The Economics of Optimal Fruit Fly Trapping

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“The School of BioSciences acknowledges the Wurundjeri and Bunurong/Boon Wurrung Peoples of the Kulin Nation as the Traditional Owners of the land on which our school and The University of Melbourne stand. We pay our respects to their Elders both past and present.”

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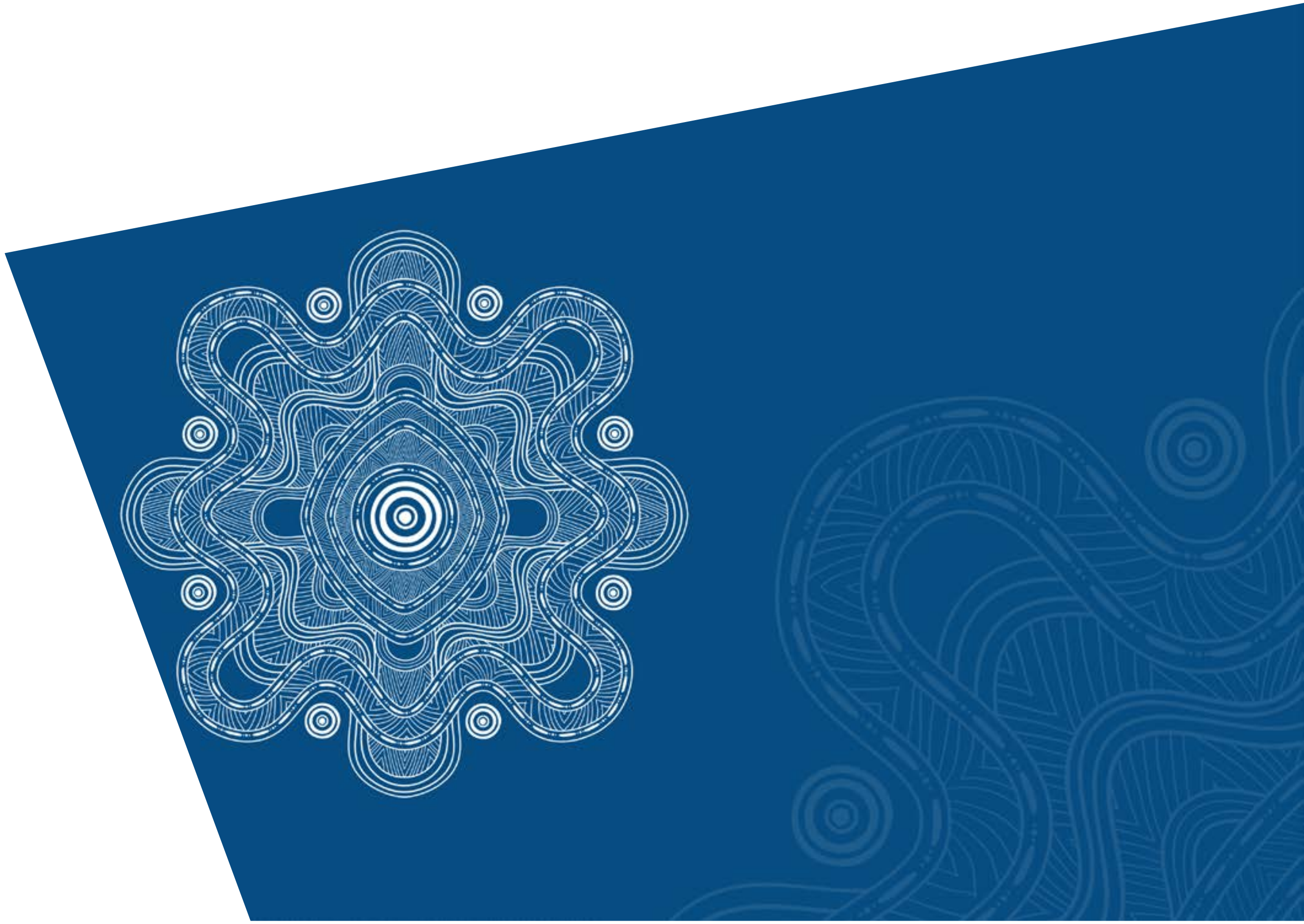
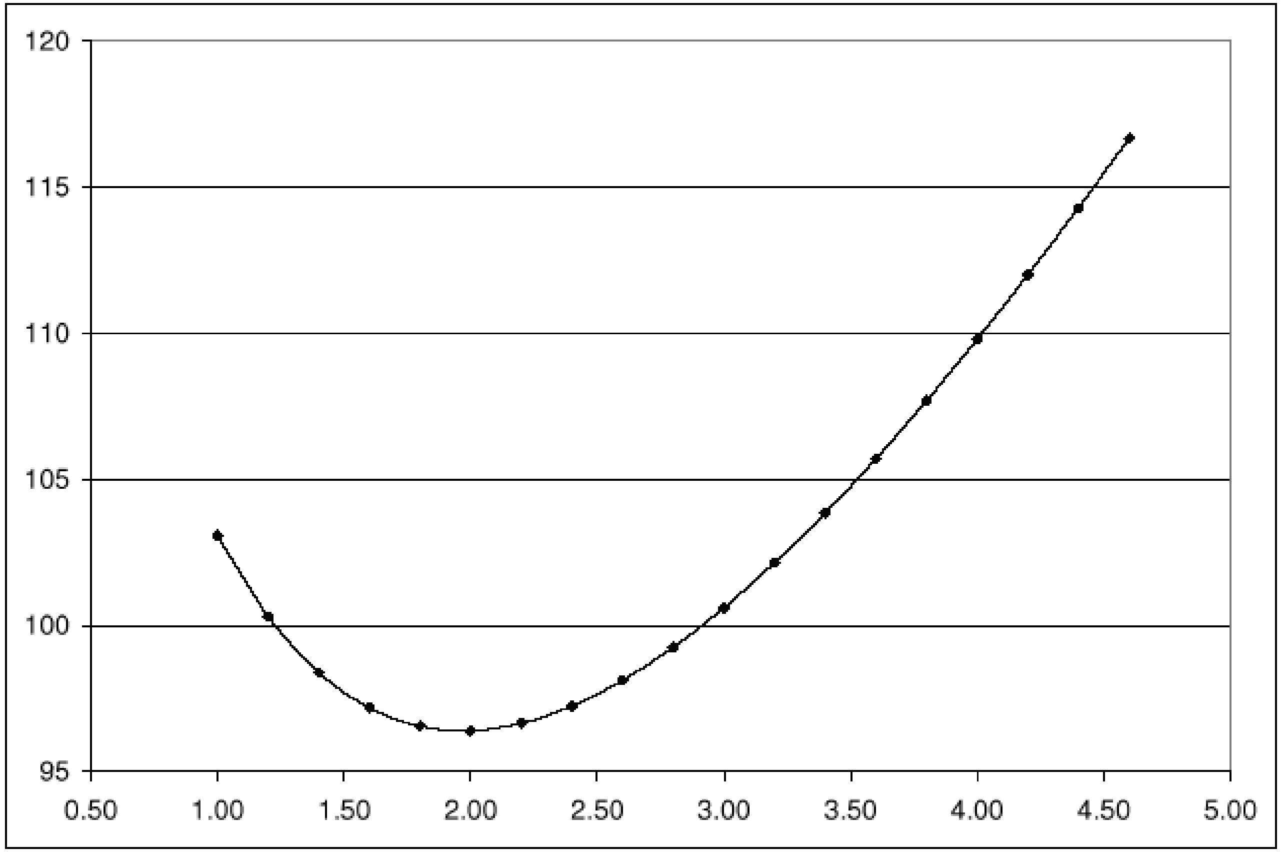


Artwork by Dixon Patten, Yorta Yorta and Gunnai Artist, Bayila Creative

Research Design: Optimal Surveillance

- *Benefit*: Surveillance ensures ‘early detection’, lowering economic and environmental losses and pest/disease management costs.
- *Tradeoff*: The more early the detection the more expensive the surveillance measure.
- *Objective*: Find optimal surveillance expenditures to minimize (how many traps and where? ...
    - Economic losses (e.g., plant and animal losses, damage to the environment, recreational losses, trade bans, etc.)
    - Eradication and management costs of any pest/disease incursion
    - Surveillance expenditures (e.g., monitoring, the cost of setting and monitoring traps, etc.)
- *Method*: Stochastic (Optimal Control) Bioeconomic Model with a Jump-Diffusion Process and Spatial Optimization.

Optimal Surveillance Grid and Expenditures



Optimal: one trap per 2,000 km^2 and $E^*(c)$ = \$3m (AUS)

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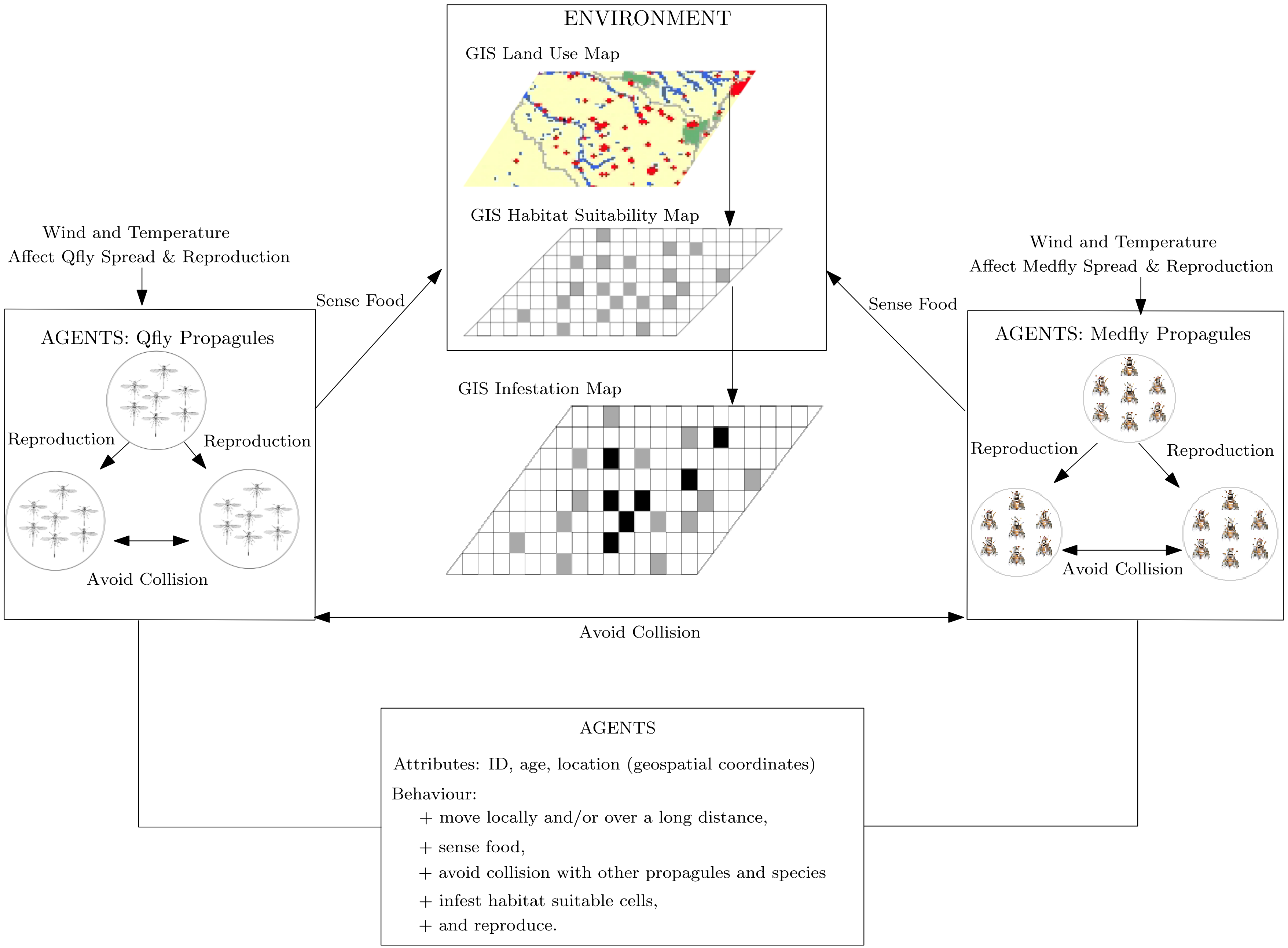

Table 1: Model parameterisation

Pameter	Description	Unit	MedFly	QFly
	Random Dispersal Model			
λ_Q, λ_M	Arrival rate by a single fruit flies[a]	per year	0.20	0.35
$\lambda_Q * \lambda_M$	Arrival rate by both fruit flies[a]	per year	0.07	0.07
A	Period when propagule can survive as flies and infest a habitable cell[b]	week	10	10
p_{jump}	Probability of a propagule to take a long jump [c]	P(X=1)	0.3	0.3
r_{jump}	Maximum distance of a long jump[d]	km/1^{st} week	9.5	40
r_{local}	Maximum distance of local travel[b,m]	km/week	1.0	1.4
γ	Time until the natural detection point ($\gamma = 1$)[h]	week	26	26
π	Average number of propagules released[e]	#/week	2.5	2
	Economic Model			
$r_{eradication}$	Radius for eradication zone[l]	km	1.5	1.5
$r_{suspension}$	Radius for suspension zone[l]	km	13.5	13.5
e	Eradication cost[f]	$/per ha	269	269
d	Damage cost (60% of production value)[h]	$	cell-specific	cell-specific
z	Suspension cost[i]	$	cell-specific	cell-specific
r	Revenue loss of the research area[h]	$/week	2905.6	2905.6
s	Surveillance cost per trap location[h]	$/year	202.9	202.9
T_{mkt}	Length of international market closure[g]	month	8.5	8.5

Figure 2: Simulated versus actual outbreaks

(a) Medfly

(b) Qfly

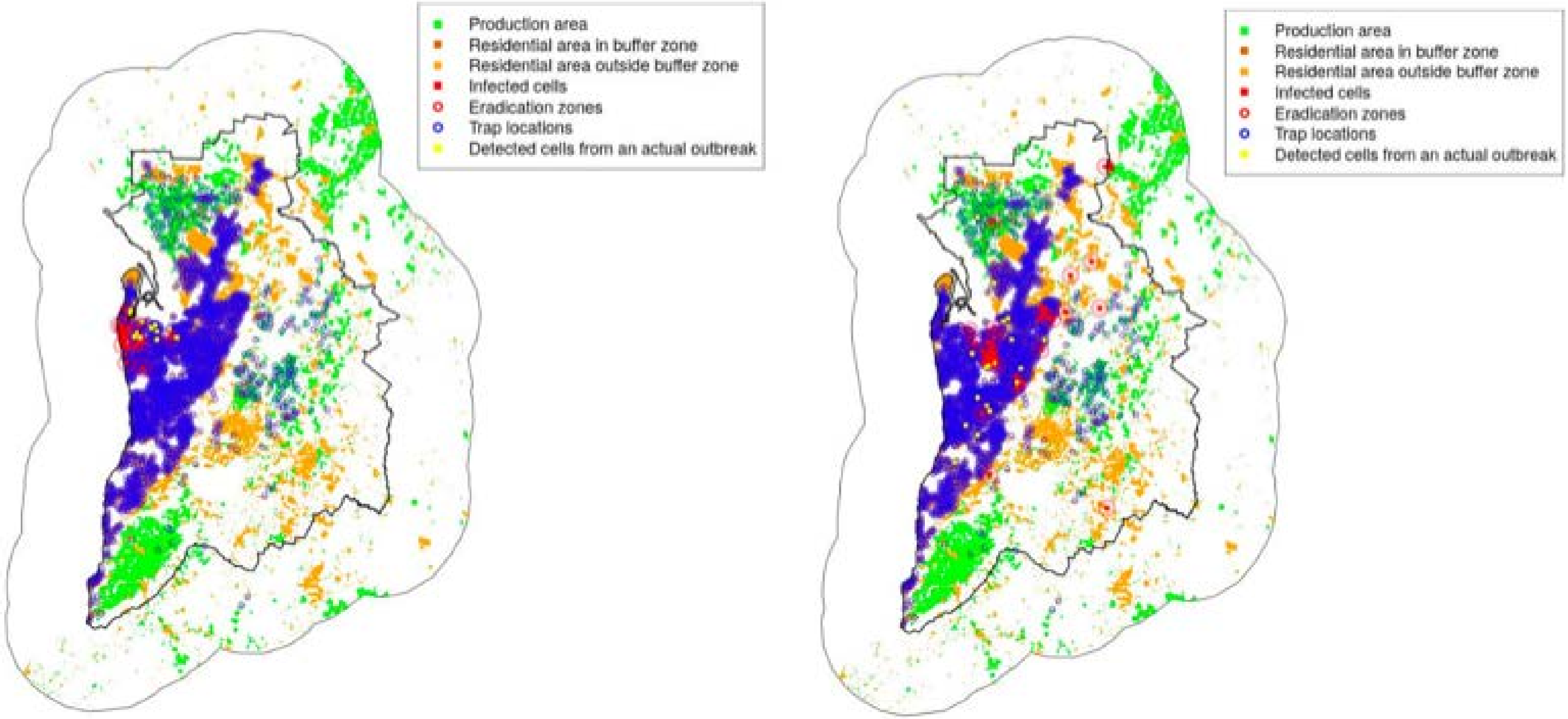

Table 3: Breakdown of the Total Expected Cost of Qfly and Medfly incursions

Grid size in residential areas (km)	Grid size in production areas (km)	Surveillance cost (Mil. $AU)	Eradication cost (Mil. $AU)	Suspension cost (Mil. $AU)	Damages (Mil. $AU)	Revenues loss (Mil. $AU)	Total expected cost (Mil. $AU)
0.1	0.1	53.0	0.052	0.997	0.032	1.62	55.7
0.4	0.5	3.57	0.402	2.78	0.294	3.34	10.4
0.4	5	2.71	0.573	3.18	0.465	3.69	10.6
5	0.5	1.30	1.38	4.23	1.061	4.83	12.8
5	5	0.263	1.70	4.43	1.344	5.26	13.0

Notes: The optimal grid size is highlighted in grey.

Thanks for listening!

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