

Best practice weed management: scientific evidence

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SCIENCE

Biography

- Professor (biosecurity and conservation) in School of Biological Sciences, University of Auckland (2007 - now)
- Manaaki Whenua – Landcare Research (post- PhD, 2001-2007) – researcher in weed ecology, weed biocontrol, ant & wasp ecology/management
- Programme Director, Masters programme in Biosecurity & Conservation (UoA) - ~20 yrs
- 95 peer-reviewed scientific publications with NZ & international researchers
- Supervised ~50 PhD & MSc students
- Technical Advisor, Ministry Primary Industries' national weed management programme (NIPR)
- Member, IUCN's Invasive Species Specialist Group

Driver: Produce science/evidence that improves conservation/biodiversity outcomes for NZ

Weed impacts – we have a lot to protect!

NZ = designated one of 25 global biodiversity “hot spots”

ENDEMIC – found nowhere else in the world



We don't know what we're losing...

- 33% of our species are 'data deficient'
- Only ~50% of insect species described

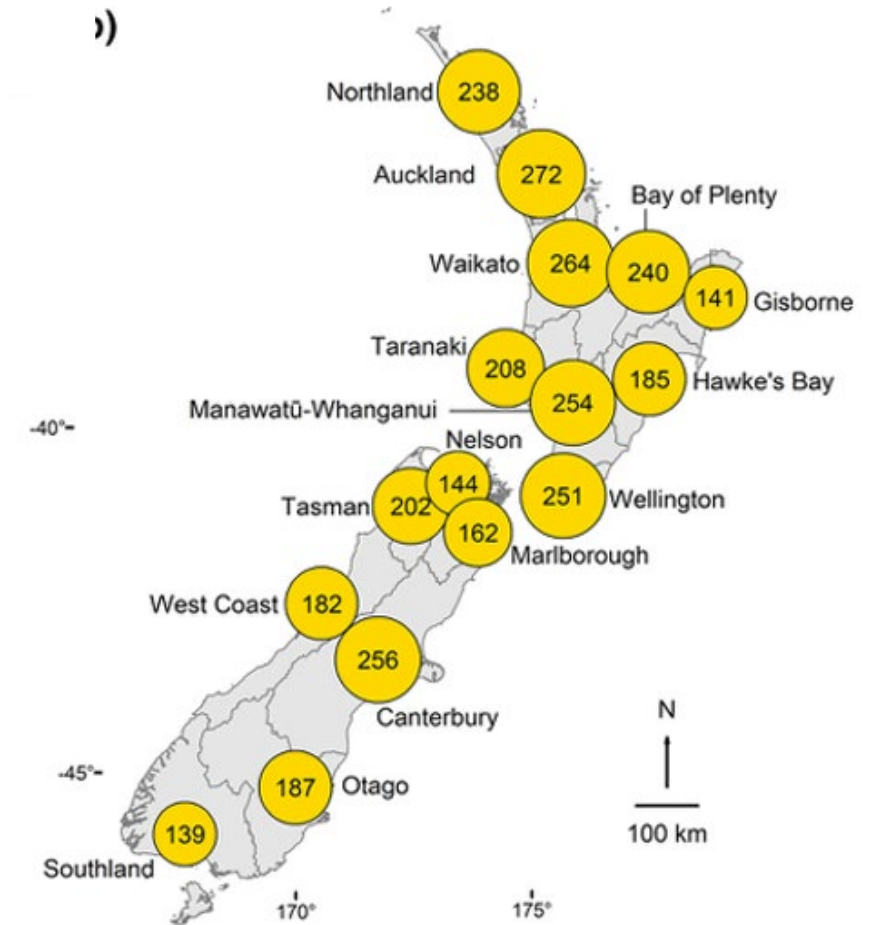


Weeds in NZ

- 380+ environmental weed species in NZ
- 58% originally imported as ornamental garden plants



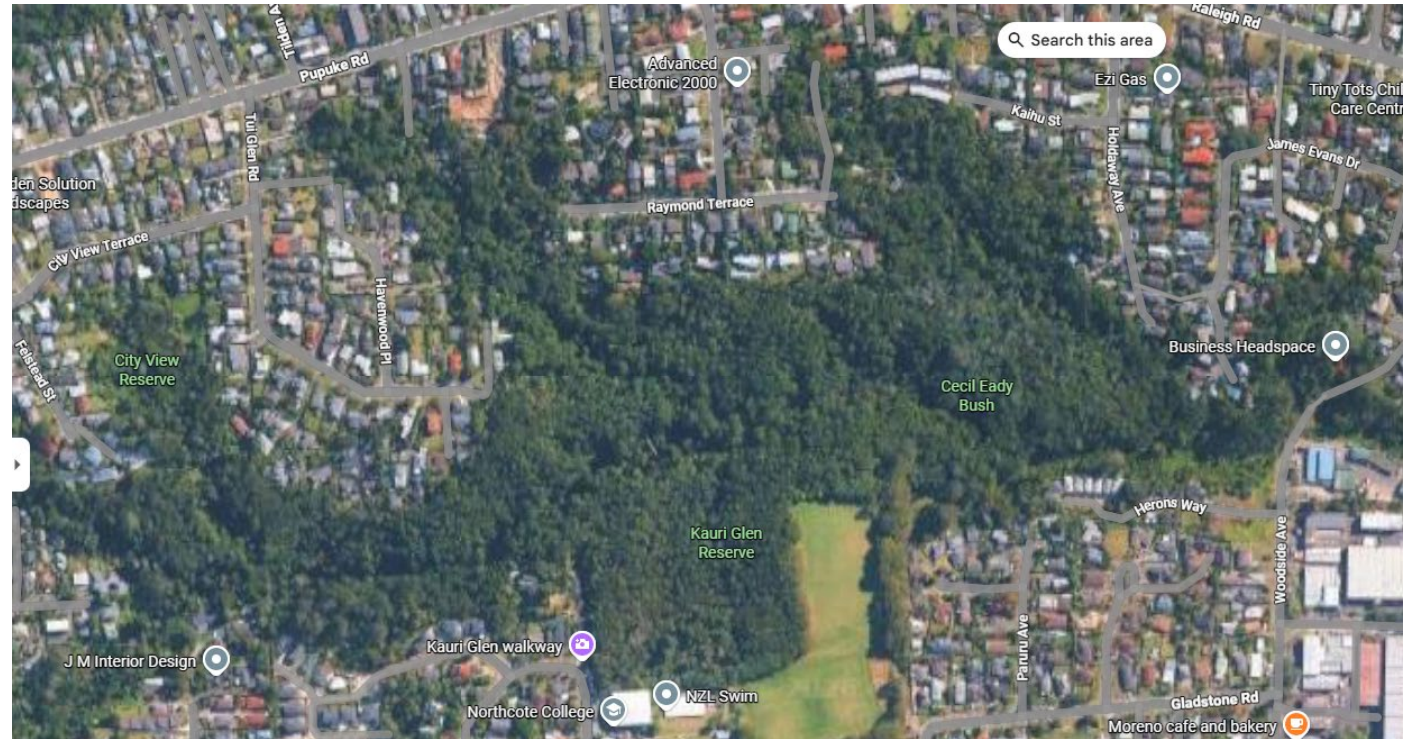
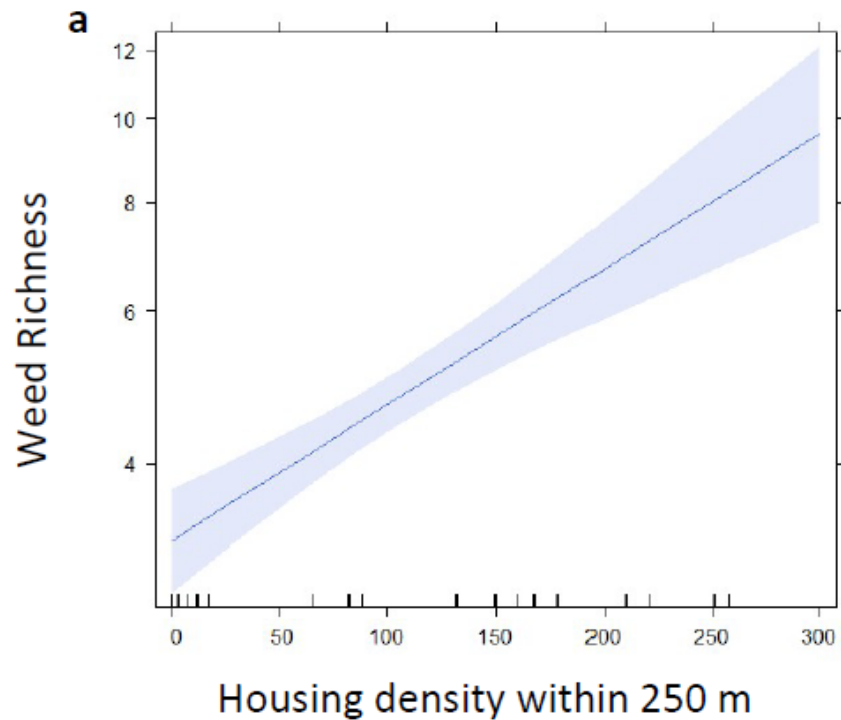
Distribution of environmental weeds



Brandt et al (2021). Naturalised plants transform the composition and function of the New Zealand flora. *Biological Invasions*
<https://doi.org/10.1007/s10530-020-02393-4>

More gardens = more weeds

More houses closer to forest patches =
more weed species in that forest



Borse et al (2026). Weed co-occurrence patterns in revegetation plantings: implications for managing multiple weed species. *Neobiota* (In Press)

More weeds on their way....



~30 000 introduced plant species

20 spp./yr

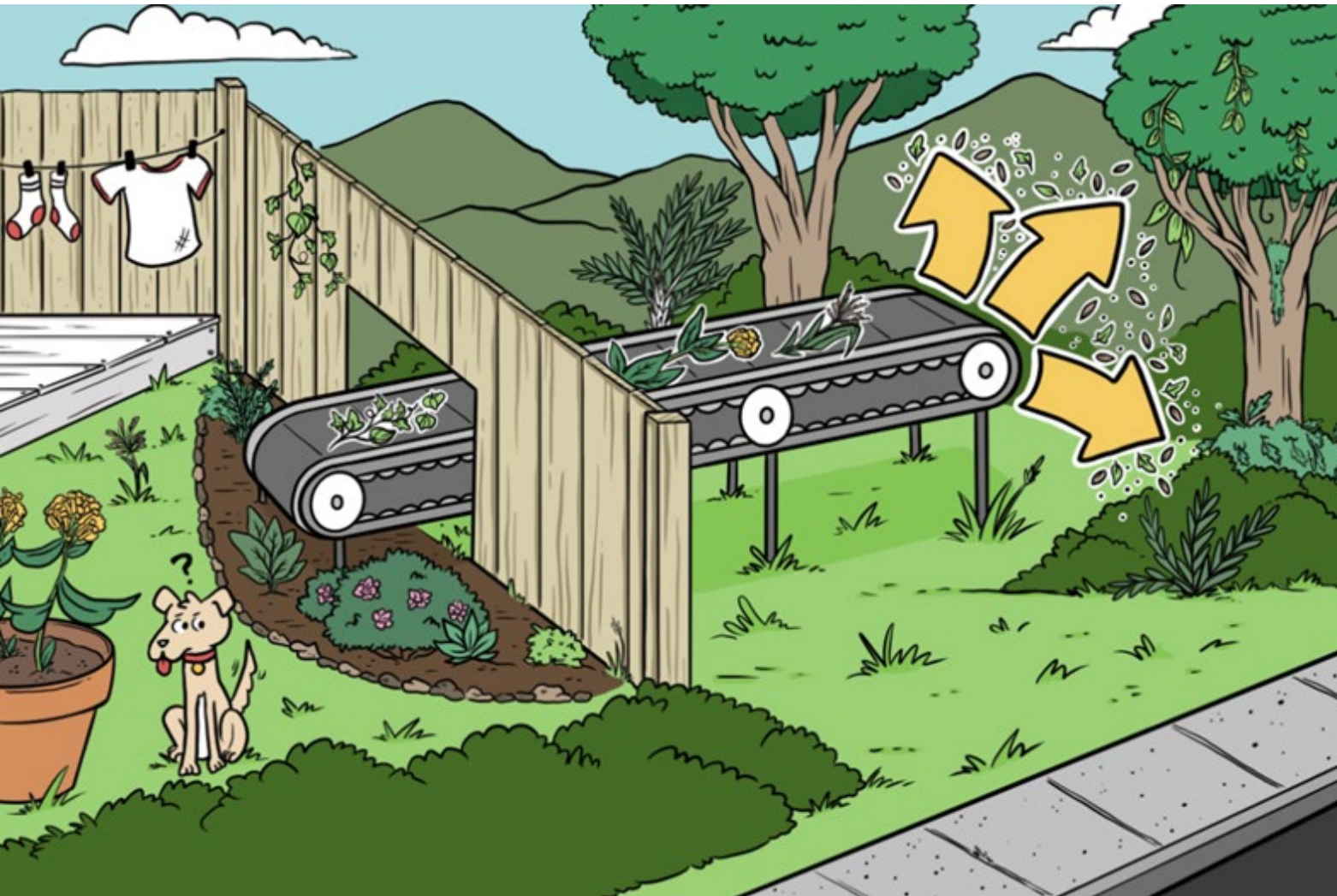
**~2158 native
plant species**

**>2600 wild introduced
plant species**

386+ environmental weeds

**58% environmental weeds originally
ornamental plants**

Garden escapes.....



PREVENTION = BEST STRATEGY

What are we planting in our gardens?

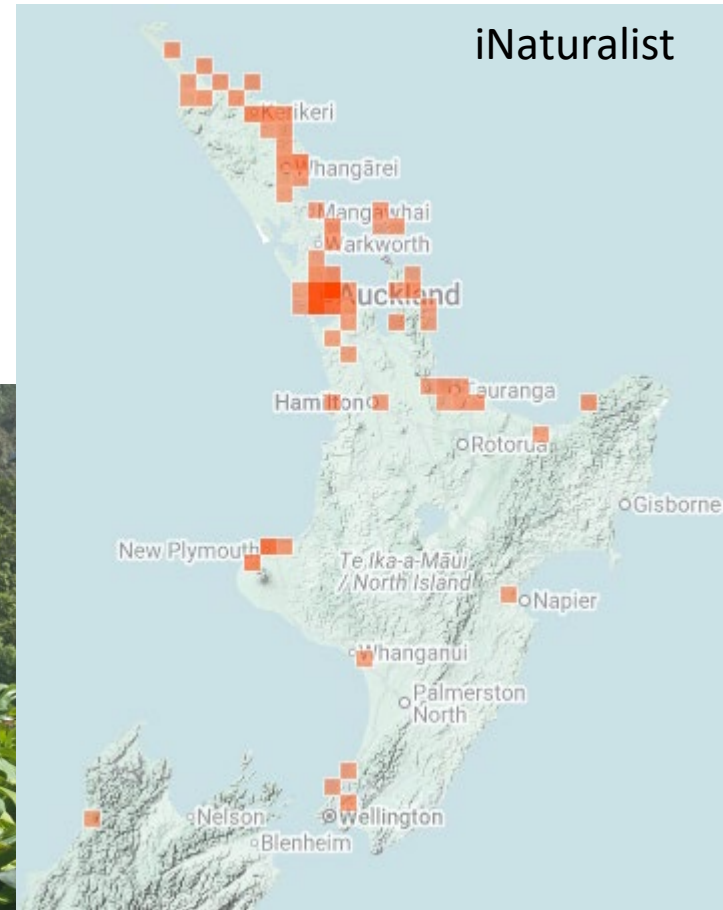
How are they escaping?

- Wind-dispersed seeds
- Bird-dispersed seeds



How are they escaping?

- Illegal dumping of green waste
- Trends!
- House/indoor plants....move outside



Weed impacts – replace native species



Heather =
outcompetes native species

Image: Simon Fowler

Weed impacts – replace native species



Image: Susan Timmins



Image: KVH

Vines (e.g. Japanese honeysuckle, climbing asparagus, banana passionfruit) =
overtop forest & cause collapse

Weed impacts – shade tolerant, replace forest



Image: <https://tea.org.nz/>



Privet (*Ligustrum* spp.)
Palms (e.g., bangalow),
Sycamore, cherry (*Prunus* spp.)...

Weed impacts – smother



Image: Weedbusters



Image: Trevor James

Herbs/forbs, ground layers: prevent seedling regeneration (e.g., arum lily, tradescantia, wild ginger, agapanthus)

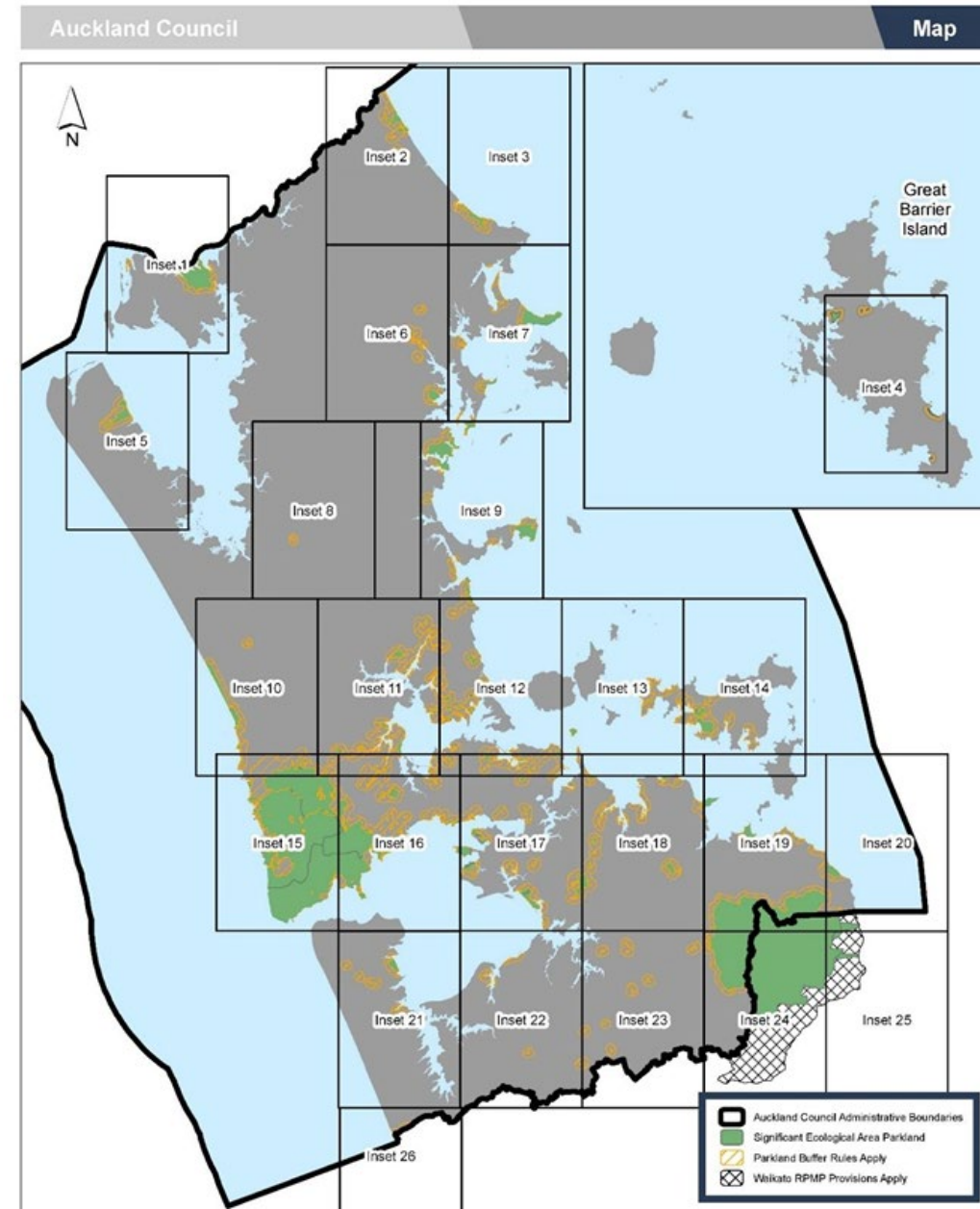
100s of environmental weed species and counting....

Best Practice Weed Management Principles

- (1) The goal is resource protection, not dead pests - *a focus on killing individual weed species can have unintended ecological consequences*
- (2) The task is pest management, not pest control - *requires understanding of the weed species, ecosystem at small and large scales*
- (3) Ranking (prioritisation) is required - *must use resources carefully and objectively to achieve the best conservation outcomes*

What is best practice pest management?

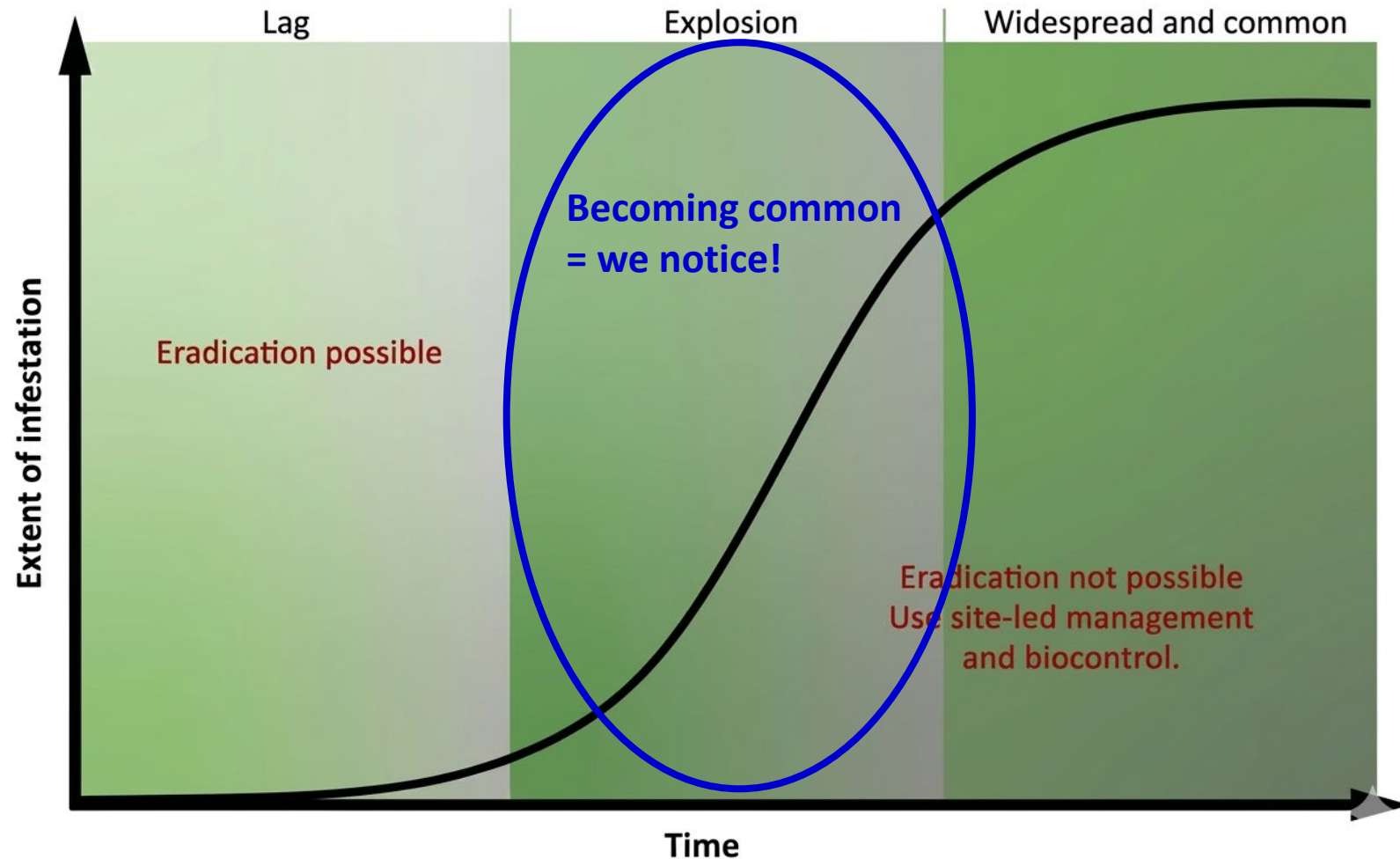
- Landscape scale (e.g. region)
- **Where** to do weed management for **what outcomes?**
- Maximising outcomes for \$\$ spent
- Prevention vs eradication vs suppression?



Best practice pest management STRATEGIES

Strategies = prevention, eradication, site-based management (long-term suppression)

Pest
invasion
curve

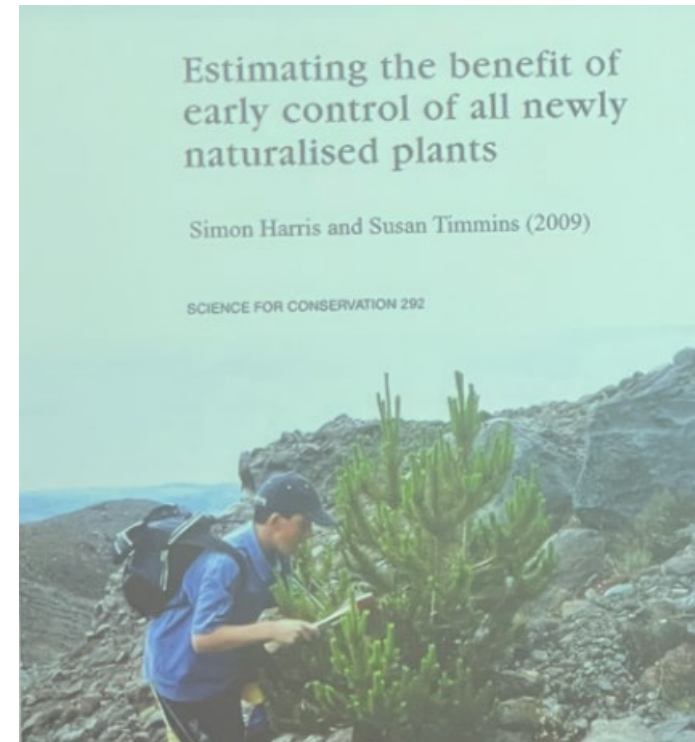


Which strategy is cost-effective?

- 58 DOC weed control programmes
- Compared costs of **early intervention vs suppression** once widespread
- Modelled spread & costs over 5, 10, 20 & 40 years

RESULT:

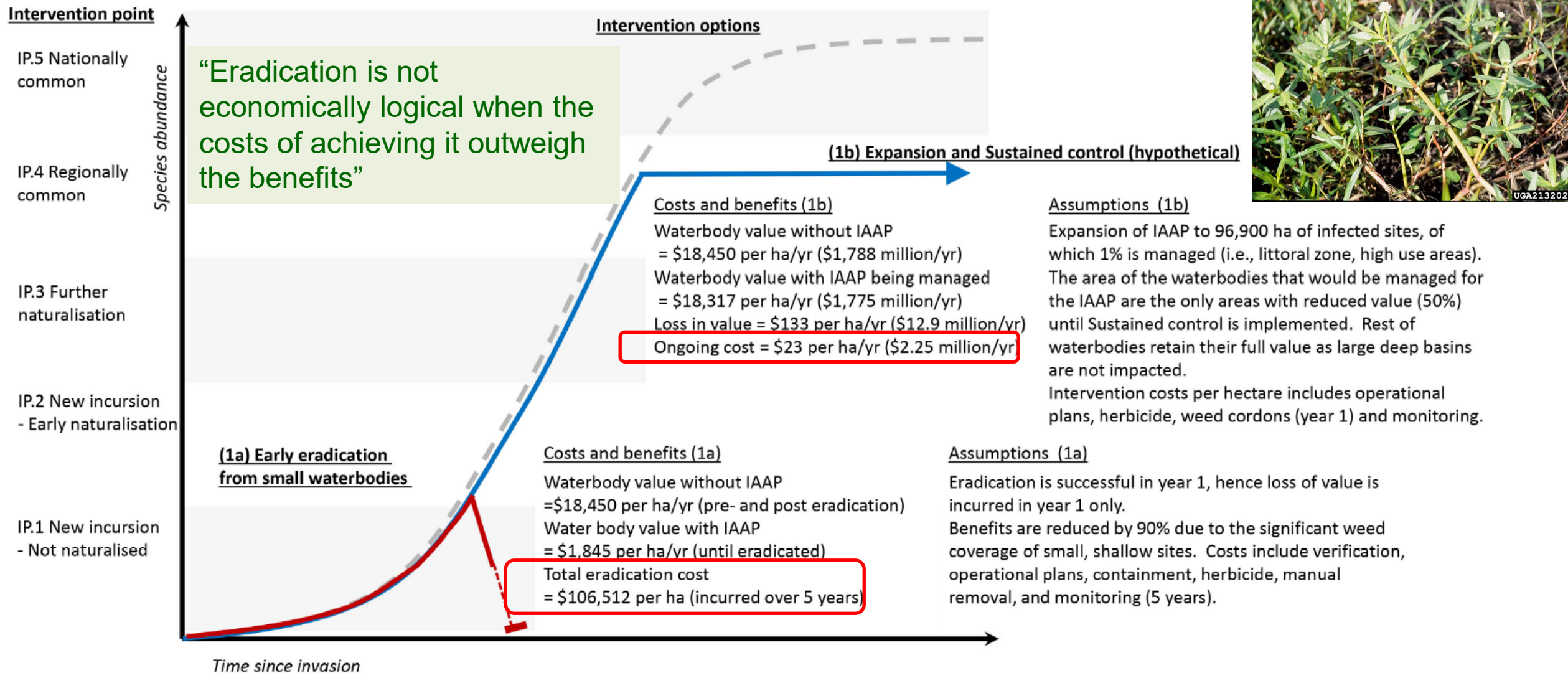
Delayed control = ~40x more expensive



Harris & Timmins (2009). Estimating the benefit of early control for all newly naturalised plants. Science for Conservation 292. Department of Conservation, Wellington.

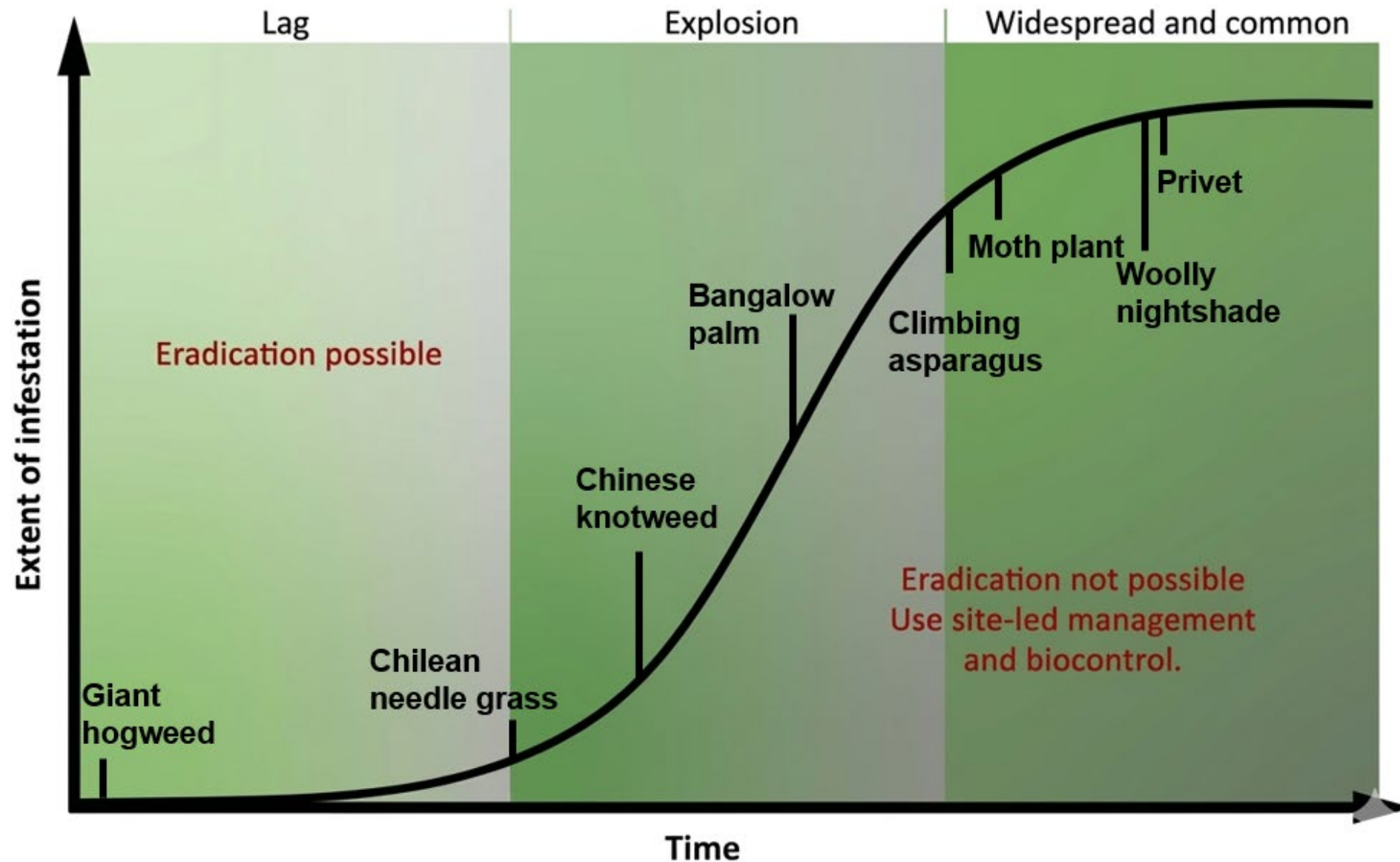
<https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc292.pdf>

Modelled \$\$ for generalized aquatic weed management in NZ



UGA2132020

Best practice pest management – which strategy?



Giant hogweed (*Heracleum mantegazzianum*) = touching it can give you 3rd degree burns, cause blindness



Image: <https://www.colnevalleypark.org.uk/wp-content/uploads/2019/07/Giant-Hogweed.jpg>

Balloon vine (*Cardiospermum grandiflorum*) – smothers forest



Eradication - Species eradicated from New Zealand*

Species	Notes
<i>Acroptilon repens</i>	Russian knapweed, pasture/cropping weed
<i>Butomus umbellatus</i>	Flowering rush, aquatic weed
<i>Chondrilla juncea</i>	Skeleton weed, cropping weed
<i>Menyanthes trifoliata</i>	Bogbean, aquatic weed
<i>Onopordum tauricum</i>	Taurian thistle, pasture weed
<i>Pontederia paniculata</i>	Brazilian water hyacinth, aquatic weed
<i>Potamogeton perfoliatus</i>	Clasped pondweed, aquatic weed
<i>Typha latifolia</i>	Greater reedmace, aquatic weed
<i>Zizania palustris</i>	Annual wild rice, aquatic weed
<i>Nymphoides peltata</i> , <i>Pistia stratiotes</i>	Subsequently found since 2008

*Champion & Clayton 2003; Howell 2008

Eradication & size of infestation

	Size of initial infestation (ha)				
	<0.01	0.1-1.0	1.1-100	101-1000	>1000
Chance %	87	45	35	25	0
Work hours	<100	200	1,000	14,000	42,000

Successful programmes = areas frequently searched for many years

Prevent new species becoming widespread – eradicate early & turn off the tap



Prevent new species becoming widespread

– find new weed species early & eradicate and stop more fires being lit!



Best practice pest management – which strategy?

Buddenhagen & Tye (2015):

Main reason for weed management failure
= choosing wrong weed target to eradicate

Weed species not suitable for eradication:

- Widespread (more than a few, small infestations)
- Have long distance dispersal (wind + bird-dispersed more difficult) or be moved by people
- Seed viability (stay alive in soil) > 3 years (moth plant > 5 yrs; gorse = 60+ yrs)
- Grow from seed to reproducing adult < 2 yrs
- Huge underground mass (e.g., rhizomes)

Panetta FD (2015). Weed eradication feasibility: lessons of the 21st century. *Weed Research* 55, 226–238.

Buddenhagen & Tye (2015). Lessons from successful plant eradications in Galapagos: commitment is crucial. *Biological Invasions*, 17(10), 2893-2912.

Failed eradications – wrong strategy!

Rhododendron (*Rhododendron ponticum*) – Gritten (1995)

1984 = 1.6% (3407ha)

Snowdonia National Park (Wales)



Image: <https://www.stayinwales.co.uk/>



10yrs later...

Greater area of park infested than in 1984 ☹️:

- £45 Million spent on eradication
- Seedling re-invasion
- Not enough funds for coordinated, frequent revisits, monitoring & control

Failed eradications – wrong strategy!

Woolly nightshade (*Solanum mauritianum*)

Pressure put on Bay of Plenty Regional Council to eradicate woolly nightshade



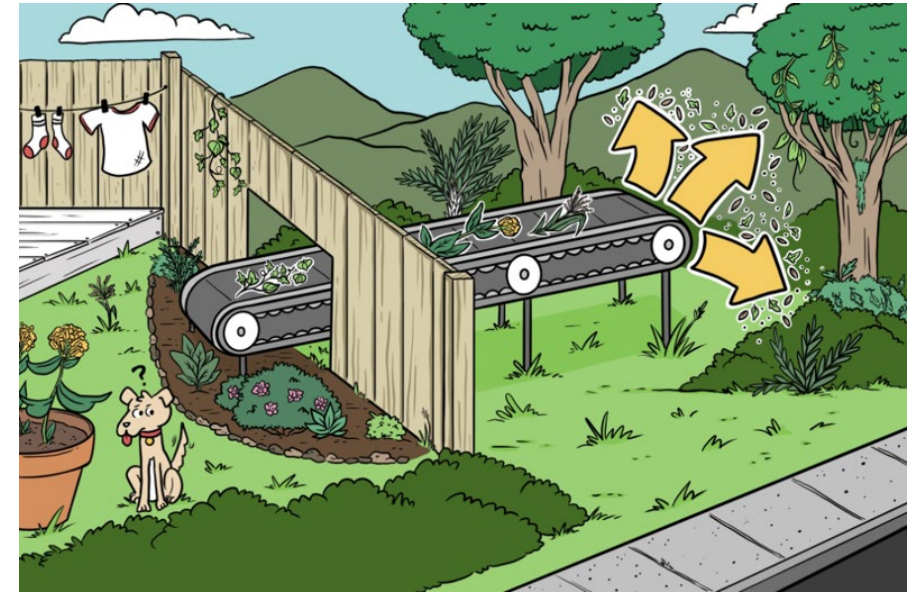
Woolly nightshade

- 54 000ha with some woolly nightshade present
- 10 years later.... 2673 infestation sites
- Relied on occupier control rules = unsuccessful and expensive, unsustainable (follow-up control)
- Repeat visits to inspect (\$300K per yr, 10 yrs), legal enforcement expensive (~\$11K court costs for 1 landowner)
- Missed chance to eradicate new weed species

Switched to site-led management & progressive containment (in some areas)

Best practice pest management – which strategy?

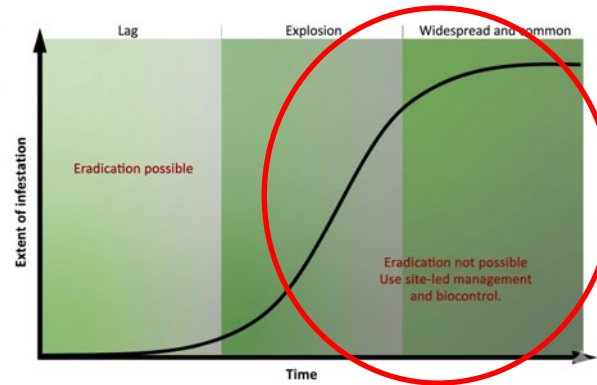
- **Emerging weeds - might be feasible to eradicate:**
~4 new species naturalise in Auckland each year (Esler 1988)
- **Widespread weeds should be managed at high value conservation sites**



Auckland has many widespread weeds (+ other pests!) with high impacts

= prioritise sites (conservation values)	+	prioritise weeds at those sites (highest impact + have tools)
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Site-led: weed suppression



GOAL: Asset protection (biodiversity, production values, cultural values....)

Keep the weeds below a level where biodiversity can thrive = reducing their impact

PRIORITISATION

- Rank assets (high value sites) = highest value to achieve our goals/outcomes
- Rank weeds (& other pests) = highest impact on values + have tools to control them
- Control ALL at once = no unintended consequences

Site-led: weed suppression

Keep the weeds below a level where biodiversity can thrive = reducing their impact

e.g., can native seedlings grow through the weed?



Remove one weed species = another weed species fills the space



Site-led: prevent unintended consequences

Replacement weeds



tradescantia



Removing 1 weed creates
a 'weed-shaped hole'

Doesn't achieve
goals – wastes
investment



selaginella

Unintended consequences from removing 1 species can be prevented by:

- Removing several species at the same time
- Re-planting with native species

Site-led: prevent unintended consequences



Control multiple pests at the same time at a site!
(Integrated pest management)

Pig & goat eradication
BUT no weed management

Vine = *Operculina ventricosa*



Doesn't achieve
goals – wastes
investment

Zavaleta et al 2001. Viewing invasive species removal in a whole-ecosystem context. *Trends in Ecology & Evolution* 16, 454-459

Best practice weed management - summary

Principles =

- 1) goal is protecting values (not dead weeds),
- 2) management must consider large scales, ecology of pest & its interaction with other pests & the ecosystem it has invaded,
- 3) prioritising/ranking is required to achieve best conservation outcomes for \$\$ invested

Strategies =

- Prevention is best (turn off the tap!)
- Eradication (prevention of weeds becoming widespread) is only possible very early when the infestation is small (before you even notice the weed!) – it's not economically logical when the costs of achieving it outweigh the benefits
- Site-based management (long-term suppression): investment must focus on goals (suppress to achieve biodiversity outcomes), protect highest value sites, control multiple pests at those sites (highest impact + have tools to control)
- Avoiding wasting \$\$ & investment - \$\$ best spent on weed species that are in early stages of invasion