PROPOSED RODENT ERADICATION
LORD HOWE ISLAND

HUMAN HEALTH RISK ASSESSMENT
PRESENTATION OUTLINE

- Who prepared the Human Health Risk Assessment (HHRA)?
- November 2016 site visit
- HHRA process and results
- Addressing the community’s health-related concerns
- Questions and discussion
WHO PREPARED AND PEER-REVIEWED THE HHRA?

• Ramboll Environ prepared the HHRA
• Independent oversight of an Expert Panel by the Office of the Chief Scientist & Engineer (OCSE):
  • Professor Mary O’Kane (OCSE)
  • Dr Chris Armstrong (OCSE)
  • Professor Brian Priestly (Monash University)
  • Professor Steven Leeder (Sydney University)
WHO IS RAMBOLL ENVIRON?

- Global company with local offices in NSW and Perth
- 2100 employees, in 130 offices in 28 countries

Dr Robert DeMott (USA)
Dr Joseph Rodricks (USA)
Dr Belinda Goldsworthy (NSW)
Dr Thomas Sendor (Germany)
Dr Nwakamma Ahubelem (NSW)
NOVEMBER 2016 VISIT TO LORD HOWE ISLAND

- Attended by representatives from Ramboll Environ and Office of Chief Scientist & Engineer
- Information gathering exercise
- Observations were made across the island
- Discussions held with:
  - The community
  - LHI Board members
  - Medical staff
  - Local produce farmers
- Occurred prior to conducting the HHRA
Two consultation sessions were held to listen to the community.

This information was used to frame the HHRA approach to address specific factors of interest to the community.

What are the community’s health-related concerns about the Rodent Eradication Program (REP)?

How could the community and island visitors be exposed to brodifacoum from the REP?
HOW DID WE ASSESS HEALTH RISK?

- Adopted Australian and globally accepted methods for health risk assessment
- Environmental Health Standing Committee (enHealth)
- 69 references including articles from peer-reviewed journals and governmental papers
HOW DID WE ASSESS HEALTH RISK?

Key Concept = For exposure to occur all three elements must exist
If one element is removed, the ‘linkage’ is broken and there is no exposure or corresponding risk
We will now visit each of these three elements that were considered in the HHRA
HUMAN RECEPTORS CONSIDERED IN HHRA

- Island residents
- Island visitors
- Most sensitive/highly exposed individual
- Individuals taking warfarin medicinally
- Elderly and individuals with impaired health

Four receptor groups considered
- Toddlers
- School child
- Young adult woman, potentially pregnant
- Adult (men and women, all ages)
HUMAN GROUPS CONSIDERED IN HHRA - CHILDREN

- Toddler
  - Can elude parental supervision, may pick up and ingest a Pestoff 20R pellet
  - More mobile than a younger child
  - Hand-to-mouth behaviour with soil and sediment
  - Ingest rainwater as drinking water

- School child
  - Bare feet at school and during playtime
  - Play along foreshore lagoon during school
  - Freedom to enter all areas of the island
  - Hand-to-mouth behaviour
HUMAN GROUPS CONSIDERED IN HHRA - ADULTS

- Young adult woman
  - Potentially pregnant
  - Specifically chosen to assess reproductive and developmental effects
  - Spend majority of time outside undertaking activities resulting in exposure to soil and hiking in forested areas

- Adult (men and women, all ages)
  - Considered activities resulting in maximum exposure to brodifacoum during REP
  - Working day outdoors e.g. island/mountain tours
EXPOSURE PATHWAYS TO BRODIFACOUM INCLUDED IN HHRA

- Direct ingestion and dermal contact with Pestoff 20R pellets
- Incidental ingestion and contact with soil beneath/adjacent to degraded pellet
- Inhalation of dust during aerial and hand broadcasting
- Ingestion of tank water/groundwater as drinking water
- Incidental ingestion and contact with surface water and sediment in creeks
- Ingestion of locally caught seafood
- Ingestion of locally grown fruit and vegetables
EXPOSURE PATHWAYS NOT COMPLETE FOR HHRA; WHY?

- Exposure via ingestion of meat, dairy and poultry sourced from LHI, not a complete pathway.
- Cattle and poultry used for human consumption will be removed before the REP.
- A small dairy herd will be confined during and immediately following the REP, provided with supplementary feed.
- Replacement cattle and poultry introduced after breakdown of pellets is complete.
THE ‘SOURCE’

- Brodifacoum (20 mg/kg) in the Pestoff 20R pellet

**What do we know about brodifacoum?**

- Anticoagulant properties
- Low water solubility
- Binds strongly to soil/sediment
- Low uptake into plants
- Essentially immobile in soil
- Can bioaccumulate in animals, primarily in the liver
- Low absorption via the skin
- Currently used on the island to manage rodent populations (background exposure)
To estimate exposure via the identified pathways, the HHRA estimated brodifacoum concentrations in:

- Soil, directly beneath or adjacent to a degraded pellet
- Groundwater, assuming a pellet dissolves and migrates through soil
- Tank water, assuming pellets landed on a roof surface used to collect drinking water
- Creek surface water and sediments, assuming pellets landed in the creek
- Locally caught seafood, following aerial broadcasting of pellets
- Airborne dust during aerial broadcast
- Locally grown fruit and vegetables
HOW DID WE ASSESS HEALTH RISK? (RE-CAP)

Human Receptor ↔ Exposure Pathway ↔ Source
HOW DID WE ASSESS HEALTH RISK? (RE-CAP)

- Toddler
- School child
- Young woman (potentially pregnant)
- Adult

Diagram:
- Human Receptor
- Exposure Pathway
- Source

Ramboll Environ
HOW DID WE ASSESS HEALTH RISK? (RE-CAP)

- **Human Receptor**
- **Exposure Pathway**
- **Source**

**Exposure to soil**
- Picking up & eating a pellet
- Exposure to soil

**Drinking tank water & groundwater**

**Eating seafood**

**Inhalation of dust during broadcasting**

**Exposure to creek water and sediment**

**Eating fruit & vegetables**
HOW DID WE ASSESS HEALTH RISK? (RE-CAP)

Brodifacoum in the Pestoff 20R pellet

Brodifacoum in:
- Soil
- Sediment
- Surface water
- Tank and groundwater
- Seafood
- Fruit and vegetables
- Outdoor air

Human Receptor → Exposure Pathway → Source
HOW DID WE ASSESS HEALTH RISK?

Calculate the amount of brodifacoum taken in via each pathway

...from all exposure pathways

...for each ‘human group’

This is known as the ‘daily dose’ of brodifacoum
HOW DID WE CALCULATE THE DAILY DOSE?

- Amount of soil/sediment adhering to skin (mg/cm²)
- Skin surface area (cm²)
- Ingestion rate (mg/day or L/day)
- Time spent indoors/outdoors (hours)
- % of skin surface exposed
- Body weight (kg)
- Exposure frequency (days/year)
- Exposure duration (years)

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(Visual representation of relationships between factors)

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(Ramboll Environ logo)
HOW DID WE CALCULATE THE DAILY DOSE?

FOR EXAMPLE, SOIL INGESTION...

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Toddler</th>
<th>Child</th>
<th>Young Woman</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure frequency (days/year)</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>Soil ingestion (mg/day)</td>
<td>100</td>
<td>100</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Brodifacoum concentration in soil (mg/kg)</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Percent of soil containing brodifacoum</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>15</td>
<td>36.5</td>
<td>66.6</td>
<td>78</td>
</tr>
</tbody>
</table>

Assumed that:

• the resident/visitor ingested soil directly beneath/adjacent to a degrading pellet every day
• brodifacoum concentration remained the same every day
HOW DID WE CALCULATE THE DAILY DOSE?

Over a period of 180 days, the HHRA assumed:

- Ingestion of soil beneath/adjacent to a degrading pellet every day
- Concentration in soil remains the same for 180 days
- Ingest water from a tank every day
- Have contact with soil beneath/adjacent to a degrading pellet every day with hands and bare feet (and the concentration remains the same)
- Inhale dust outdoors for 15 days
- Ingest locally caught seafood and locally grown vegetables/fruit every day
- Swim in creek 20 days/year and ingest some of this water
- Play on creek bank 20 days/year and ingest/have contact with sediment
ESTIMATION OF BRODIFACOUM EXPOSURE – REPEATED DAILY EXPOSURE

• Compared the ‘daily dose’ linked to the REP against published levels of brodifacoum exposure expected to be safe for people

• Most protective criterion was adopted – from European agency that considered developmental/reproductive effects demonstrated for warfarin could “read across” to brodifacoum

ESTIMATED DOSE OF BRODIFACOUM FROM REP (VIA ALL PATHWAYS) VS DOSE OF BRODIFACOUM NOT PRODUCING ADVERSE HEALTH IMPACTS (SPECIFICALLY INCLUDING REPRODUCTIVE & DEVELOPMENTAL EFFECTS)
HHRA RESULTS – REPEATED EXPOSURES – OVERALL CONCLUSION

• Overall conclusion: estimates of exposure from all potential sources associated with the REP are below criterion established to protective for the most sensitive potential endpoint – reproductive or developmental effects.

• HHRA results provided information to the REP organisers such as:
  • Importance of removing pellets and dead rodents that land on roof surfaces (if pellets land on the roof)
  • ‘Target’ concentrations of brodifacoum in the environment, tank water and seafood for the monitoring program
  • Communication with parents regarding child exploratory behaviour during REP
HHRA RESULTS – ACUTE SCENARIO – CHILD INGESTION OF PELLETS

• To reach a dose resulting in reported adverse health effects (anticoagulation effects):

  Toddler
  >5 large pellets
  >19 small pellets

  School Child
  >13 large pellets
  >45 small pellets

• Assumes the pellets are consumed anytime within a day
• Consumption over multiple days unlikely due to food dye alerting adults to the incident
THANK YOU

DISCUSSION AND QUESTIONS