



Knowledge to Action on Aquatic Invasive Species:
Island Biosecurity – the New Zealand and South Pacific Story

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Overview

- Research towards proactive management of aquatic pests

- Why does this approach work in New Zealand?

Strategic objectives for aquatic biosecurity research

1. Risk assessment, prediction & intervention

ID tomorrows pests today, move risk offshore, pinpoint new incursions
Validate & rank pest threat
ID pathways & vectors, develop predictive models

2. Ecosystem impacts, values & surveillance

Develop & extend monitoring & valuation tools
Fill key ecosystem data gaps, inventory & delimitation
Target effective surveillance
Targeted protection & early detection

3. Management & mitigation of pests

Optimise & expand tool box, smarter use
Screen & adopt suitable products & technologies
Develop novel technologies
Improve tool environmental acceptability
Integrated control approaches

4. Inform policy & operations

Embed research in agency responses
Provide training & advice
Design decision & reporting tools
Provide resource evaluation framework
Provide Best Practice frameworks

Inter-Linkages

Response ready research

Agile
Rapid delivery
Future focus
Regular stock-takes
Industry aligned
Optimized
Internationally linked

Proactive management of aquatic pests

1. Identify pests off-shore to prevent importation
2. Management at the border
3. Develop and apply risk assessment tools
4. Understand and mitigate introduction/dispersal pathways
5. Surveillance for new incursions
6. Incursion response
7. National eradication programs

1. Identify new pests

- Weed and pest history elsewhere one of the best indicators of pest potential
- Scanning international literature (e.g. Randall 2017), conferences and network of international collaborations
- Identify importation pathways
- Legislation: The Biosecurity Act 1993
  - Notifiable Organisms
- Pest Risk Assessment (next section)

1. Identify new pests

- 75% of NZ current aquatic weeds introduced as ornamental plants (Champion & Clayton 2000)
- Those weeds are still traded internationally, but some weeds still not recorded here
- There are few accidental entry pathways for freshwater spp.:
  - Contamination of aquatic plants or related material
  - Historical introduction e.g. through ballast
  - Contaminated equipment used in freshwater

1. Identify new pests

- Notifiable Organisms Register (2016)
  - 8 diseases affecting crustacea (e.g., *Aphanomyces astaci*)
  - 10 diseases affecting molluscs (e.g., *Xenohaliotis californiensis*)
  - 15 diseases affecting fish (e.g., koi herpesvirus)
  - 5 aquatic weeds (already in NZ)
  - 15 mosquito spp. (e.g., *Aedes camptorhynchus*)
  - 3 freshwater animals (e.g., *Ictalurus punctatus*)
  - 7 marine taxa (e.g., *Caulerpa taxifolia, Carcinus maenus*)

Legally obliged to report the occurrence of any NO

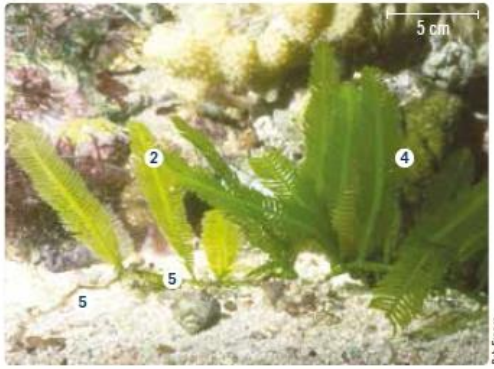
1. Identify new pests

AQUARIUM CAULERPA

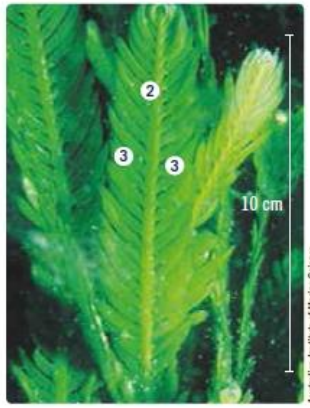
Caulerpa taxifolia

Key features

1. Bright green
2. Fronds have a smooth midrib
3. Paired branchlets, all flattened in the same plane



Bob Fraser



Australian Institute of Marine Science

Government of South Australia, Biosecurity SA

4. Fronds up to 15 cm (tropical form) or 40+ cm (Mediterranean form) in length
5. Long horizontal runners (stolons) with many upright, flattened fronds

Habitat

- Marine aquaria

If *Caulerpa* was to be released into the environment, then it would be found in:

- Sand, mud, rock or seagrass beds
- Estuaries, harbours and coasts
- Sheltered to semi-exposed environments
- Low tide to 100 m depth

Impact

- Forms vast, dense beds
- Smothers and displaces native and fisheries species
- Fast-growing
- Disrupts natural ecological balance
- Accumulates toxins

*If found anywhere in New Zealand, immediately call
0800 80 99 66

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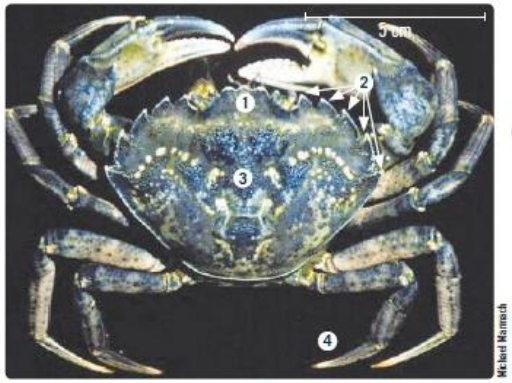
EUROPEAN SHORE CRAB

Carcinus maenas

Key features

1. Three rounded "teeth" or lobes between the eyes
2. Five spines on each side
3. Adult up to 8 cm wide



Michael Mamouch

Hans Hillewaert

7. Adult colour varies from green on top and yellowish underneath, to mottled red and orange above and orange or partly red underneath

A.M. Ayles

4. No swimming paddles on legs
5. Juveniles generally lighter in colour than adults

Habitat

- Intertidal to 60 m depth
- Sand, mud, rock or seagrass beds
- Estuaries, harbours and coasts
- Generally nocturnal

Impact

- Can form dense colonies (up to 200 per m^2)
- Aggressive and highly effective predator
- Displaces native and fisheries species
- Highly detrimental to shellfish aquaculture
- Can collapse wild-harvest shellfisheries
- Facilitates other pest invasions

*If found anywhere in New Zealand, immediately call
0800 80 99 66

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2. Management at the border

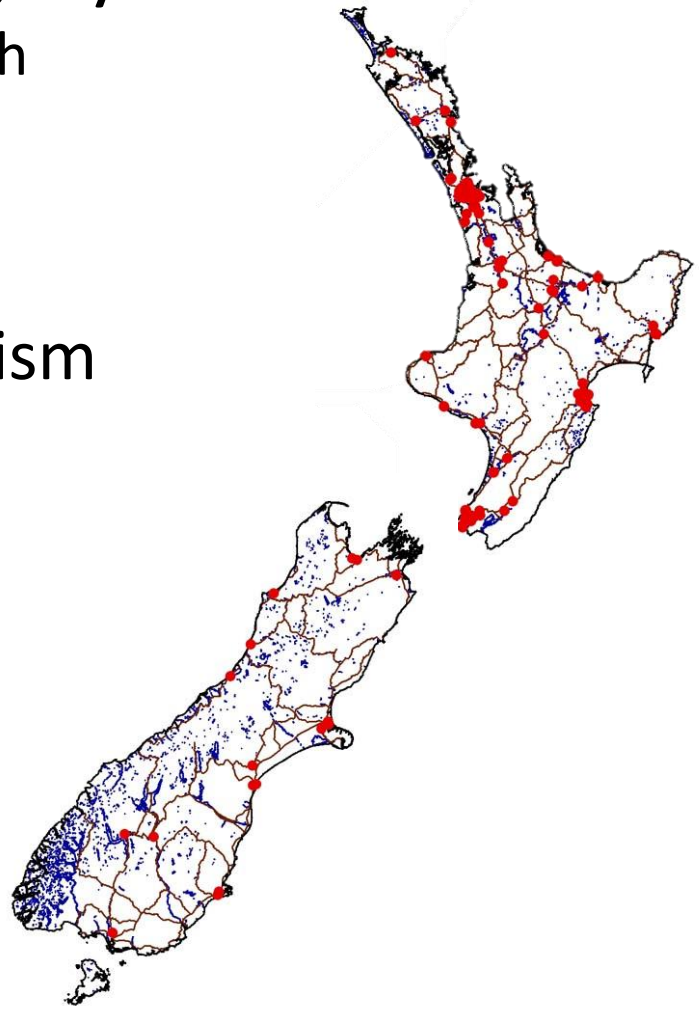
- Hazardous Substances and New Organisms Act (1996)
  - New to NZ organisms must go through risk assessment protocol provided by importer
  - No protection for importer once approved
  - No new aquatic spp. imported (< 50 spp. In total)

- Biosecurity Act
  - Inspection at ports and soft x-ray of all mail items
  - PEQ
  - IHS

2. Management at the border

- 27% of all aquarium plants entered NZ illegally
  (Champion & Clayton 2000) ~ 5-10% Australian marine fish
  (Morrisey et al. 2011).
- Smuggling bypasses:
  - evaluation of risk posed by an imported organism
  - IHS for imported goods including PEQ

Hydrodictyon reticulatum – Wells et al. (1999)



2007 – first prosecution

2. Management at the border

- Several interceptions since then
  - Prosecutions with fines ($100,000) and imprisonment
  - *Hydrilla verticillata*

10/7/2012

Japanese scumballs threaten New Zealand!

Student sentenced for importing fish tank algae

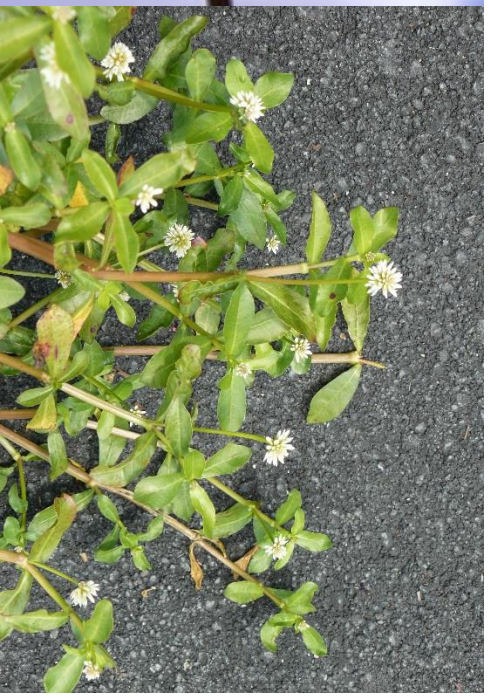
TVNZ | October 03, 2012

3. Pest risk assessment

- Weed Risk Assessment models
- Around since end of 1980's, mostly for screening imports
- Pheloung (1995) used in Australia and New Zealand
- Usually score of 1 or -1 allocated to each weed attribute
- Rejection score (no importation if >6)
- Further evaluate if score 1-6
- If an aquatic automatically score 5
- Model brands all aquatic spp. as potential weeds!!

3. Pest risk assessment

- Aquatic Weed Risk Assessment Model (AWRAM) Champion & Clayton (2000)
  - Model assesses:
  - Invasiveness – e.g. habitat versatility
  - Competitive ability
  - Dispersal – propagule/diaspore output, natural vs human (deliberate/accidental)
  - Impact – economic, environmental, recreational
  - Potential distribution – current vs uncolonised habitat
  - Resistance to management – scope of methods, effectiveness
- Maximum theoretical score of 100



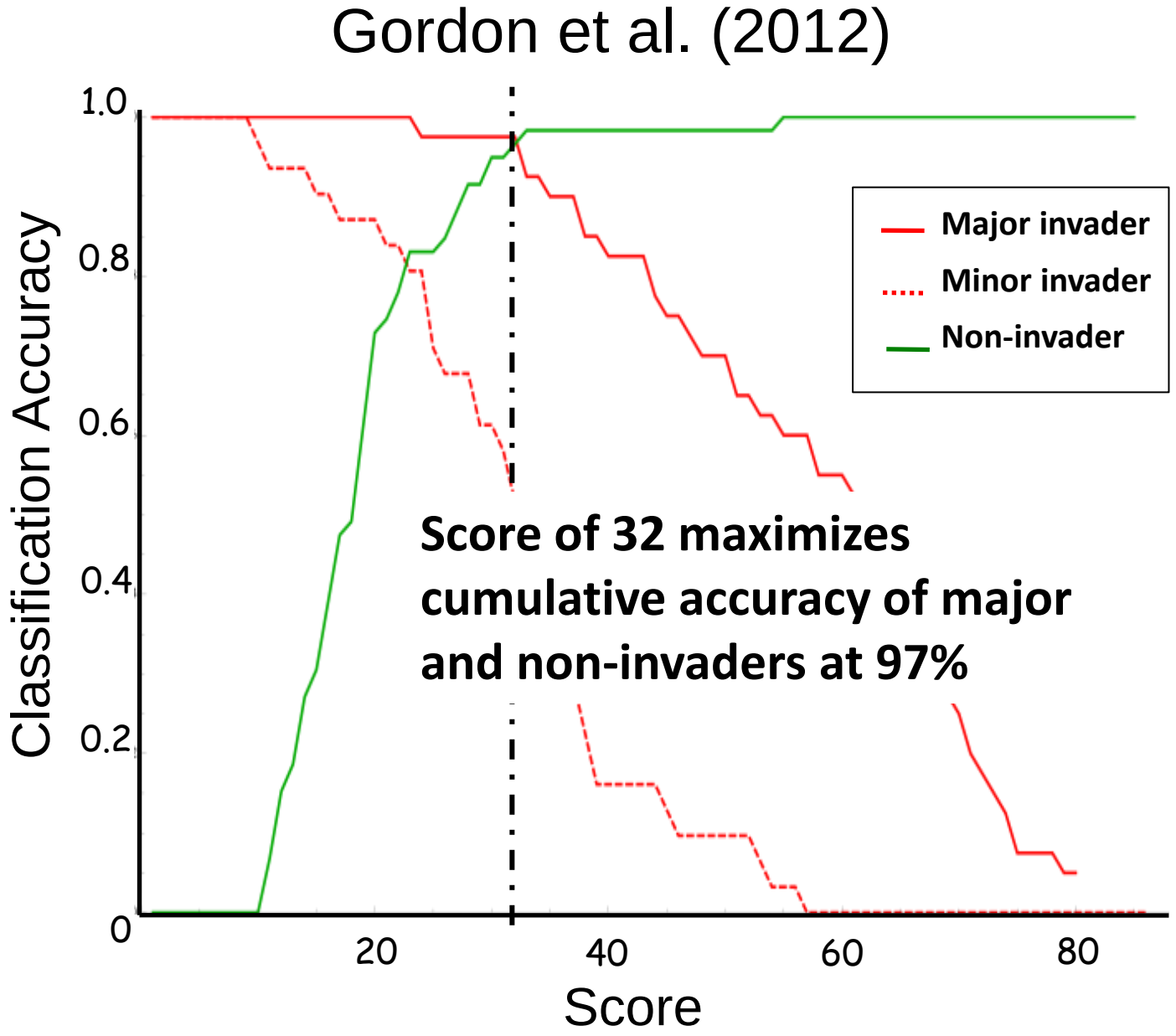
3. Pest risk assessment

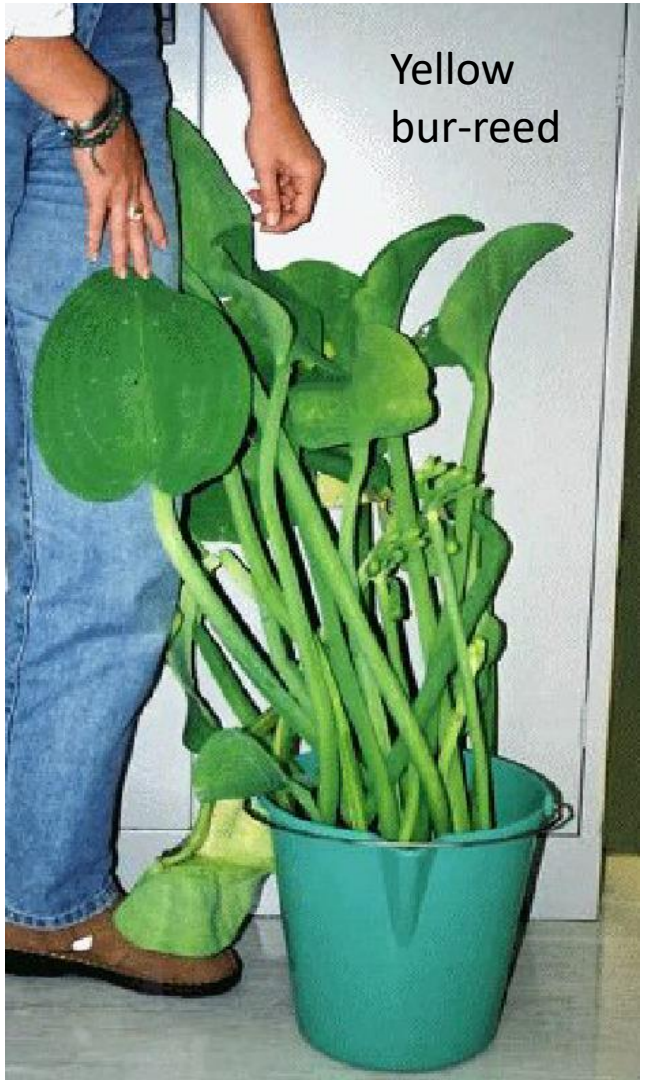
Champion et al. (2014)

Versatility	Temperature tolerance	1/3	8/10	6/10	1/2	Physical- water use (recreation)
	Salinity	1/1			0/2	Physical- access
	Range of habitat	3/3			2/2	Physical- water flow, power generation
	Water/substrate type	2/2			2/2	Physical- irrigation, flood control
	Water clarity	1/1			1/2	Aesthetic- visual, olfactory
Habitat	Lentic	3/3	8/9	6/10	5/5	Reduce biodiversity
	Lotic	2/3			1/3	Reduce water quality
	Wetland	3/3			0/2	Negatively affect physical processes
Competitive ability	Within growth form	5/8	7/10	3/3	2/2	Health impairment
	Between growth form	2/2			1/1	Weed of agriculture
Propagule dispersal	Natural dispersal outside catchment	0/5	4/10	4/9	4/9	Extent of suitable habitat
	Accidental dispersal outside catchment	2/3				
	Deliberate introduction outside catchment	1/1				
	Effective spread within water body/catchment	1/1				
Maturation rate	Maturation rate	3/3	3/3	4/10	1/2	Ease of implementation
					0/1	Recognition of problem
					0/2	Scope of control methods
					1/1	Suitability
					1/2	Effectiveness
					1/2	Duration of control
Seeding ability	Quantity	0/3	0/5	5/5	5/5	Problem in other countries
	Viability/persistence	0/2				
Cloning ability	Cloning ability	5/5	5/5			
			35	**28**		

Versatility	**Obstruction**
Habitat	**Damage to natural areas**
Competitive ability	**Other undesirable traits**
Propagule dispersal	**Extent of suitable habitat**
Maturation rate	**Resistance to management**
Seeding ability	
Cloning ability	**Problem in other countries**

3. Pest risk assessment





3. Pest risk assessment

Competition experiments

- Compare competitive ability pairwise with native species and introduced species of known weediness
  (e.g. Hofstra et al. 1999; Champion et al. 2007)

Controlled temperature experiments

- Compare growth of candidate species at different temperatures
  (e.g. Burnett et al. 2006)

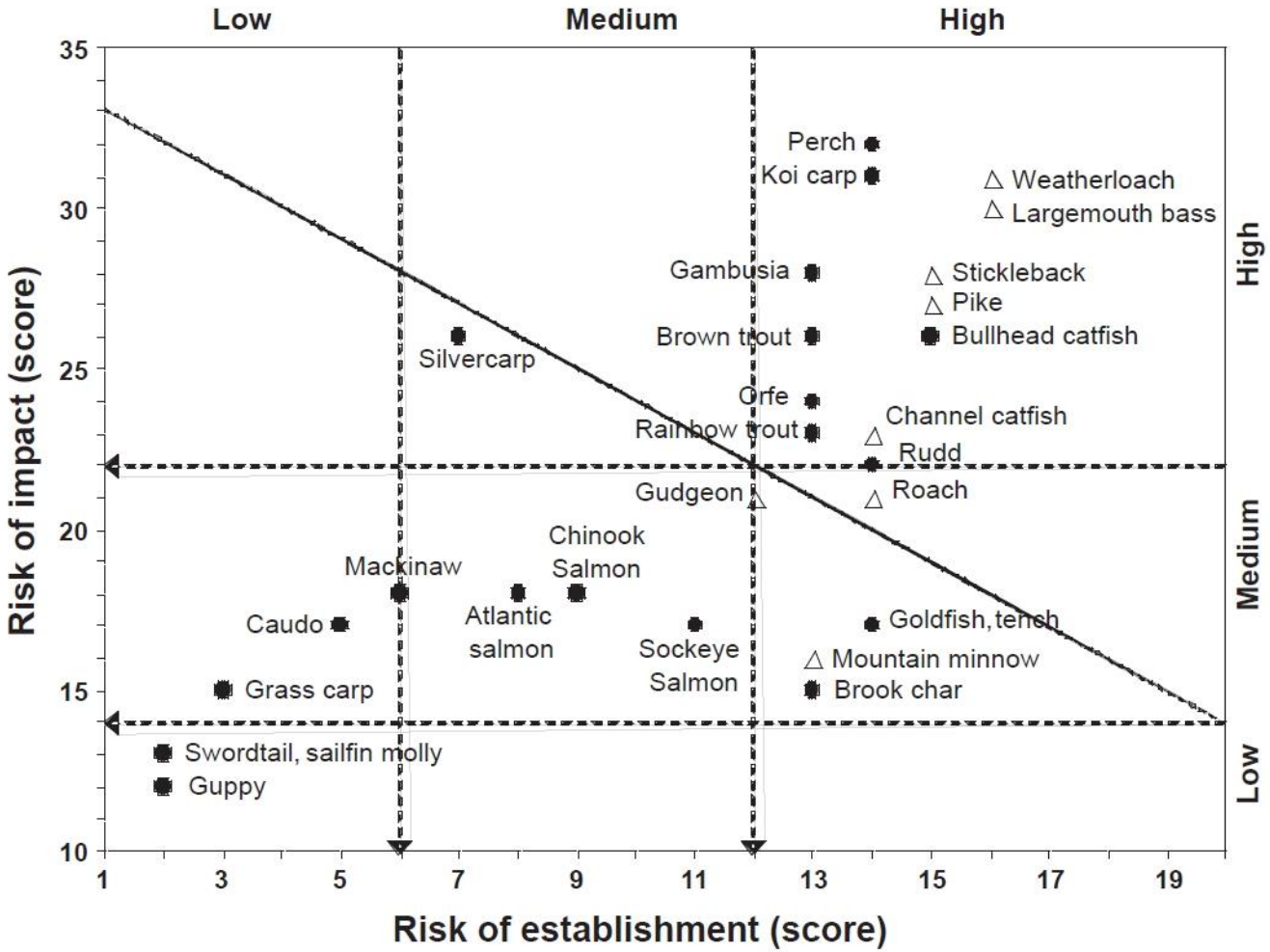
Ceratophyllum demersum

Hygrophila polysperma

Ruakura Research Facility, Hamilton, New Zealand

3. Pest risk assessment

- Risk assessment model for the introduction of non-native freshwater fish into New Zealand (Rowe & Wilding 2012)



4. Manage introduction/dispersal pathways

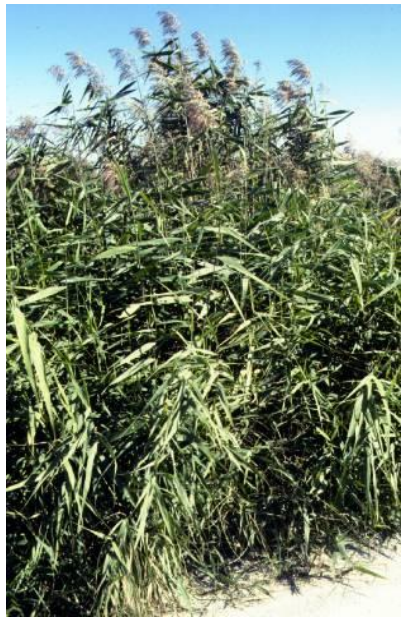
Rationale:

- All of NZ's current top 15 weeds are traded internationally, all but one are dispersed exclusively by humans
- 75% of naturalised aquatic plant species currently known from New Zealand were imported through the trade
- Humans are the main agents of spread, both accidentally and deliberately, especially long-distance dispersal
- Highly effective reduction in distance and volume being dispersed

4. Manage introduction/dispersal pathways

- Noxious Plant Act 1987
  - Class B species banned from sale and distribution
- Weed Risk Assessment models used to prioritise species (Biosecurity Act)
  - National Pest Plant Accord 2002
    - National Programme overseen by Ministry for Primary Industries with nursery industry, other central and regional government buy-in
  - ~30 aquatic plants declared Unwanted Organisms and banned from sale

4. Manage introduction/dispersal pathways






Species	AWRAM Ranking
Phragmites australis	75
Hydrilla verticillata	74
Zizania latifolia	68
Ceratophyllum demersum	67
Eichhornia crassipes	67
Egeria densa	64
Alternanthera philoxeroides	63
Lagarosiphon major	60
Nymphoides peltata	58
Typha latifolia	58
Gymnocoronis spilanthoides	57
Salvinia molesta	57
Myriophyllum aquaticum	56
Lythrum salicaria	54
Utricularia gibba	54
Iris pseudacorus	52






4. Manage introduction/dispersal pathways

- Also modified to assess:
  - Risks posed by the aquarium/ornamental pond plant trade in Australia (Petroeschevsky & Champion 2008)

    - ~ 400 spp. traded including 140 indigenous spp.
    - Of these 90 spp. are reported as weeds elsewhere
    - 25 spp. are recommended for national ban on sale, with 20 spp. requiring further evaluation

  - Aquatic weed risks to Micronesia (Regional Biosecurity Plan for Micronesia and Hawaii 2015)

    - 7 spp. recommended for eradication
    - Surveillance of high risk water bodies

4. Manage introduction/dispersal pathways

Didymosphenia geminata incursion to NZ in 2004

Developed a protocol for spread prevention

Includes recommendations for decontamination

Application to other freshwater pests

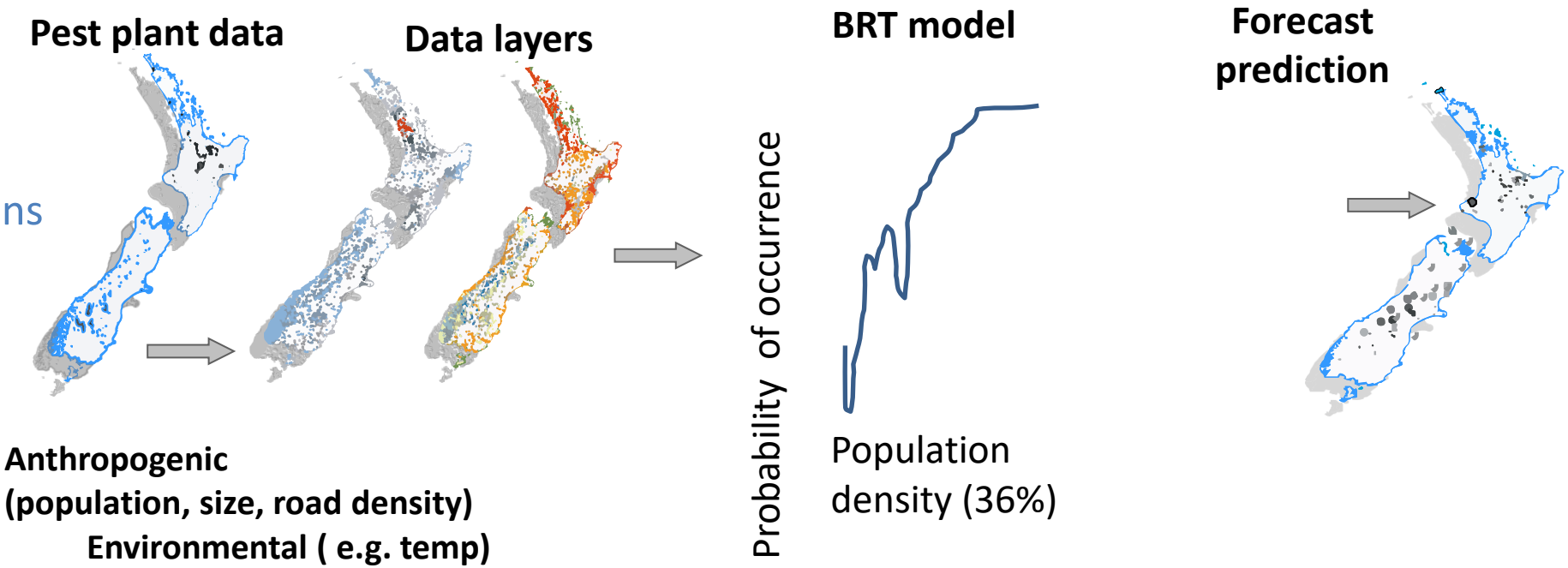
4. Manage introduction/dispersal pathways

Modelling approach (**B**oosted **R**egression **T**ree analysis – Compton et al. 2012, Leathwick et al. 2016).

Compton et al. (2012) used:

- Records for 4 weeds in lakes (presence/absence)
- Lake data representing human movement & activities, plus environmental
- Relationships between these data sets

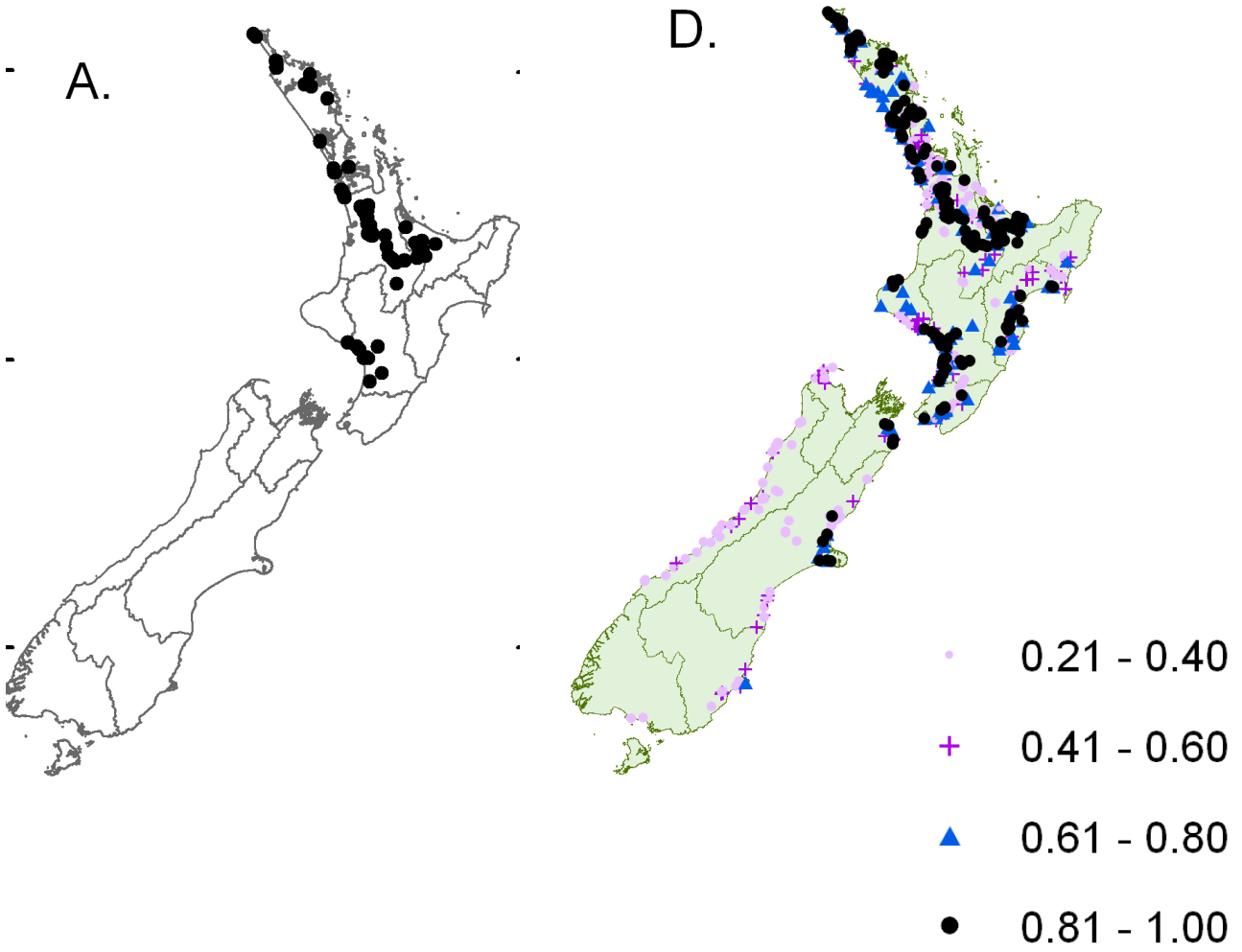
Model to forecast future pest distributions



4. Manage introduction/dispersal pathways

- Correlate to human population density, roading network and lake size
  - Except *Utricularia gibba*
- Up-weighted sparsely invaded records
- Forecast spread to new areas
- Discriminated well between current weed presence and absence (>0.9)

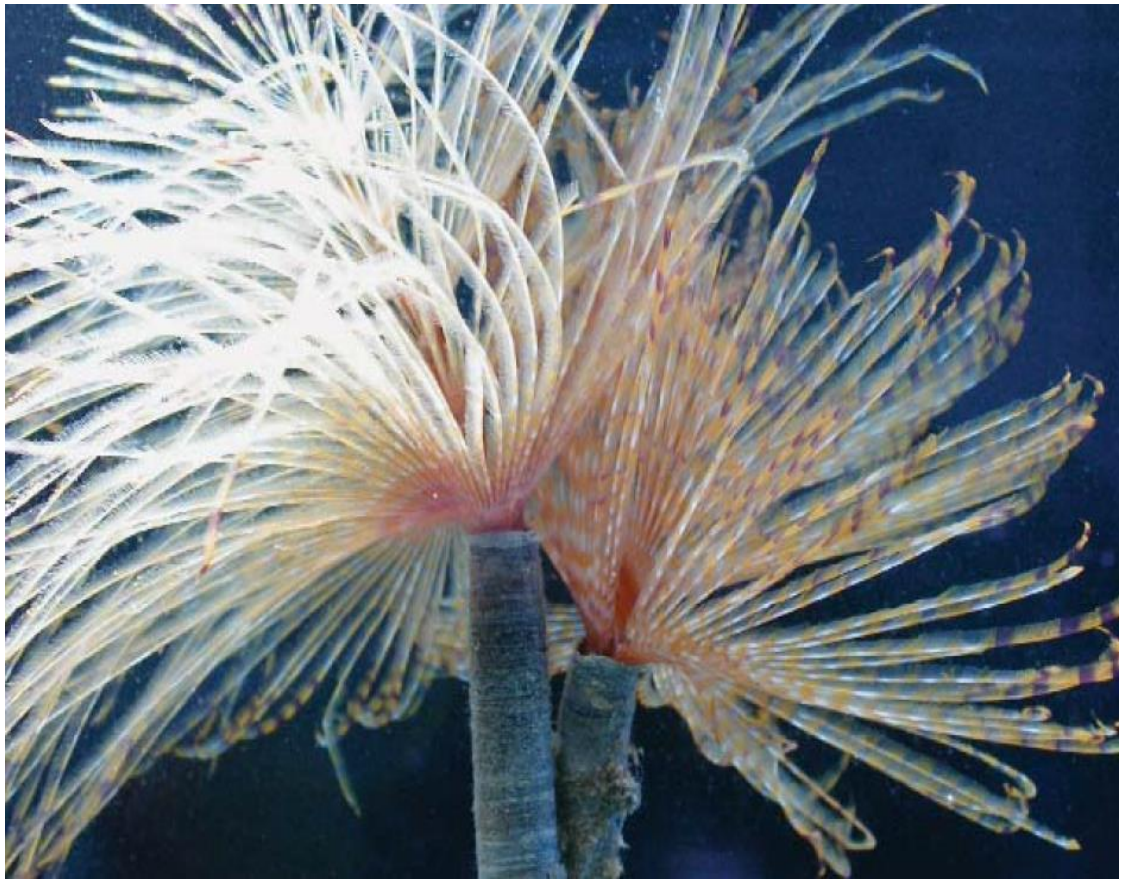
Example for Egeria



5. Surveillance

5. Surveillance

- Marine High Risk Site Surveillance Programme (detection of NO's)
  - NZ port surveys (11 ports) for new marine pests (Woods et al. 2017)
    - 351 non-indigenous species were identified (187 established)
    - 10% increase since baseline survey (2009)
    - Between 2010 and 2015, 33 new-to-New Zealand spp. (12 established)
- includes *Sabella spallanzanii* (NO)



5. Surveillance

Freshwater pests

- Prioritise waterbodies
  - Evaluation of waterbodies (type, value, condition)
- Biosecurity risk to water bodies
  - Which pests (distribution data – current/potential)
  - Which pathways
  - How likely is invasion (modelling data)
- Pest surveillance
  - Where and how to detect new incursions

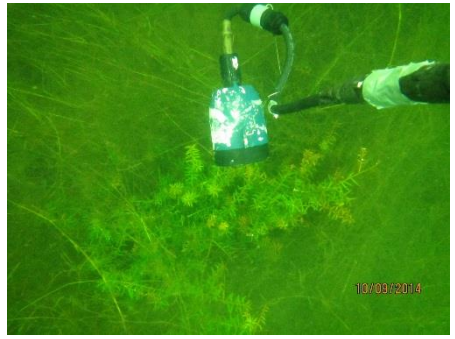
5. Surveillance

5. Surveillance

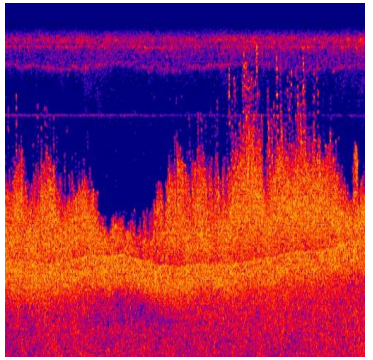
Shoreline search

Manta board tow

Scooter with SCUBA



Drop camera



Side scan sonar

5. Surveillance

Lake Ōkataina weed cordon

5. Surveillance

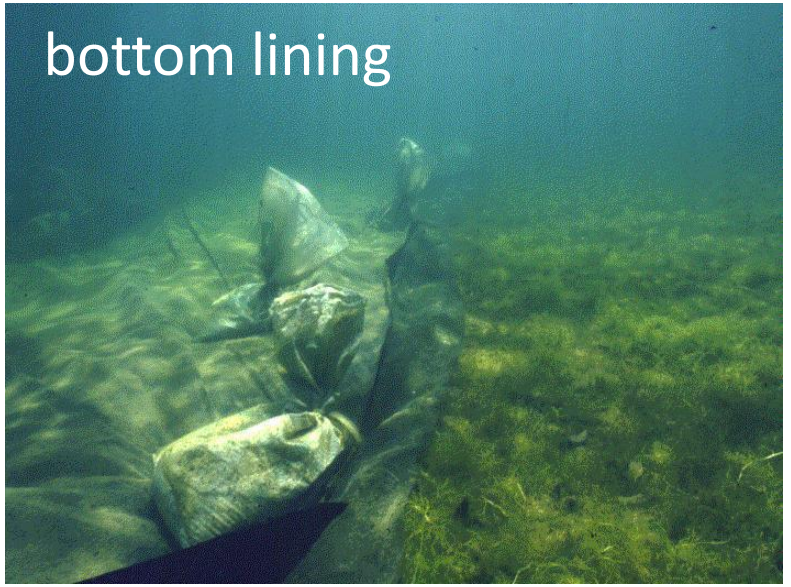
Lake Rotomā weed cordon

5. Surveillance

- Incursion response sequence from pre-planning to containment actions is established

6. Incursion response

6. Incursion response - control

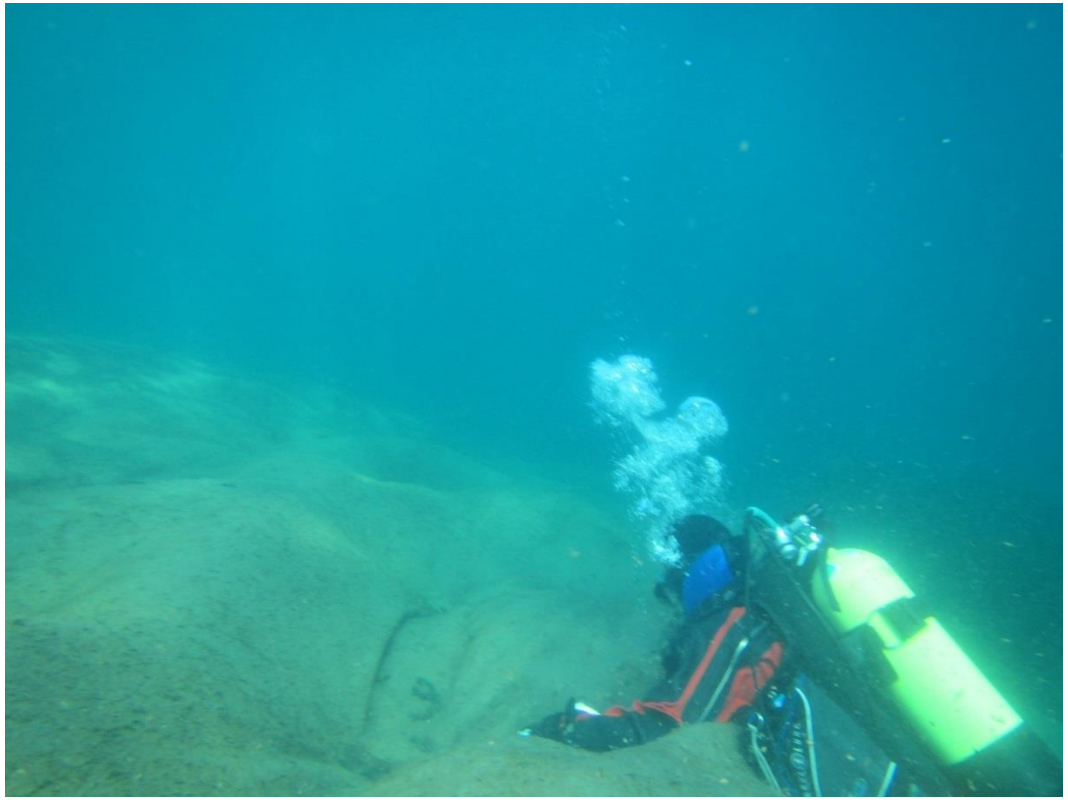


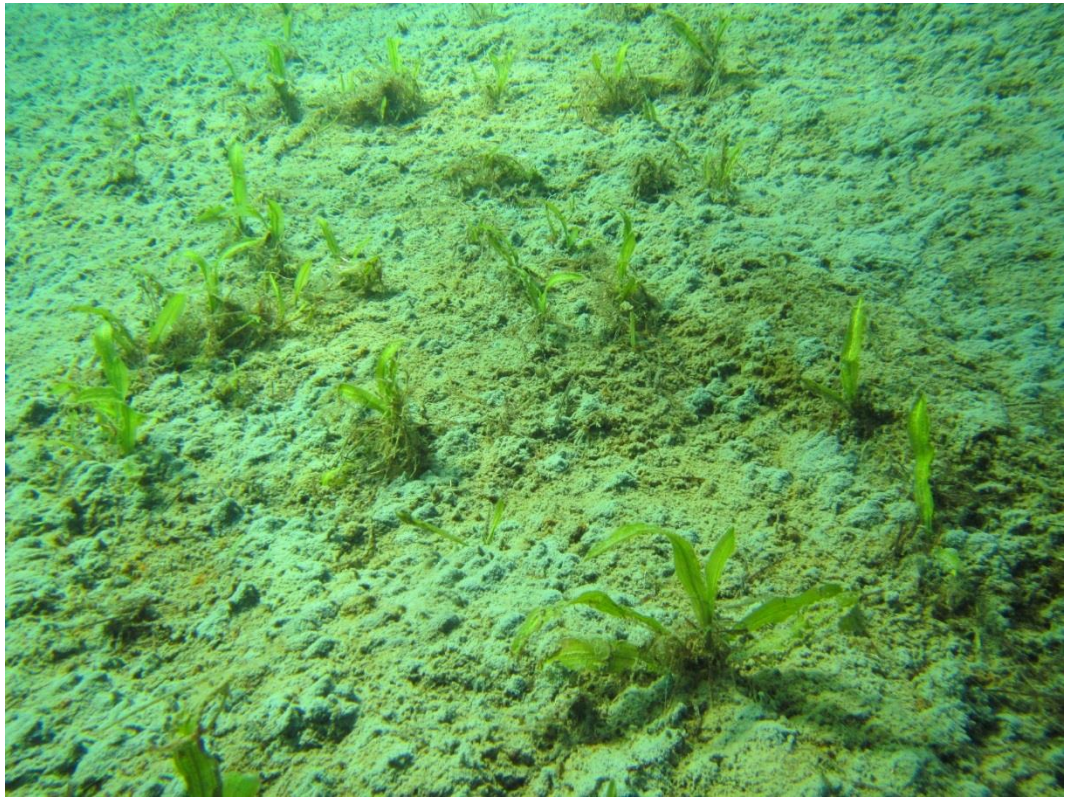
Delimitation, containment and an eradication programme using a range of control options

6. Incursion response – control research

- Herbicide use optimization (what, where, when, how often?)
- Herbicide placement (dyes, gel, drop nets)
- Pre-herbicide assessment protocols (dirtiness scale for diquat use)
- Bottom lining (synthetic to biodegradable)

6. Incursion response – application of research



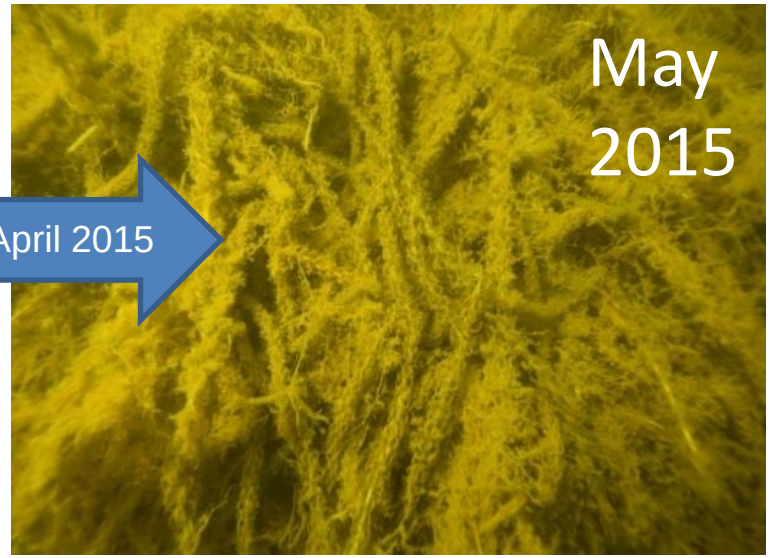


- Bottom lining using hessian matting
- 10% cost of suction dredging
- Selective eradication tool

Hofstra & Clayton (2012) based on Caffrey et al. (2010)

6. Incursion response - example

Endothall April 2015

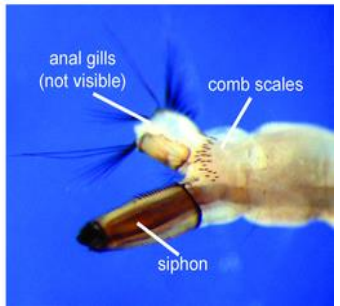


Native biodiversity maintained

7. Eradication

7. Eradication

http://www.abc.net.au/news/image/1964218-3x2-940x627.jpg



- *Aedes camptorhynchus* capable of transmitting Ross River fever
- First detected in 1998
- Eleven populations (all but one in NI)
- Regular aerial and ground-based application of S-methoprene and *Bacillus thuringiensis israelensis*
- Surveillance for mosquito larvae and adults to monitor for successful control and check available habitat
- Eradication programme cost about NZ$70 million

7. Eradication

Environment Southland/MPI/DOC confident undaria can be eradicated soon

June 19 2016
Environment Southland biosecurity officers are confident marine pest undaria will be successfully eradicated from Fiordland.

The highly invasive Japanese seaweed was discovered in Fiordland waterways in April 2010.

Biosecurity officer Shaun Cunningham said divers had not found the pest in Sunday Cove, Fiordland, since December 2015.

7. Eradication

Species eradicated from New Zealand

Species	AWRAM score	Status in NZ	Method of eradication
Nymphoides peltata	58	regional response (NPPA)	Benthic barrier, waterbody destruction
Typha latifolia	58	regional response (NPPA)	Herbicide, physical
Potamogeton perfoliatus	55	regional response (NPPA)	Physical removal
Butomus umbellatus	54	local response	Physical removal
Zizania palustris	45	national response	Mechanical
Menyanthes trifoliata	45	national response (NPPA)	Herbicide, physical
Pistia stratiotes	42	Eradicated Class A Noxious Weed (NO)	Herbicide
Eichhornia paniculata	18	local response	Physical removal


Butomus umbellatus


Pistia stratiotes


Nymphoides peltata


Potamogeton perfoliatus


Menyanthes trifoliata

7. Eradication





Coontail eradicated from all South Island sites – 2013

National Interest Pest Responses (NIPR) – MPI 2008 onwards

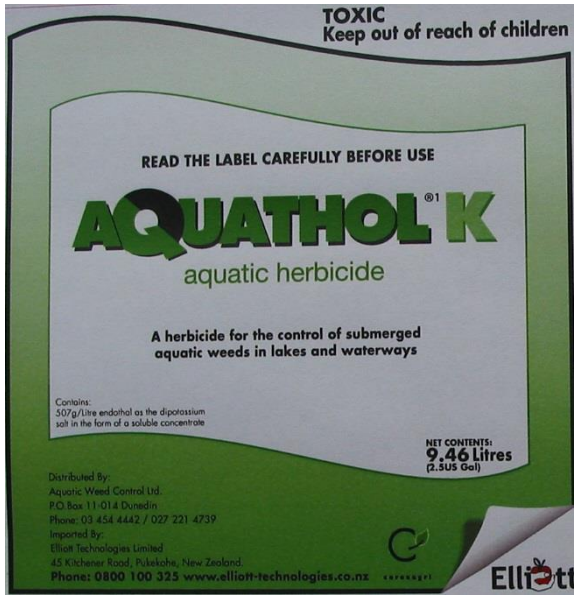
Phragmites australis	*75*	National program
Hydrilla verticillata	*74*	National program
Zizania latifolia	*68*	National (excluding a containment area)
Ceratophyllum demersum	*67*	South Island only
Eichhornia crassipes	67	National – since 1950
Salvinia molesta	57	National – since 1983

7. Eradication - example

Lake Eland hydrilla control trial – 1988 – Proof of concept


Lake Eland – John Clayton with a grass carp (2004)
Ctenopharyngodon idella Val.

7. Eradication



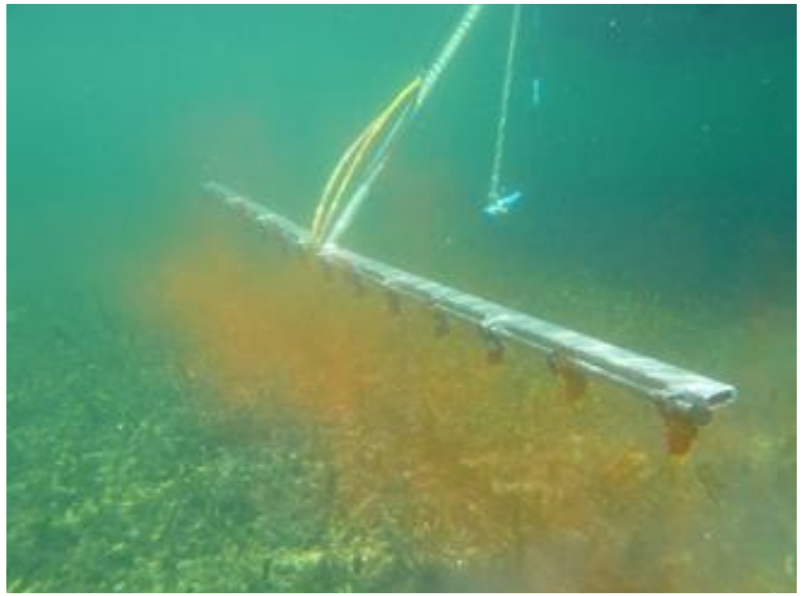
Hydrilla verticillata

NIWA research/management initiatives

- Lake Waikopiro – EUP trial using Endothall (2001)
- Limited commercial market for Endothall in New Zealand
- NIWA led consortium of central and regional government and power companies to fund an application for registration
- Registration in 2005

Lake Tutira

1.74 sq. km
2.4 km long
21 m max depth



Endothall used to reduce biomass of large weed beds


2700 grass carp released December 2008


TOYOTA

By fall 2010 – no hydrilla plants remained

Native milfoils dominated littoral zone

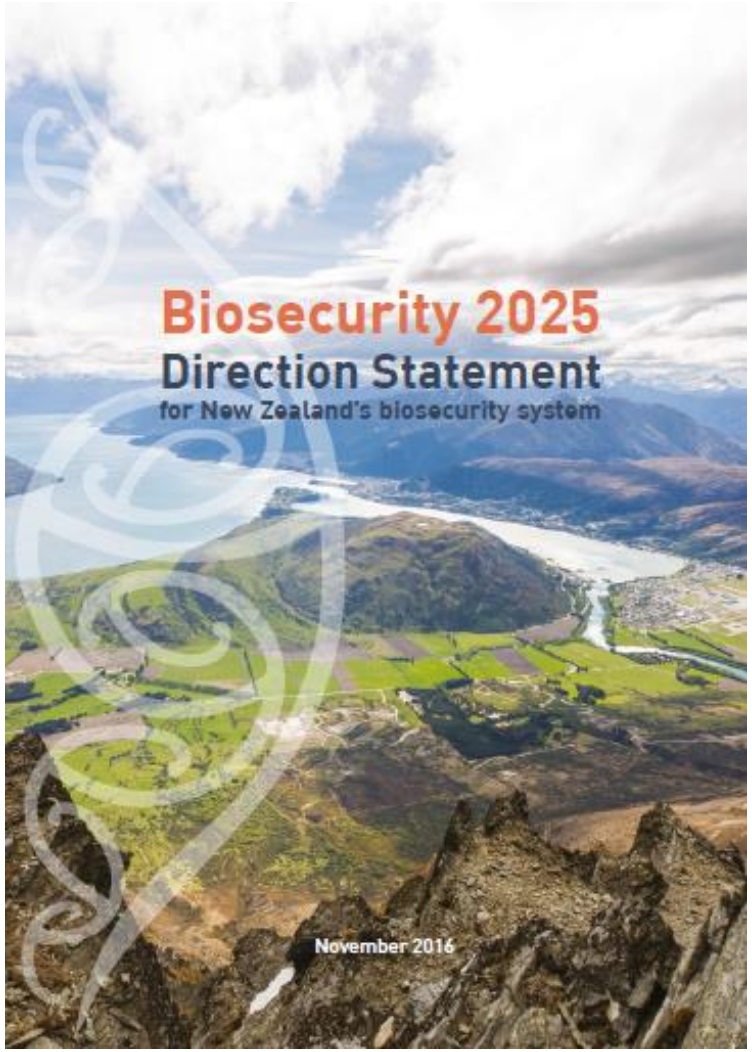
Some hydrilla plants amongst milfoil – more fish 2014

No hydrilla plants seen on last visit

Proactive management – why it works?

- New Zealand isolated with relatively small population
- Reliant on primary production, population familiar with the concept of biosecurity
- Freshwater a hugely valued resource
- Strong effective legislation
- Strategic focus
- National/regional interagency collaboration
- Initiatives engage all affected parties
- Science driven, with direct uptake of research

Biosecurity 2025

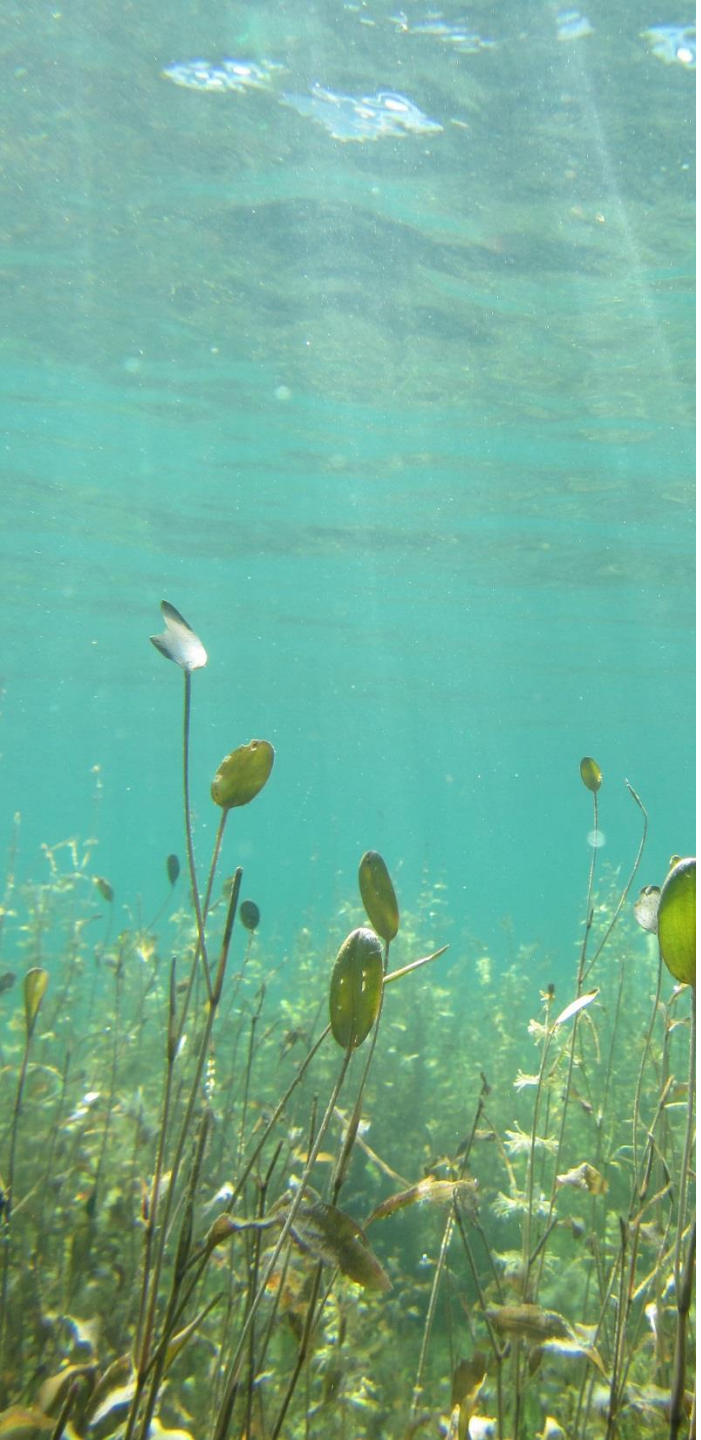


- A BIOSECURITY TEAM OF 4.7 MILLION – Every New Zealander and every New Zealand business becomes part of the team.
- A TOOLBOX FOR TOMORROW – Science and technology can revolutionise biosecurity. Innovation must be prioritised, adapted and applied.
- FREE-FLOWING INFORMATION HIGHWAYS – Information underpins biosecurity decision-making. Need to better to inform risk management in real time.
- EFFECTIVE LEADERSHIP AND GOVERNANCE – System-wide leadership and inclusive governance support all participants.
- TOMORROW'S SKILLS AND ASSETS – A capable and sustainable workforce and world-class infrastructure provide the foundation for an effective system.


Successful biosecurity means
that nothing changes

What might have been?

Topped-out hydrilla



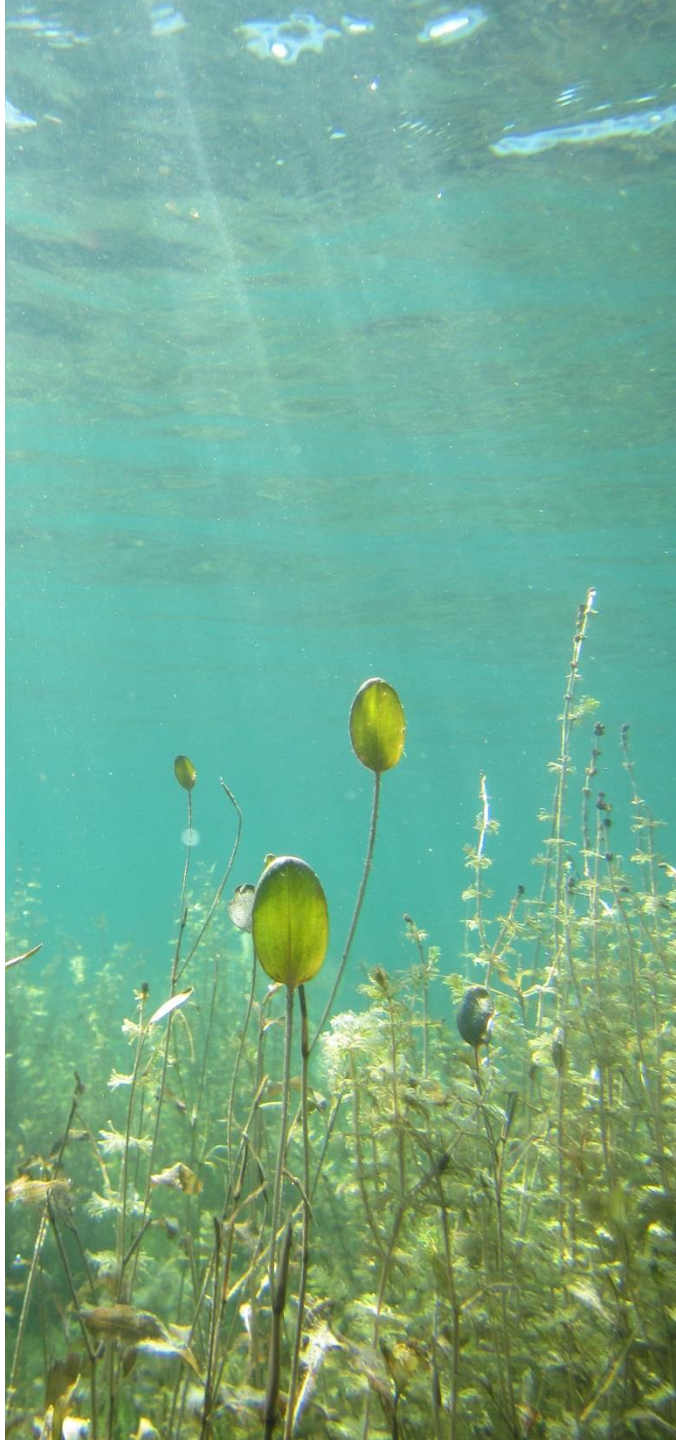
You are invited to ...

New Zealand 2018

15th International Symposium on Aquatic Plants

Rydges Queenstown, New Zealand

18th to the 23rd February 2018







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NIWA
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