

# CEBRAnar: Proportional value of interventions across pathways and layers of the biosecurity system.

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# Where We Are Headed.

Introduction

Pre-Border and Border

Post-Border

Mechanics

Results

# The Remit.

Determine the proportional impact of interventions against Gypsy Moth.

Assess counterfactuals

- What if there were no Surveillance? and
- What if there were no Readiness?

KISFFS!

# The Big Picture

## Establishment



## Costs



\$ (eradication | size, readiness)  
Expert elicitation and GERDA

Pr(eradication | size, readiness)  
Expert elicitation and GERDA

Cost of Endemism  
Expert elicitation or literature or CRS

Pr(cost of establishment | detection)

\$ (measures)

Propagule Pressure

Attenuation  
Expert elicitation

Establishment Rate

Pr(cost)

# Gypsy Moth: Expert Elicitation Exercise: The Simple. 18 Questions.

## Pre-Border / Border (12)

- ▶ Six approach rates (low/high risk on three pathways);
- ▶ Three intervention impacts;
- ▶ Three attenuation rates (incursion  $\rightarrow$  establishment);

## Post-Border (6)

- ▶ Two expected incursion size at detection (surveillance / no surveillance);
- ▶ Two cost of eradication at given size (ready / not ready); and
- ▶ Two success probability of eradication at given size (ready / not ready).

# SEJ: wisdom of crowds or last-chance saloon?

Ask smart folks. But . . .

## Avoid personal cognitive frailties

- ▶ Anchoring
- ▶ Framing
- ▶ Availability
- ▶ Overconfidence

## And avoid group cognitive frailties

- ▶ Group think
- ▶ Dominance
- ▶ Halo effect

# IDEA protocol

**Investigate** use all resources except each other!

**Discuss** surface assumptions, identify points of difference.

**Estimate** privately! No-one needs to know!

**Aggregate** we do that with computers.

## Example SEJ question.

“Imagine 1000 random high-risk ships from all countries. How many of those 1000 random high-risk ships will carry a minimum viable unit of GM?”

Be pessimistic — think of all the reasons that this number might be high.

Be optimistic — think of all the reasons that this number might be high.

Record your higher limit, lower limit, and best guess.

The estimates then inform the simulation study.

# Pre-Border and Border Model

The Pre-border and Border sub-model comprises the following components:

- ▶ Raw exposure — the rate per 1000 at which units that are arriving on six pathways are contaminated with gypsy moth;
  - ▶ High / Low risk variants of containers, ships, and vehicles & machinery
- ▶ Interventions — three key activities that are performed or mandated by MPI to reduce the exposure and therefore the likelihood of incursion;
  - ▶ Inspection, offshore certification & inspection, heat treatment
- ▶ Attenuation from incursion to establishment — propagules that arrive past the border may still fail to establish.
  - ▶ All from ports

## Pathway-level exposure before and after intervention

**Table:** Pathway-level exposure. *Approach* and *Impact* are percentages of pathway units that are contaminated and effect of interventions upon contaminated units, respectively.

Path	Volume	Approach	Intervention	Impact
Low-risk Containers	770900	?		
High-risk Containers	100	?	Inspection	?
Low-risk Ships	1918	?		
High-risk Ships	658	?	Offshore Cert & Insp.	?
Low-risk V'cles & Mach.	104009	?		
High-risk V'cles & Mach.	189323	?	Heat Treatment	?

## Pathway-level exposure before and after intervention

**Table:** Pathway-level exposure. *Approach* and *Impact* are percentages of pathway units that are contaminated and effect of interventions upon contaminated units, respectively.

Path	Volume	Approach	Intervention	Impact
Low-risk Containers	770900	0.26	Inspection	0
High-risk Containers	100	31.00		73
Low-risk Ships	1918	0.16	Offshore Cert & Insp.	0
High-risk Ships	658	18.56		35
Low-risk V'cles & Mach.	104009	0.46	Heat Treatment	0
High-risk V'cles & Mach.	189323	23.80		94

## Pathway-level post-border annual establishment rates, post shenanigans

**Table:** Pathway-level post-border annual establishment rates, corrected. *Establishment* is the percentage of establishments per incursion. *Established* is the expected number of establishments per year.

Path	Intervention	Residual	Establishment	Established
Low-risk Containers	Inspection	5.0109	0.112	5.6e-03
High-risk Containers		0.0207	0.112	2.3e-05
Low-risk Ships	Offshore Cert & Insp.	0.0077	0.037	2.8e-06
High-risk Ships		0.1997	0.037	7.4e-05
Low-risk V'cles & Mach.	Heat Treatment	1.1961	0.132	1.6e-03
High-risk V'cles & Mach.		6.9841	0.132	9.2e-03

The expected number of established incursions per year across all three conveyances is the sum of the final column: 0.0165.

# Post-Border Model

The Post-border sub-model focuses on the effect of post-border activities upon the consequences of incursion. It comprises the following components:

- ▶ Detection of the established pest — this is assumed to happen sooner or later, so the unknown is the size of the population at detection. (We use the Weibull distribution.)
- ▶ Eradication of the population, the success probability and cost of which depend on the (unknown) size of the population at the time of detection.

# Incursion Impacts

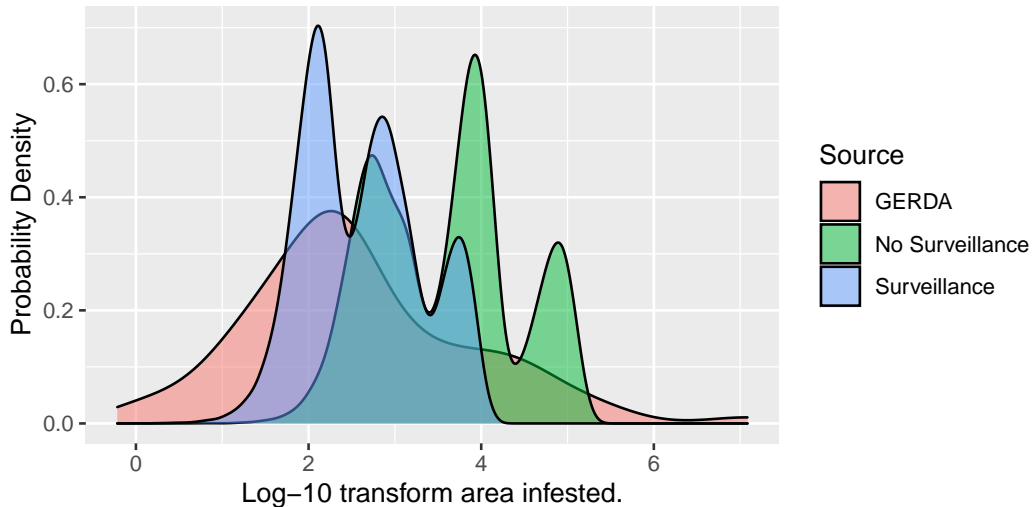
The impact of an invasion is affected by a range of factors, many of which can be anticipated in advance, for example,

- ▶ the prevalence of host material,
- ▶ likely climate suitability,
- ▶ availability and permeability of pathways,
- ▶ the value of affected resources, and
- ▶ so on.

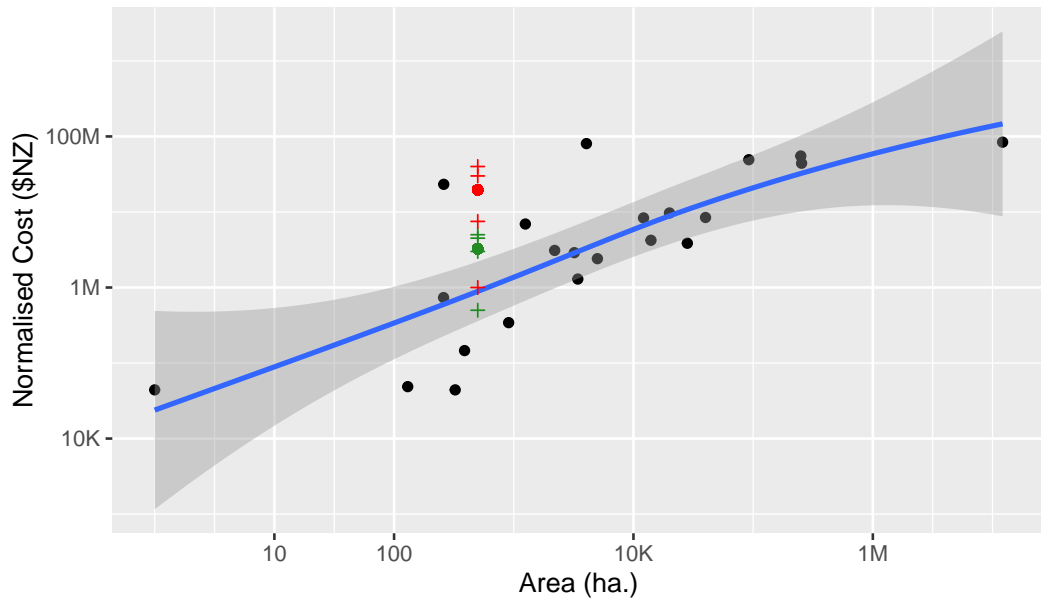
Population Extent at Detection is Pivotal.

Population Extent at Detection Cannot be Anticipated.

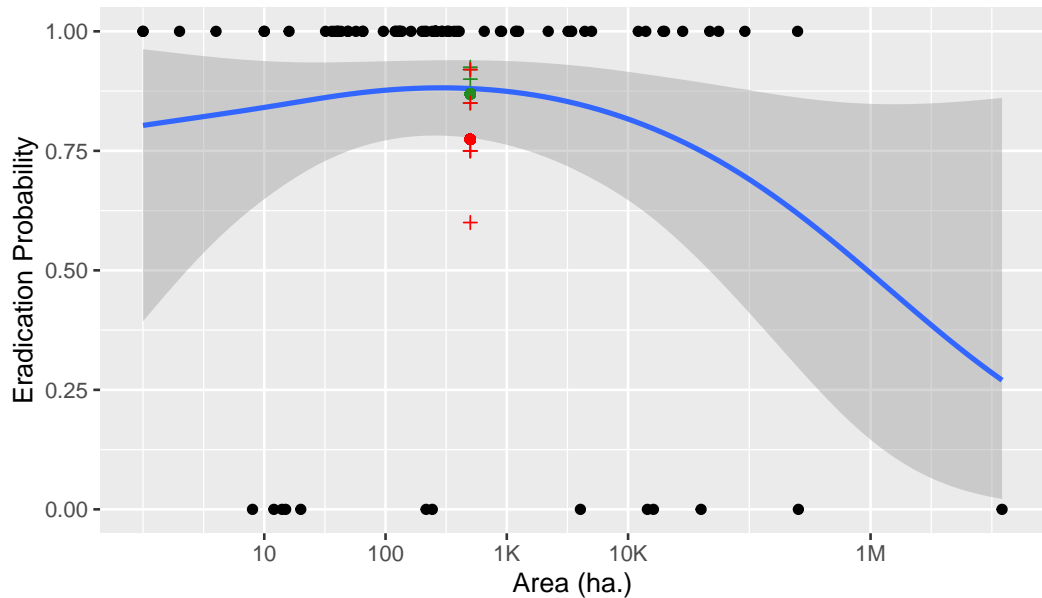
## Area Occupied by Invasive at Time of Detection



## Eradication Cost Model (Data from GERDA: \$M NZ)



# Estimated Probability of Eradication Success (GERDA) — Overruled!



# Cost of Management if Incursion Fails

We assume an annual cost of \$50 million and 5% discount rate. Then the overall impact of an *un-eradicated* incursion would be \$1000 million.

# Sources Of Uncertainty

1. Expert elicited estimates;
2. GERDA modeled estimates of eradication cost;
3. GERDA modeled estimates success probability (set to 1 under current readiness);
4. The discount rate;
5. The size of the incursion at the time of detection;
6. Economic impacts of failure to eradicate; and
7. The extraordinary corrections.

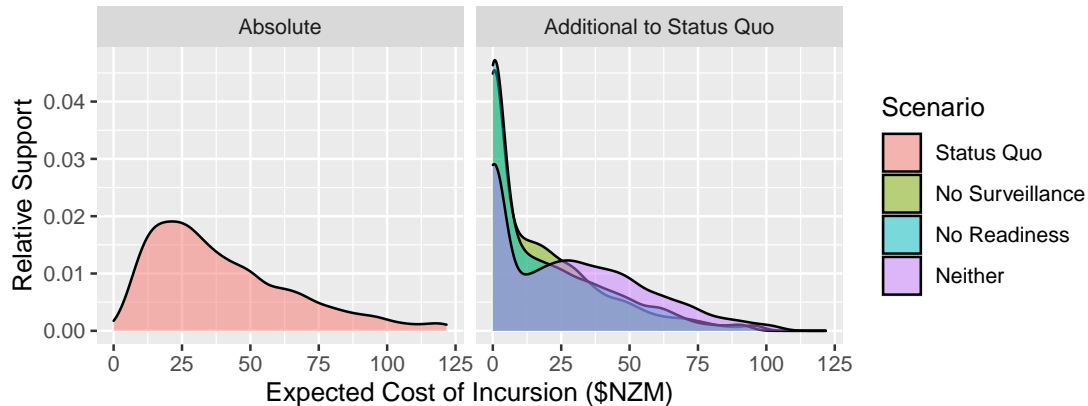
Approach: scaled triangular distributions.

# Results

**Table:** Total elicited and estimated cost of incursion in \$NZ (millions).

	With Surveillance	No Surveillance
With Readiness	40.11	58.07
No Readiness	58.47	68.05

# Counterfactuals

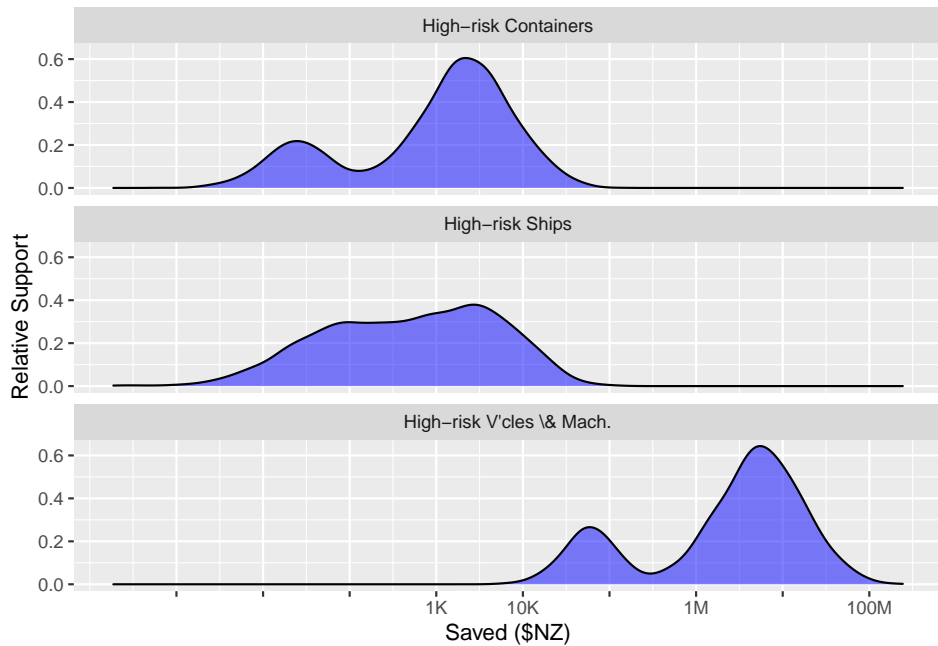


**Table:** Pathway-level intervention outcomes, with shenanigans. *Approach* and *Impact* are percentages of pathway units that are contaminated and effect of interventions upon contaminated units, respectively. *Volume* and *Border* are numbers of arrival and incursions per year.

Pathway	Volume	Approach	Impact	Reduction	Established	Saved	MNZD
HR Containers	100	0.073	69.3	0.05	0.0000	0.00	0.00
HR Ships	658	0.053	31.7	0.11	0.0000	0.00	0.00
HR V'cles & Mach.	189323	0.062	89.9	104.69	0.0026	0.26	8.12
LR Containers	770900	0.002	0.0	0.00	0.0022	0.00	0.00
LR Ships	1918	0.001	0.0	0.00	0.0000	0.00	0.00
LR V'cles & Mach.	104009	0.003	0.0	0.00	0.0005	0.00	0.00

NB: standard deviation is similar order of magnitude.

# Impact of Interventions



# Lessons Learned

- ▶ The current balance seems about right.
  - ▶ Expert elicitation takes a half-day face to face after appropriate preparation.
- ▶ If border data and establishment data exist, then find a pro-active way to use them.
  - ▶ How best to do that is an open question.
- ▶ If quantities have a natural rank then elicit in a way to preserve the rank (e.g., does it ever make sense for eradication to be cheaper when we are *not* ready?)
  - ▶ How best to do that is an open question.

SEJ: It's better to light a candle than curse the darkness.

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