedings against Reckitt in 2013

California Restrictions for Second Generation Anticoagulant Rodenticides

- 2013 (proposed): CA Dept. of Pesticide Regulation
  - All SGARs to be designated as CA Restricted Materials
  - Limits possession and use to licensed pesticide applicators only
  - Package size, sales/distribution/use restrictions
- The reason: High rates of both primary and secondary poisonings of children, pets and wildlife. US EPA restrictions did not go far enough.

First Generation Rodenticides

- Chlorophacinone, diphacinone, warfarin
  - Anticoagulant effects
  - LD_{50} (20–200 mg/kg)
  - Multiple-dose poison, sequential feedings provide a fast kill
  - Excretion (if dose not sufficient to cause death) occurs within 48 hours
  - Effects are immediate if dose is sufficient—mouse dies quickly
  - Secondary poisonings do occur, but less common than with second generation rodenticides because they do not bioaccumulate

Diphacinone Physical Properties

- Water solubility: 0.3 mg/L
- Average aerobic half-life: 5 days
- Excretion: 80% in rats in ~8 days
- Plasma half-life in dogs: 6 days
- Bioaccumulation potential much lower than brodifacoum

Exposure Potential

- Primary exposure: Eating the bait directly
  - Western gulls and other omnivorous birds
  - Fish
  - Marine mammals
- Secondary exposure: Predation on animals or insects that have consumed the bait
  - Western gulls
  - Burrowing owls
  - Other raptors
  - Marine mammals

Concerns About RDEIS

- Increased burrowing owl predation of ASSP not considered. No mice → ASSP a likely food source
- Translocation of owls "too labor-intensive" for preventing ASSP predation problem and permits under the MBTA "would not be possible," but used as a mitigation for protecting the owl and other birds from rodenticide poisoning.

Concerns About RDEIS

- Bait stations ruled out as too labor intensive, but carcass removal (same process) is an integral part of the mitigations.
- Sub-lethal effects on Western Gull not examined

Concerns About RDEIS

- Hazing effectiveness overrated
  - 75% efficacy as "worst-case", but a prior study* (not cited) shows that hazing success drops off rapidly over time:
    - T = 0 minutes, 95% success
    - T = 15 minutes, 73%
    - T = 20 minutes, 53%
    - T = 60 minutes, 0% (hazing site equivalent to control site)
- Inidicates that predicted losses of Western Gulls (no more than 1,700) are substantially lower than what will actually occur

Jonas *et al.*, 2008. An Evaluation of the Non-Lethal Hazing of Gulls (Larus spp.) at Lower Columbia River Dams, 2005.

Concerns About RDEIS

- Estimate of number of mice remaining above-ground after death at 13% of killed is an underestimate.
  - Prior IC study* demonstrated that 40% of radio-collared rats died above-ground
  - Result is an underestimate of gull deaths

*Buckelwe *et al.*, 2008. Progress in restoration of the Aleutian Islands: Trial rat eradication, Bay of Islands, Adak, Alaska, 2006. Report to the USFWS by Island Conservation, Santa Cruz, CA.

Concerns About RDEIS

- Brodifacoum risks *underestimated*
- High sensitivity of gulls to brodifacoum
- Modeled population effects on gulls dependent on LD_{50} value used
  - Southern black-backed gull, LD_{50} <0.75 mg/kg
  - Mallard duck, LD_{50} = 4.6 mg/kg
  - LD_{50} used for Rat Island assessment = 0.26 mg/kg
  - LD_{50} used for Farallones assessment = 0.59 mg/kg
- Probit approach used to obtain Farallones LD_{50} is unreliable, according to Mineau *et al* (1994, 2001) and Giddings *et al.* (2004)

References

- Mineau, P. et al. 2001 Pesticide Acute Toxicity Reference Values for Birds. Rev Env Contam Toxicol 170: 13-74.
- Mineau, P. et al. 1994 A critique of the avian 5-day dietary test (LC-50) as the basis of avian risk assessment. Tech Rep No. 215. Canadian Wildlife Service Headquarters, Hull, Quebec. http://publications.gc.ca/site/eng/46636/publication.html
- Giddings, J. 2004 A Probabilistic Assessment of the Risk of Brodifacoum to Non-target Predators and Scavengers. Unpublished document submitted to Bell Laboratories, Liphatech, Reckitt Benckiser and Syngenta Crop Protection. www.epa.gov/oalj/filings/Reckitt_HrgReq_Ex18.pdf

Concerns About RDEIS

- Diphacinone risks *overestimated*
- LD_{50} value used was the most sensitive one
  - American Kestrel, LD_{50} 97 mg/kg
  - Non-raptors, LD_{50} = 2,000–3,150 mg/kg
- Predicted availability of dead mice above-ground was 100% in this case
- Same dose rateof diphacinone used for second and third applications, while subsequent dosing rates for brodifacoum are halved, skewing the results

Possible Outcomes Not Considered

- Burrowing owls running out of mice to eat could start eating Ashy Storm Petrels, driving the population down further
- Food web around the islands becomes contaminated for the better part of a year or more.
- Hazing efforts disturb other nesting birds, leading to nesting failures
- The final number of dead Western Gulls is significantly higher than predicted

Potential Off-Island Effects

- Poisoned birds die a gruesome death in very public places, e.g. Fishermans Wharf
- Raptors from the mainland (e.g., raptors migrating through the area (GGNRA) in the winter months) die from consuming poisoned gulls/mice

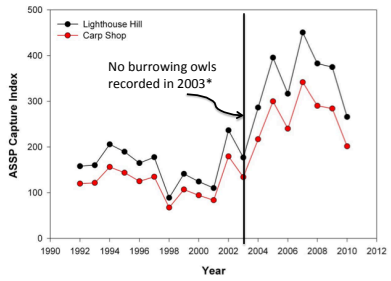
Is it necessary?

US FWS Declines to List ASSP

- October 21, 2013: US FWS concluded that the ASSP does not warrant protection under the Endangered Species Act.

. . . the population trend data for ASSP indicates that the species is currently undergoing natural population fluctuations and that the species is not in a long-term decline.

Trend in ASSP population over time



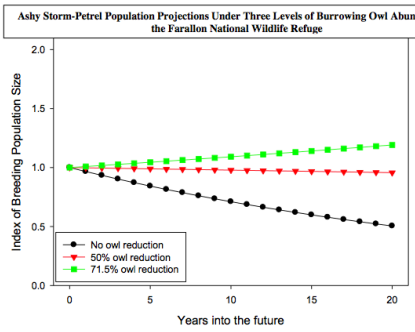
Data source:
PRBO Technical Brief, 2/23/2011

*Richardson *et al.* 2003. Migratory Birds on Southeast Farallon Island, *Western Birds, Vol. 34, No.* 2.

Burrowing Owl Population

- Number of burrowing owls visiting the islands each year ranges from 2 to 11, on average about 6

RDEIS Projections



Error bars?

Is this the best approach to protect the ASSP?

- Alternatives with less collateral damage
  - Remove or reduce mouse's food supply
  - Remove burrowing owls
  - Use traps in accessible areas
  - Use bait stations in accessible areas
  - Use diphacinone instead of brodifacoum to reduce primary and secondary poisonings
  - Use the funding to find a solution with less collateral damage

Weighing One Species Against Others

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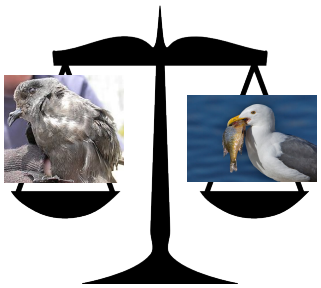

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