Spatial modelling of *Miconia calvescens* invasion risk

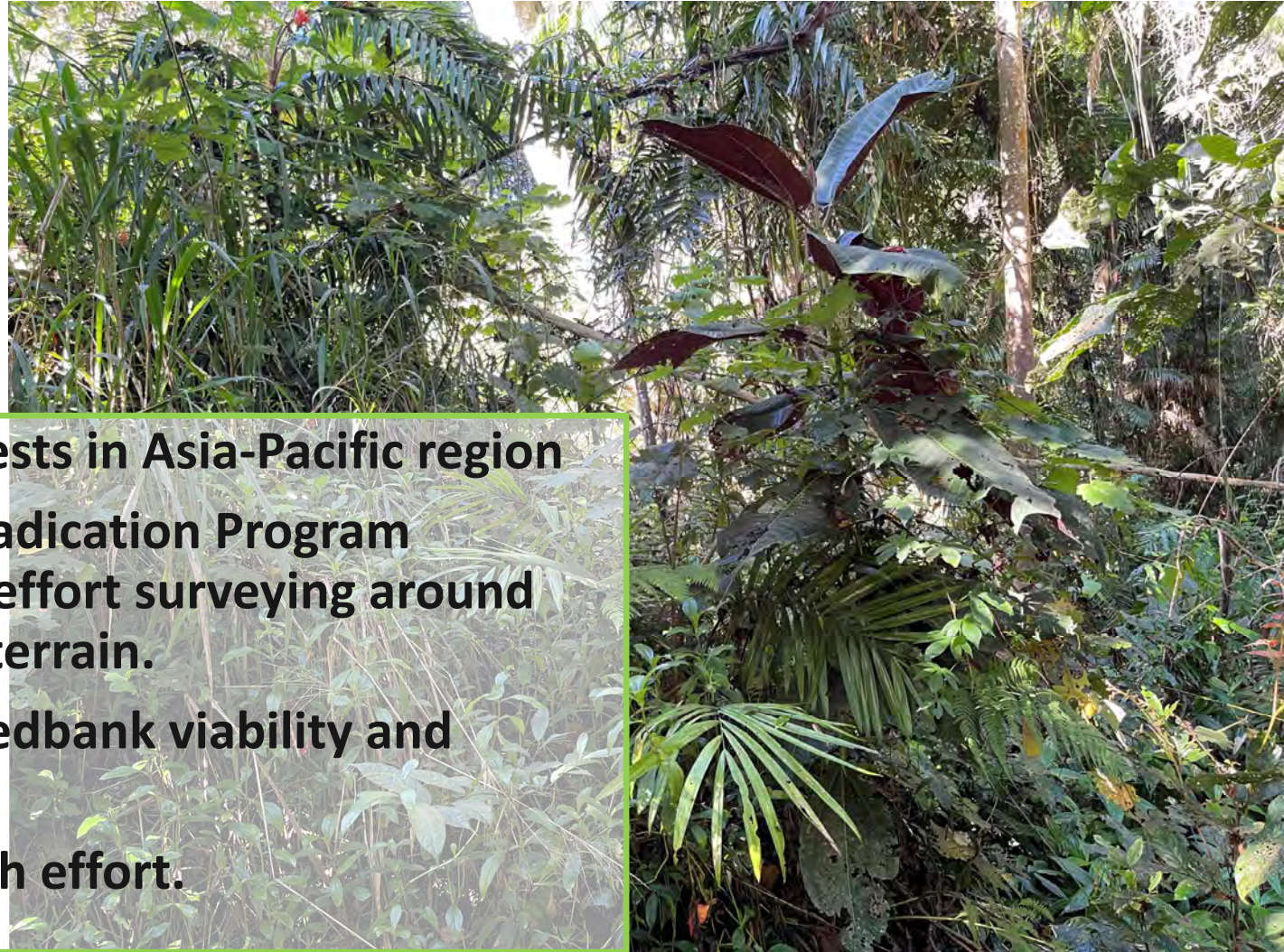Helping to refine surveillance planning in north Queensland rainforests

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Queensland Government

Miconia calvescens: the problem

Invader of tropical rainforests in Asia-Pacific region

National Tropical Weed Eradication Program (NTWEP) expends a lot of effort surveying around known loci in challenging terrain.

M. Calvescens has long seedbank viability and dispersal by birds

= significant ongoing search effort.

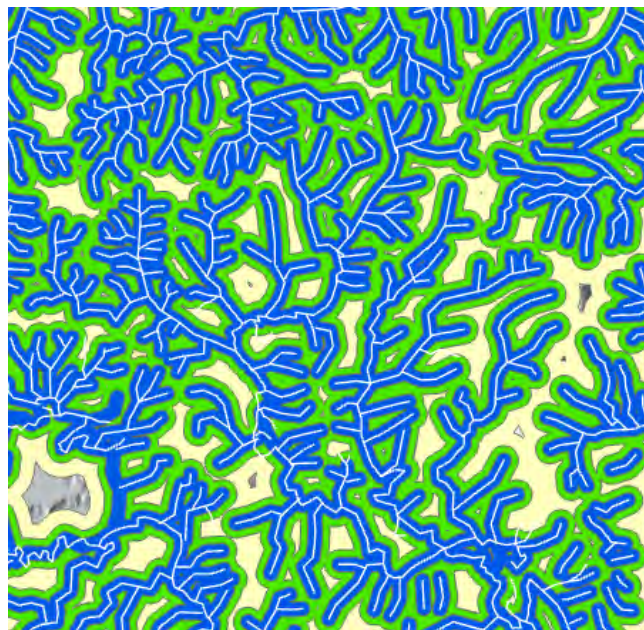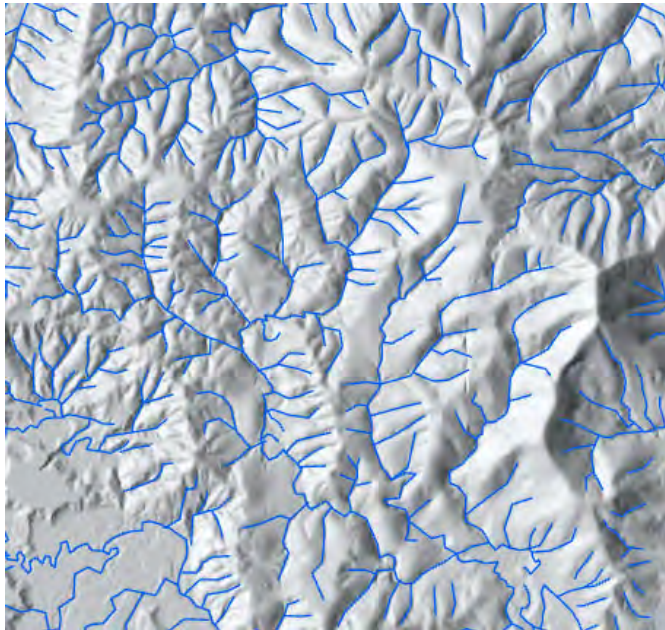# RiskMapr uses a Bayesian Network modelling approach
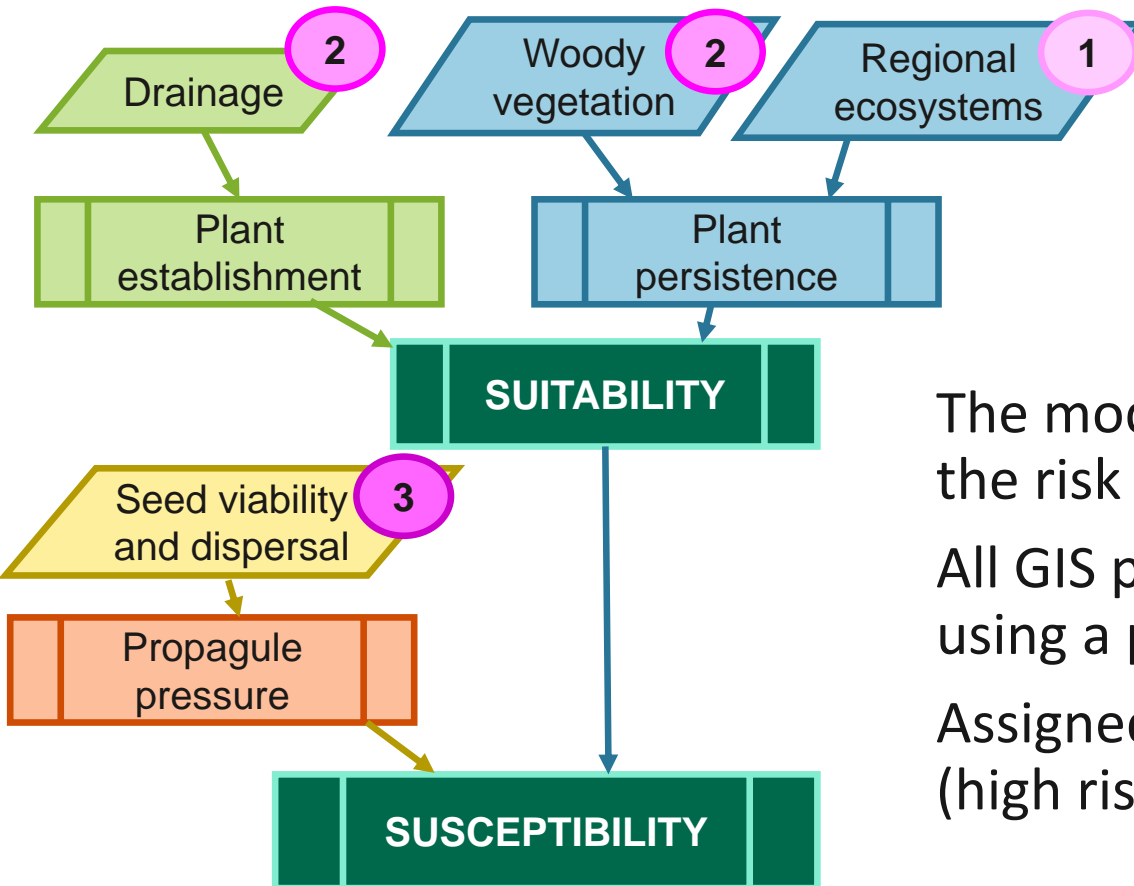
The model requires GIS proxies to represent the risk factors

All GIS proxies are rasterised to 10m pixels using a planar projection.

Assigned risk values from 0 (low risk) to 100 (high risk).
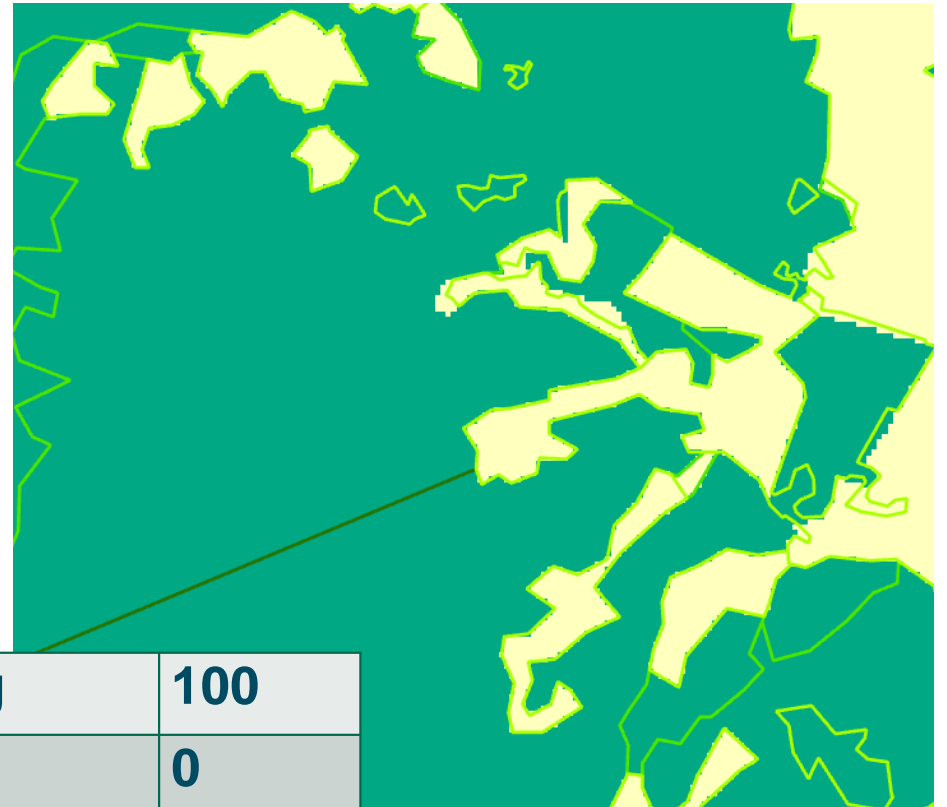
Establishment proxy: drainage (riskmapr weighting = 2)

0-30m buffer around creeklines	100
30-60 m	30
60-120 m	10
120 m +	5
Ocean + inland water bodies	0

Legend:
- 0-30 m
- 30 - 60 m
- 60 - 120 m

Persistence proxy: Woody vegetation (riskmapr weighting = 2)

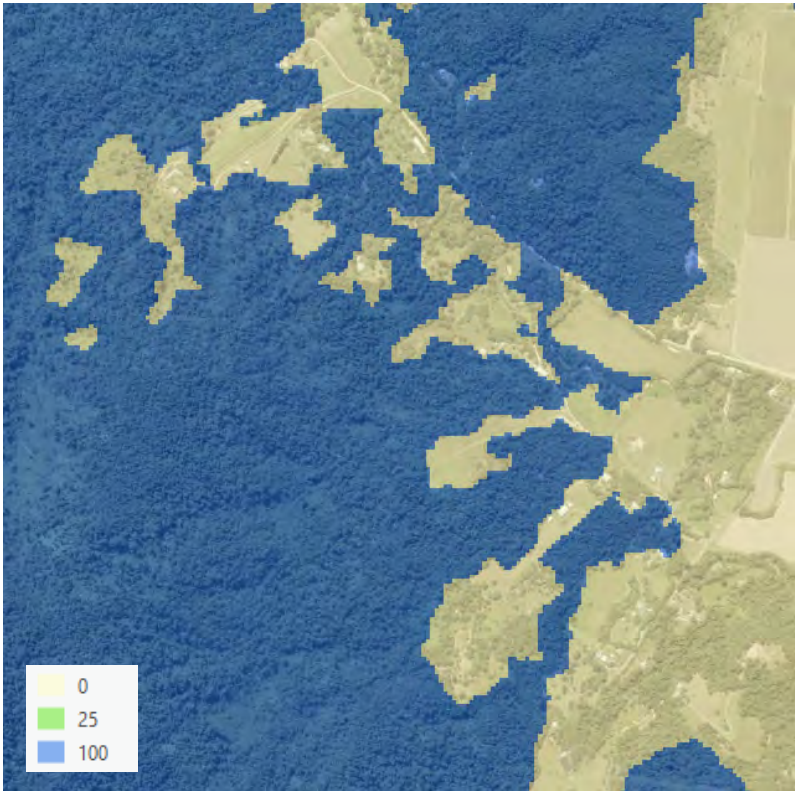| Woody veg	100
Open	0

Persistence proxy: regional ecosystems (riskmapr weighting = 1)
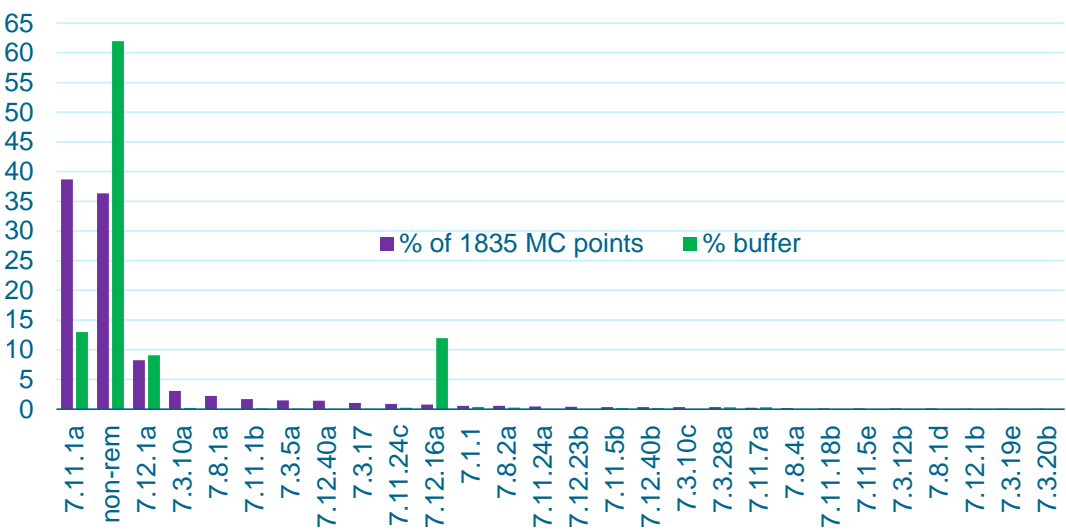
RE within 1200m buffer with Miconia	100
Other Res + non remnant	25
Any RE in 1200m buffer with no Miconia	0

Susceptibility proxy: seed viability categorisation

- We used the mature plant dataset maintained by NTWEP
- Categorised by difference between model date and discovery date
- < 6 years | 6-10 years | 10 – 16 years | > 16 years

Miconia calvescens status at the end of 2021-22

M. calvescens cummulative proportion monitoring to control relapses
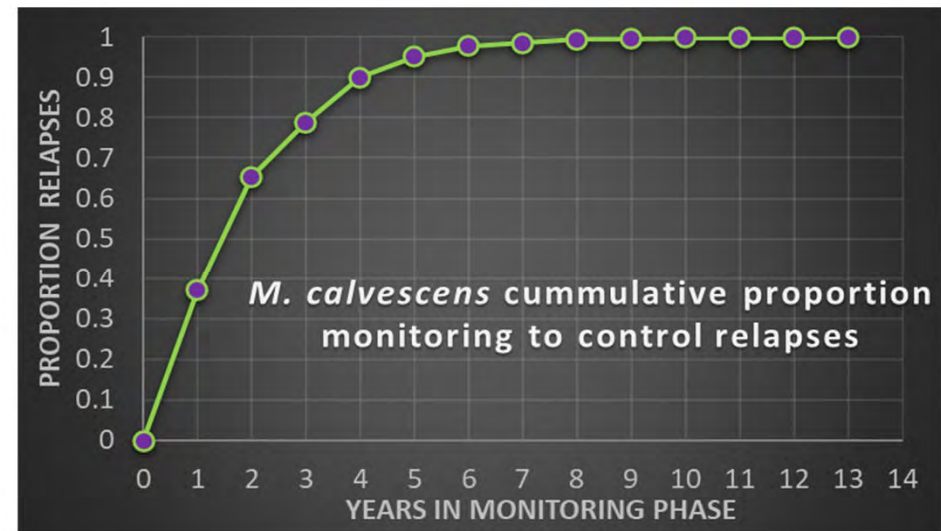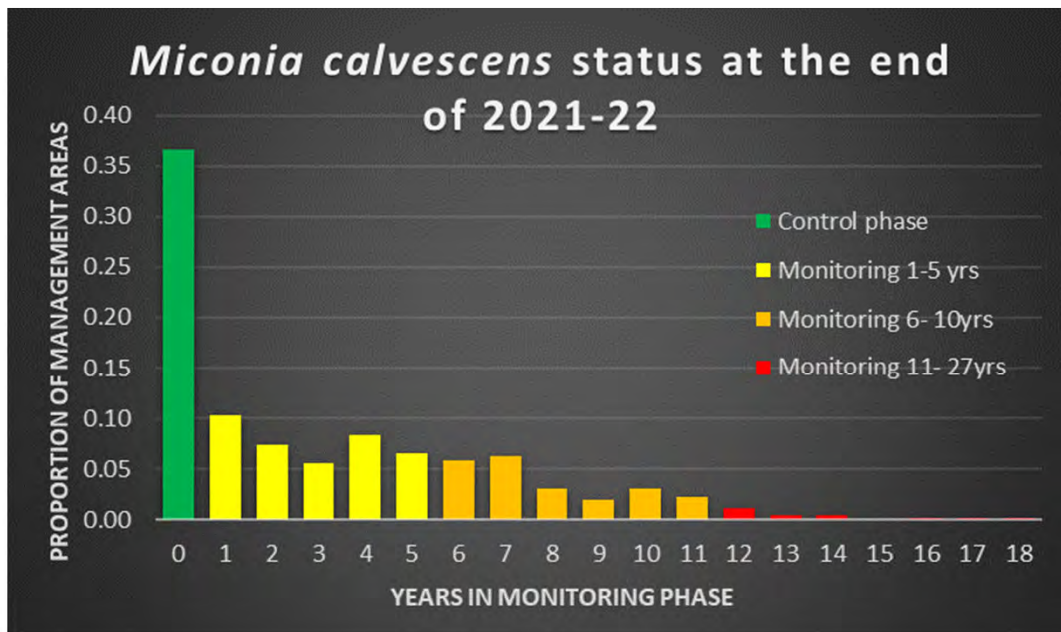
Susceptibility proxy: bird dispersal, background

- Westcott and Dennis (2006) estimated dispersal curve for small multi-seeded species including M. calvescens

- birds fly shorter distances within forested areas
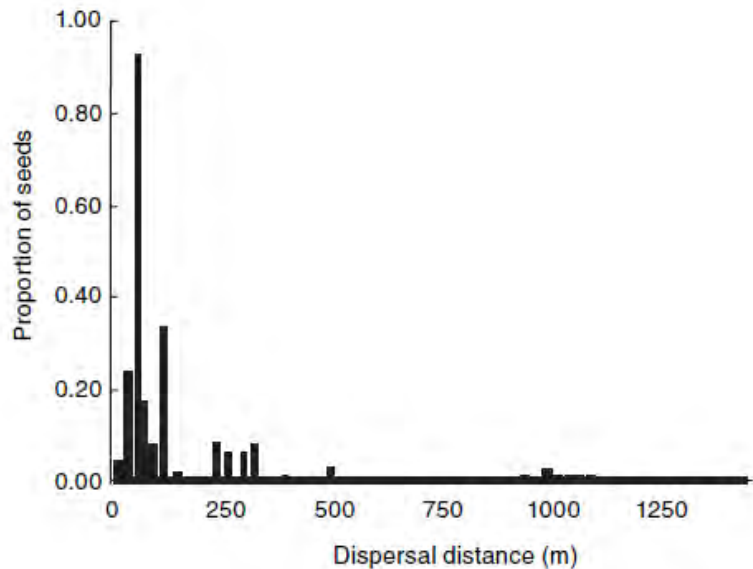- fly further over open areas til they reach a tree line
- tend to hop sideways along the edge of forest
- fly further up gullies
- high ridgelines can act as a barrier to bird movement

NTWEP and Michael Graham, BQ pers comm, observations of bird movement.

Susceptibility proxy: bird dispersal friction surface

- 2 = non-woody (least friction)

- 3 = open woodland (partial woody) and along creek-lines

- 4 = woody vegetation (most friction)

Susceptibility proxy: building the proxy I

- ESRI ArcGIS Pro Distance accumulation tool:
- Generates dispersal buffers
- input source points (mature classes + seedlings < 6 years)
- Friction surface
- Barriers to movement (high ridgelines)
- Absolute maximum distance threshold (3600 m (x friction value) for matures; 500 m (x friction value) for seedlings less than 6 years).
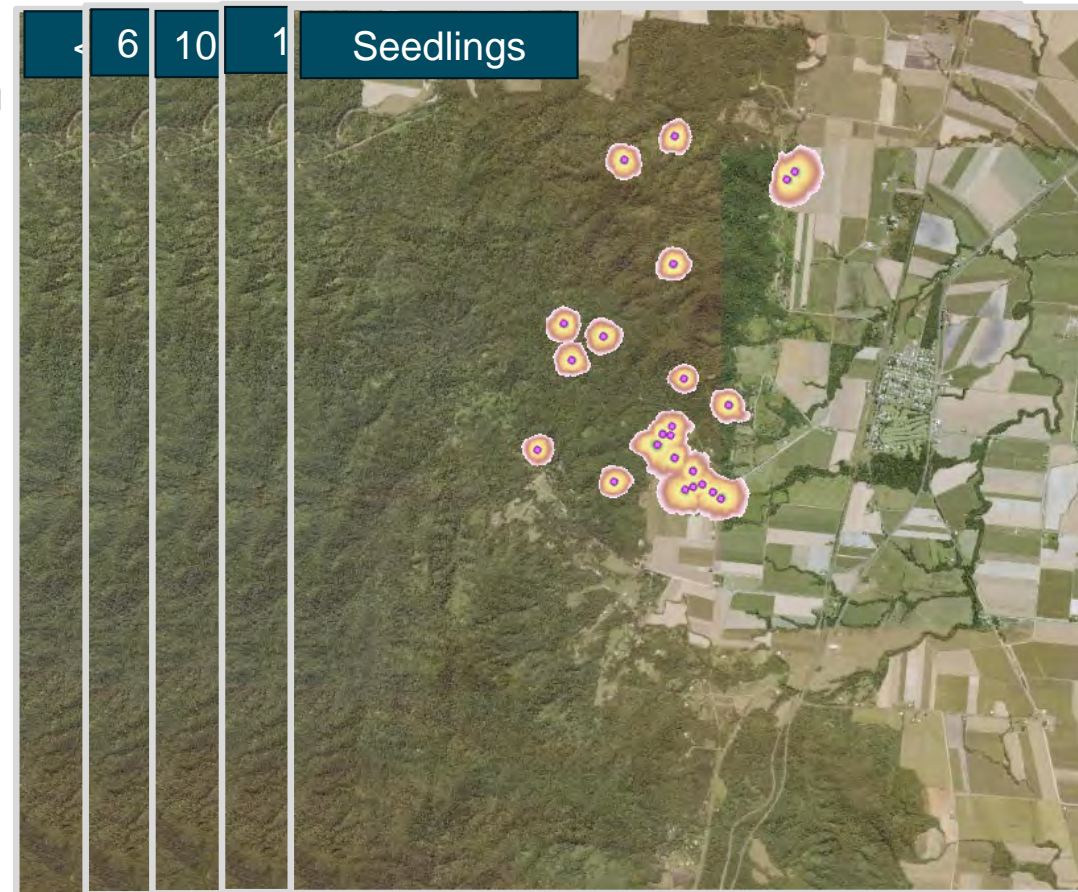
Susceptibility proxy: building the proxy II

Mature source locations

Reproductive timeframe	0-600 m	600–1200 m	1200–2000 m	2000-3600 m
< 6 years	100	75	40	20
6-10 years	50	25	10	0
10-16 years	25	10	0	0
Over 16 years	10	5	0	0

Seedlings (< 6 years, > 250m from mature source locations < 16 years)

Seedlings	0-300 m	300-500 m
< 6 years	100	50
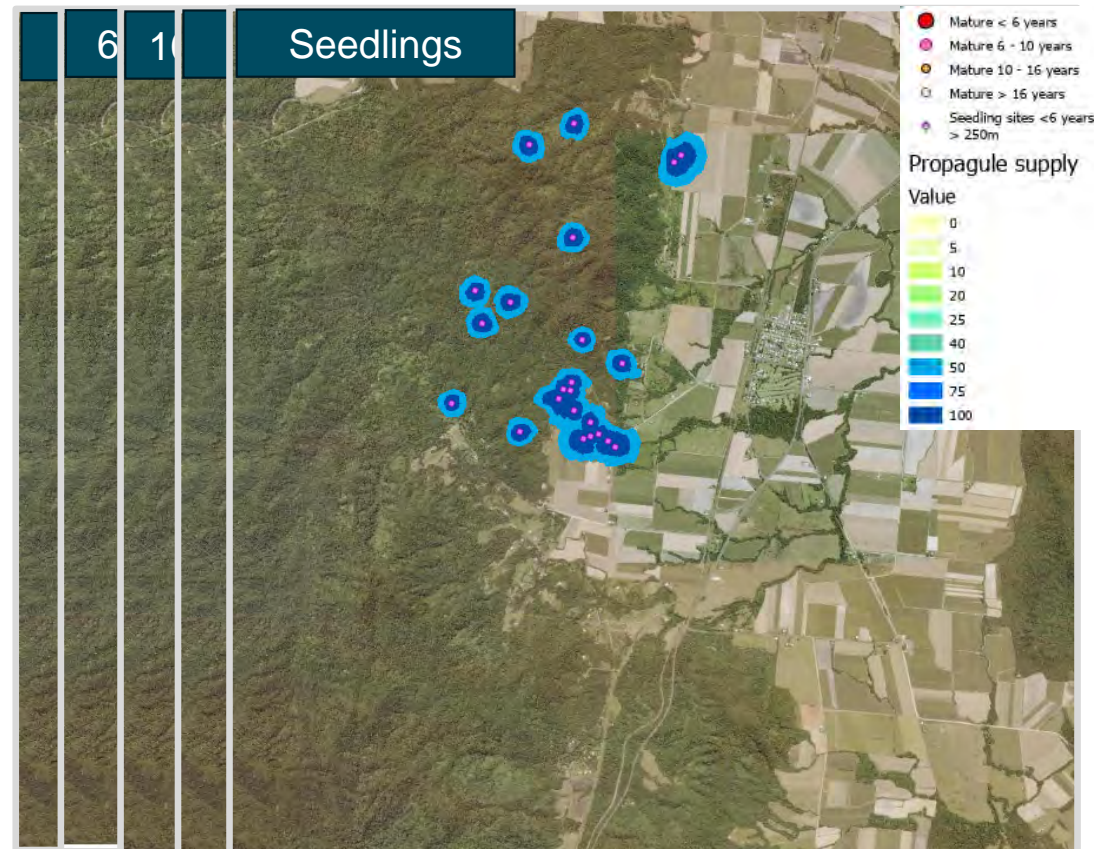
Susceptibility proxy: building the proxy III

Riskmapr model

Drainage [2]

Woody vegetation [2]

Regional ecosystems [1]

Plant establishment

Plant persistence

SUITABILITY

Seed viability and dispersal [3]

Propagule pressure

SUSCEPTIBILITY

- ● Mature < 6 years
- ● Mature 6 – 10 years
- ◉ Mature 10 – 16 years
- ○ Mature > 16 years
- ✻ Seedling sites <6 years, > 250m

RiskMapr output (susceptibility)

Value

93

6
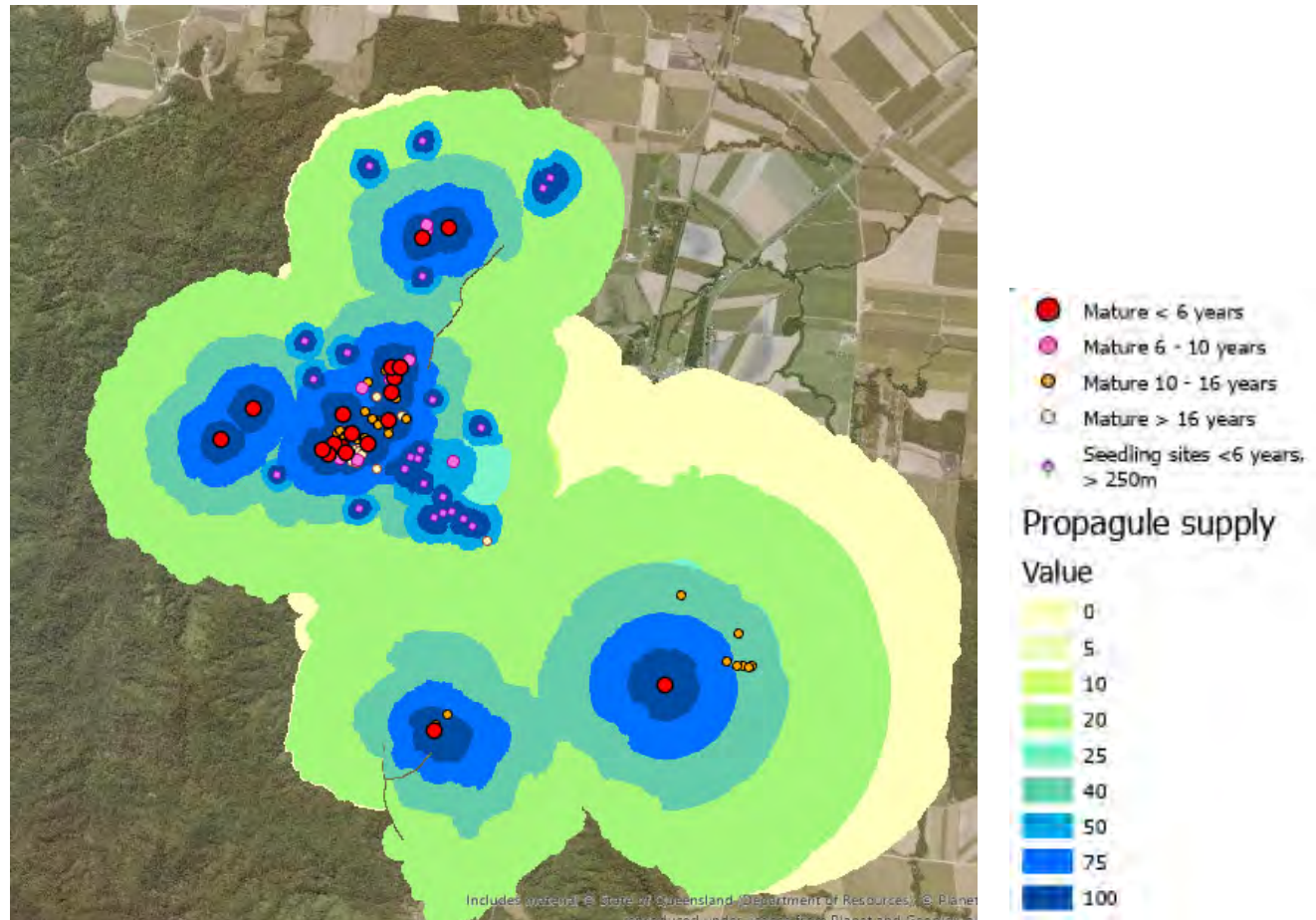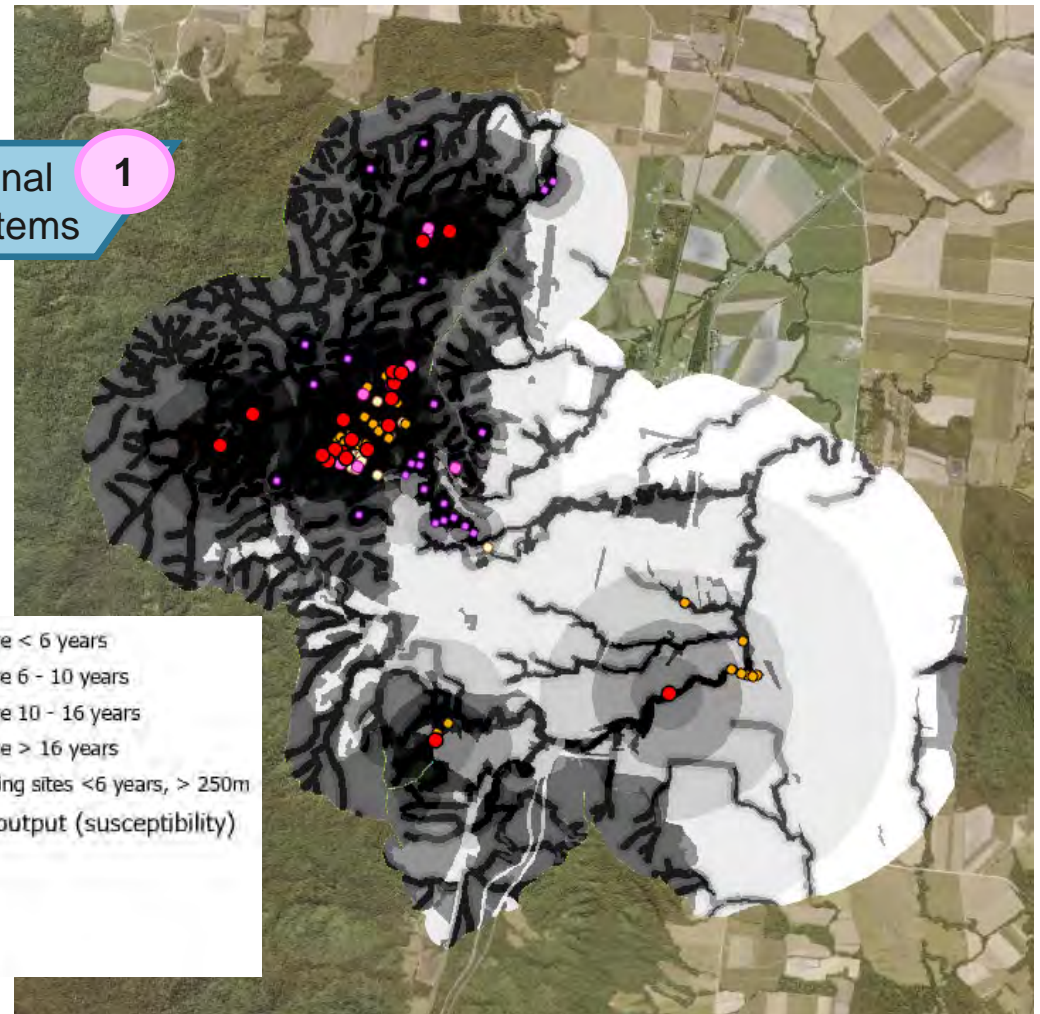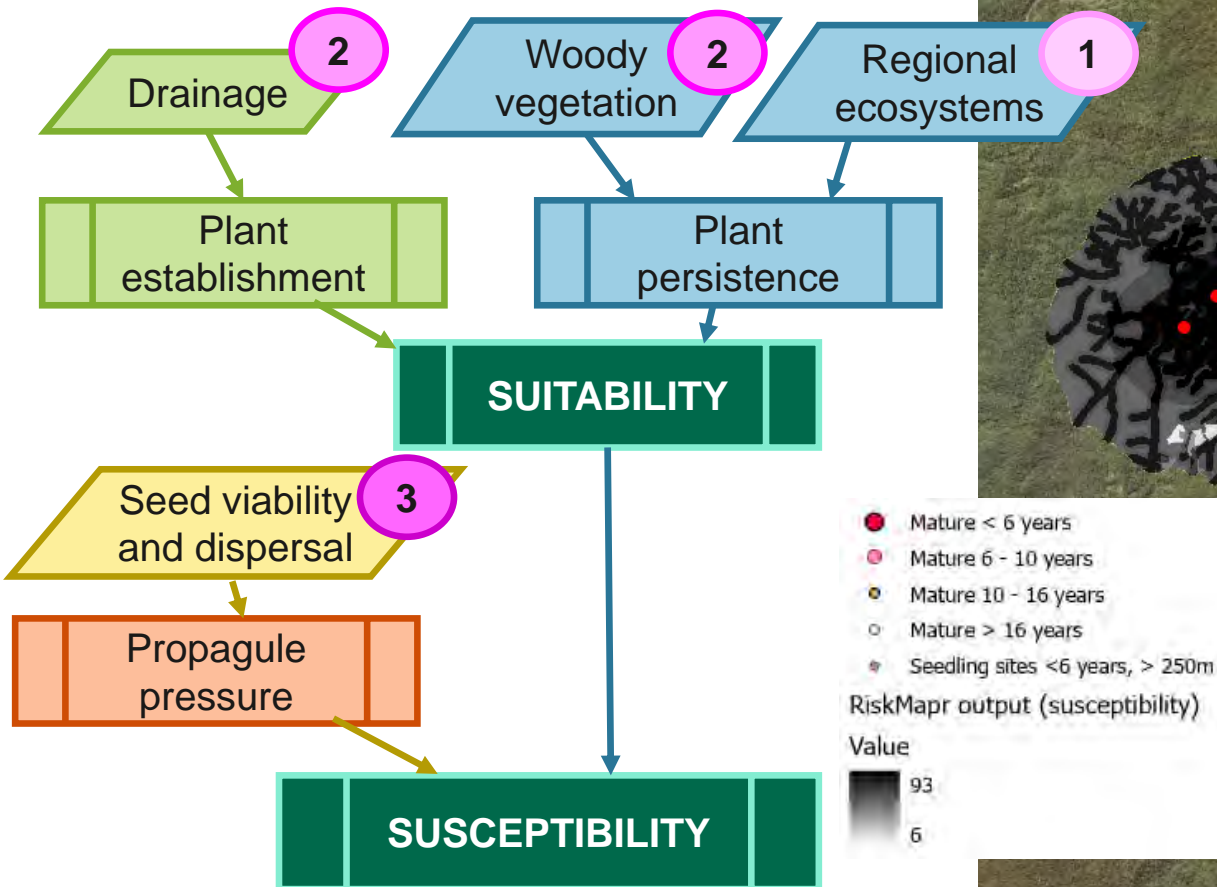
Validation
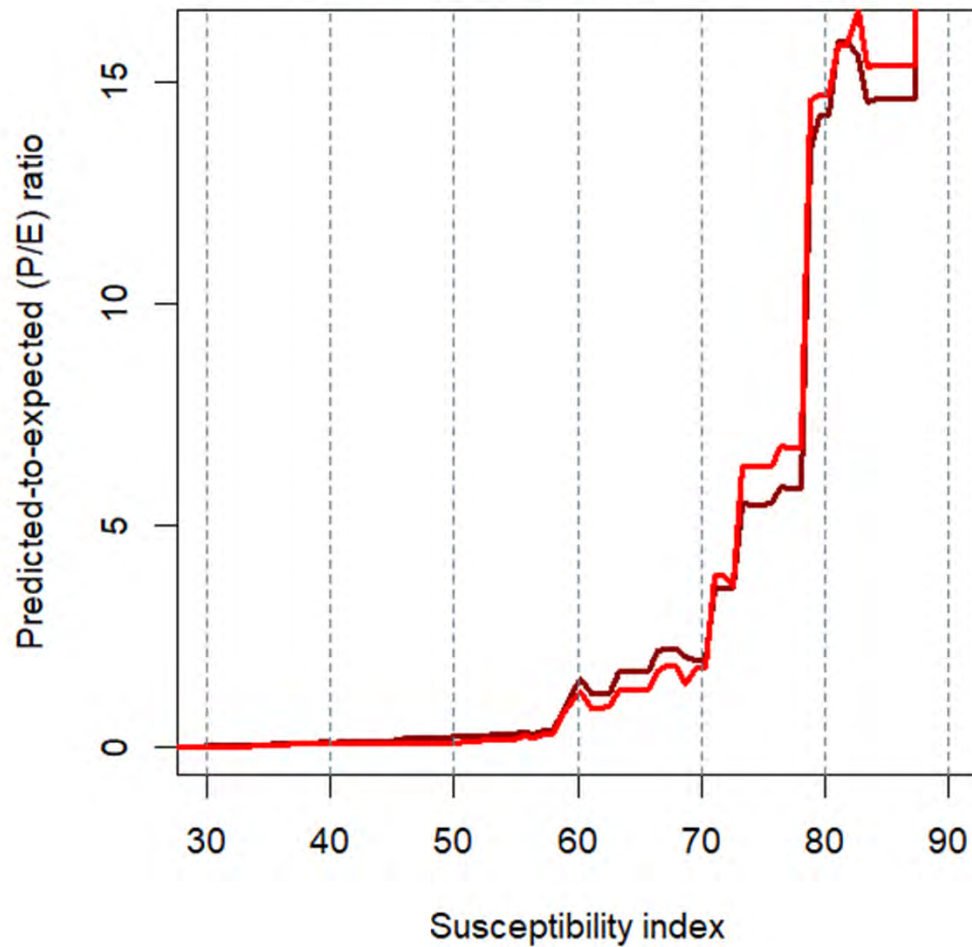
Legend

— 2016 model, 2017-19 detections: CBI = 0.987

— 2019 model, 2020-22 detections: CBI = 0.988

Classifying the model

Legend:
- Mature < 6 years
- Mature 6 - 10 years
- Mature 10 - 16 years
- Mature > 16 years
- Seedling sites <6 years, > 250m

RiskMapr output (susceptibility)

Risk category
- Very low
- Low
- Moderate
- High
- Very high
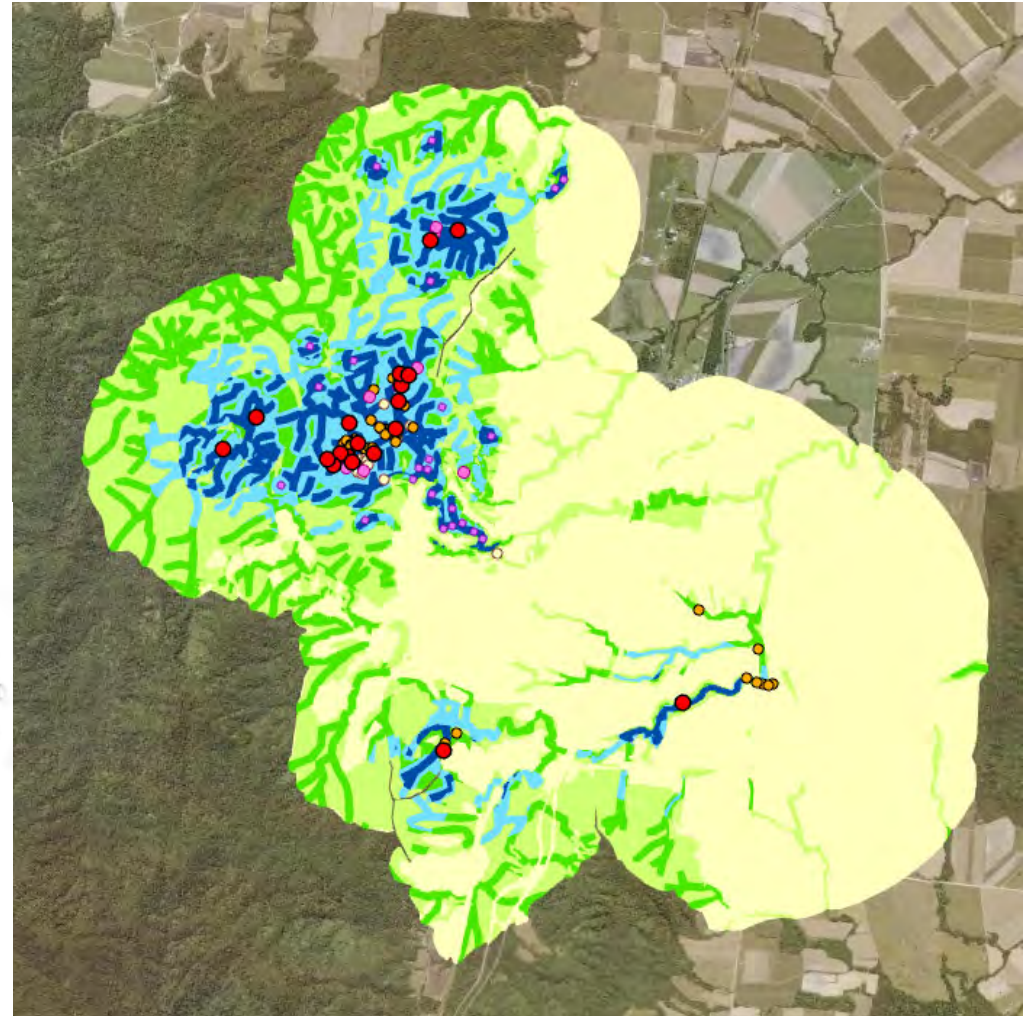
Retrospective analysis against actual search effort
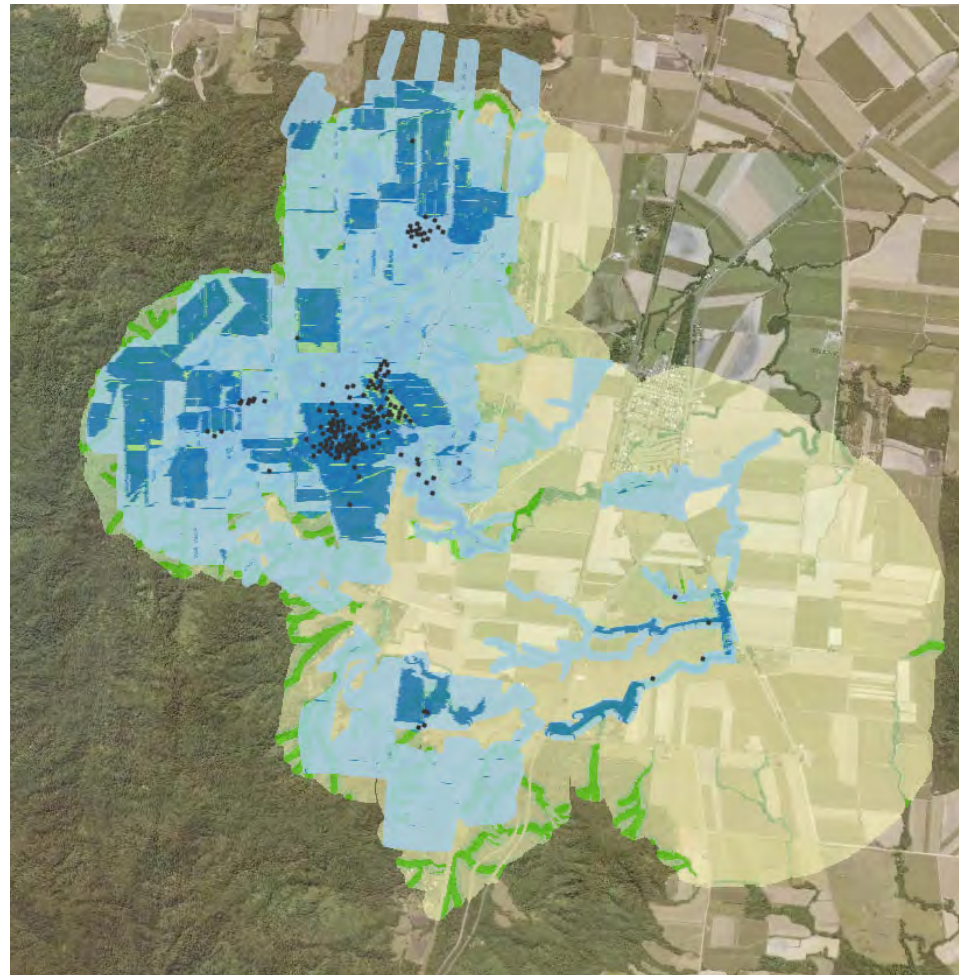
Detections (Jan2020 to Dec22)

Search and control (2020 - 2022)
Number of visits
1
2

Retrospective analysis against actual search effort

Risk category	Model-predicted risk area	Actual search effort in following 3 years			Actual plant detections	
	hectares	hectares	% risk cat.	% total search effort	count	% total detections
2016 model		7,916				
Very high	674	602	89%	7.6%	859	57.6%
High	1,066	922	86%	11.6%	273	18.3%
Moderate	3,031	1,650	54%	20.8%	238	16%
Low	6,178	3,112	50%	39.3%	94	6.3%
Very low	25,181	209	1%	2.6%	19	1.3%
Outside risk area	-	1,421	-	18%	8	0.5%
2019 model		8,475				
Very high	801	706	88%	8.3%	953	66.5%
High	1,124	986	88%	11.6%	270	18.8%
Moderate	3,404	1,680	49%	19.8%	168	11.7%
Low	6,482	2,930	45%	34.6%	32	2.2%
Very low	26,086	1,520	6%	17.9%	10	0.7%
Outside risk area	-	653	-	7.7%	1	0.1%

Evaluation against planned surveillance targets defined in Response Plan 2021-24

Model-predicted susceptibility 2022		Current surveillance areas 2021-24	
Risk category	Hectares (%)	Coverage targets	Hectares (%)
High + very high	1,564 (14%)	100% surveyed	4,334 (37%)
Moderate	3,368 (30%)	75% surveyed	6,222 (52%)
Low	6,258 (56%)	50% surveyed	1,320 (11%)

Conclusion

Most of NTWEP cost is driven by search areas.

Riskmapr is a documented basis for reducing the survey frequency, intensity, or extent of surveillance over areas of lower propagule pressure.

NTWEP already undertake considerable analysis to monitor progression towards eradication, but this is a finer management area scale.

Future outputs could help document eradication progress at the search area scale and provide additional evidence to reduce the visit frequency to zero, thereby complementing multiple eradication criteria across whole, or portions of infested loci.

Combined with other innovative tools such remote detection using drones and AI, we hope this model will help the NTWEP meet their goal of eradicating *M. calvescens*.

Acknowledgements

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