Using the New Zealand Aquatic Weed Risk Assessment Model to manage potential weeds in the ornamental trade

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Introduction

- The international aquarium and pond plant trade
- Potential pathways for aquatic weed introduction
- The Aquatic Weed Risk Assessment Model AWRAM (Champion & Clayton 2000) as a decision support tool
- Pre-border and border management
- Banning from sale as a management tool
- Additional information requirements and experimental approaches

The International Aquarium and Pond Plant Trade

Huge number of aquarium plant growers and suppliers:

- e.g. Singapore, Indonesia, Thailand
- Tropica (Denmark) produces 2 M plants p.a.
- Pisces (Queensland) stock over 700 plant varieties

Significant amount of the trade supplied by wild collected material

The International Aquarium and Pond Plant Trade

European and Mediterranean Plant Protection Organisation (EPPO) (2007):

- Charles de Gaulle Airport (Paris) aquarium plant imports during 2006
- >350 consignments
- 38 consigments in June contained ~ 100,000 samples with ~162 taxa, many mislabelled

Maki and Galatowitsch (2004) ordered plants from around USA:

- >90% had contaminant plants including AIS
- >90% non-compliant, supplying banned spp.

Even higher numbers of pond plant growers often associated with nurseries supplying garden plants

Potential Pathways for Aquatic Weed Introduction

Most current aquatic weeds were deliberately introduced into NZ:

- 75% of the 50+ naturalised species imported through the trade
- Only 3 of the 30 species managed under legislation were not imported through the trade

There are few accidental pathways for entry:

- Contamination of aquatic plants or related material
- Historical introduction e.g. through ballast

AWRAM as a Decision Support Tool

Aquatic Weed Risk Assessment Model (AWRAM)
Champion and Clayton (2000)

Model assesses:

- Invasiveness – habitat versatility, competitive ability
- Impact – economic, environmental, recreational
- Dispersal – propagule/diaspore output, natural vs human (deliberate/accidental)
- Potential distribution – current vs uncolonised habitat
- Resistance to management – scope of methods, effectiveness

Maximum theoretical score of 100

AWRAM as a Decision Support Tool

AWRAM score is a synthesis of characters relevant to the weed potential and management of a species

Provides a means for managers/policymakers to prioritise species for control actions

AWRAM requires well documented information on the species performance which can be supplemented with field observations (e.g. other spp. displaced, management effectiveness etc.)

Pre-border and Border Management

Many potential problem spp. not present in New Zealand or Australia are traded internationally

AWRAM can evaluate potential weeds not present in a country comparing them with existing weed spp.

Unwanted Organism (UO) status under the Biosecurity Act (1993) prevents legal importation of spp. not known from New Zealand

Pre-border and Border Management

Under the Biosecurity Act a UO must:

- be capable of forming self-sustaining populations
- have the potential to cause adverse impacts (economic, environmental and cultural)

Many spp. are likely to fit both these criteria, but unrealistic to prevent introduction of all such spp.

In New Zealand non-resident spp. evaluated as risk plants by AWRAM are designated UOs e.g.:

Sparganium erectum, Myriophyllum spicatum, Najas marina, N. guadalupensis, Typha domingensis, Trapa natans, Stratiotes aloides

Trapa natans

Water chestnut

Sparganium erectum

Branched bur-reed

Pre-border and Border Management

Importation into New Zealand under increased scrutiny:

- mail – soft x-rays
- passengers – soft x-rays and beagles
- freight – container inspections
- freight – importation of fishing, boating, diving gear IHS

Post-entry quarantine

Issue with illegal imports (27% of spp. in trade!), including some UOs not previously recorded in NZ


Typha latifolia
Greater reed-mace

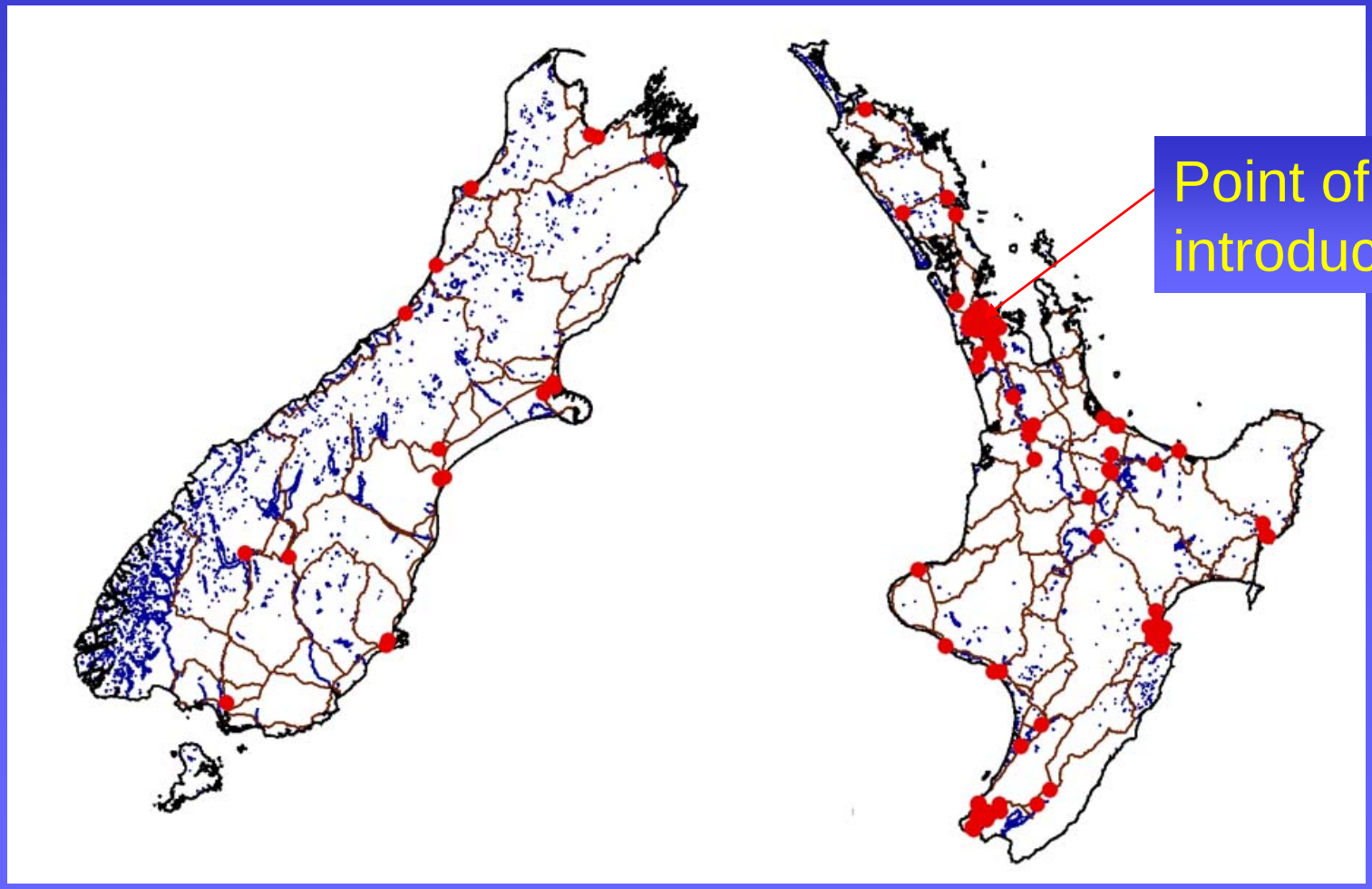
Banning from Sale as a Management Tool

Rationale:

- All of NZ's current top 15 weeds are traded internationally but none are dispersed by wind or waterfowl, except *Utricularia gibba*
- Humans are the main agents of spread, both accidentally and deliberately, especially long-distance dispersal
- Trade of aquatic plants is an effective dispersal mechanism
- Freshwater bodies/catchments are islands in a sea of land
- Once established, many weeds are almost impossible to effectively manage with current methods and legislation

Highly effective reduction in volume being dispersed

Trace-forward of all risk items from internet sales (from recent aquatic plant smuggling case)



The New Zealand and Australian Aquarium and Pond Plant Trade

Quantify what species are in cultivation:

- based on species lists from aquarium/pond plant suppliers (verification and check for synonyms)
- based on surveys/visits to suppliers (e.g. Champion & Clayton 2001)

Literature search for weedy tendencies:

- including published information on their invasiveness, weed lists, Global Weed Compendium, ISSG etc.
- also include evaluation of known naturalised sites

The New Zealand and Australian Aquarium and Pond Plant Trade

New Zealand:

- ~ 180 spp. traded that are not naturalised
- Of these 73 spp. are reported as weeds elsewhere
- 30 spp. are on NPPA

Australia:

- ~ 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

Banning from Sale as a Management Tool – the NZ Top 16

Species	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

Modifying AWRAM for Australia and to capture factors relating to the trade

Parts of the New Zealand Aquatic Weed Risk Assessment Model were not appropriate for mainland Australia (e.g. hydro-electricity impacts), or did not fit with different climatic zones (e.g. tolerance to freezing).

The new model increased the importance of competitive ability, the importance of fluctuating water levels, turbidity, increased salinity (southern and inland areas), irrigation and flood control.

The model also includes factors relating to the ornamental plant trade including:

- if the plant has been traded for more than 25 years without naturalising (- 5 to + 5)
- volume of trade (- 5 to + 5)
- water plant use (pond vs aquarium vs foodplant) (max. of 10)

The Aquarium and Pond Plant Trade – relevant factors for risk assessment

Amount of time in the trade:

- If traded for 25+ years without naturalisation is a sp. low risk?
- No mechanism for lag phase when spread is by asexual propagules?

Volume of trade:

- Similar issues if high volume without naturalisation

Aquarium vs. pond plants:

- Plants grown outside at ambient temperatures are likely to have a much greater risk of naturalisation

Some Australian spp. recommended for a national ban

Alternanthera philoxeroides	**WONS**	**AAWRA score=94**
Myriophyllum aquaticum	**Banned in Tas, WA, ACT**	**AAWRA score=92**
Salvinia molesta	**WONS**	**AAWRA score=91**
Eichhornia crassipes	**Banned in all states**	**AAWRA score=88**
Gymnocoronis spilanthoides	**Banned in all states except NT, V**	**AAWRA score=88**
Cabomba caroliniana	**WONS**	**AAWRA score=87**
Egeria densa	**Banned in Tas, SA, NT, WA, NSW**	**AAWRA score=84**
Iris pseudacorus	**Banned overseas**	**AAWRA score=84**
Ludwigia peruviana	**Banned in SA, NSW, WA, Q**	**AAWRA score=83**
***Lythrum salicaria* 'non-indigenous cvs'**	**Major weed in US, both native and introduced strains sold**	**AAWRA score=79***
Typha latifolia	**Banned in WA**	**AAWRA score=76**
Eichhornia azurea	**Banned in NSW, WA, Q**	**AAWRA score=75**
Hygrophila costata	**Banned in NSW, WA, Q**	**AAWRA score=74**
Trapa natans? **if present in Australia**	**Banned in all states except V, ACT**	**AAWRA score=74**
Sagittaria platyphylla	**Banned in Tas, SA, NSW, WA**	**AAWRA score=73**
Myriophyllum spicatum? **if present in Australia**	**Banned in all states except V, ACT**	**AAWRA score=71**
Lagarosiphon major	**Banned in all states**	**AAWRA score=70**
Sagittaria sagittifolia	**Banned overseas**	**AAWRA score=67**
Sagittaria montevidensis	**Banned in Tas, SA, NSW, WA**	**AAWRA score=67**
Hydrocotyle ranunculoides	**Banned in SA, WA**	**AAWRA score=66**
Stratoites aloides? **if present in Australia**	**Banned in SA, NSW, WA, Q**	**AAWRA score=47**

Additional Information Requirements

Many aquatic spp. in the trade do not have a weed history in the country (e.g. *Cabomba caroliniana* in New Zealand)

Key gaps in assessment

- How competitive will a species be?
- What habitat is likely to be colonised?

Experimental evaluation:

- Competition trials
- Assessment of performance in a range of environments

Experimental Testing of Aquatic Plants

Competition experiments

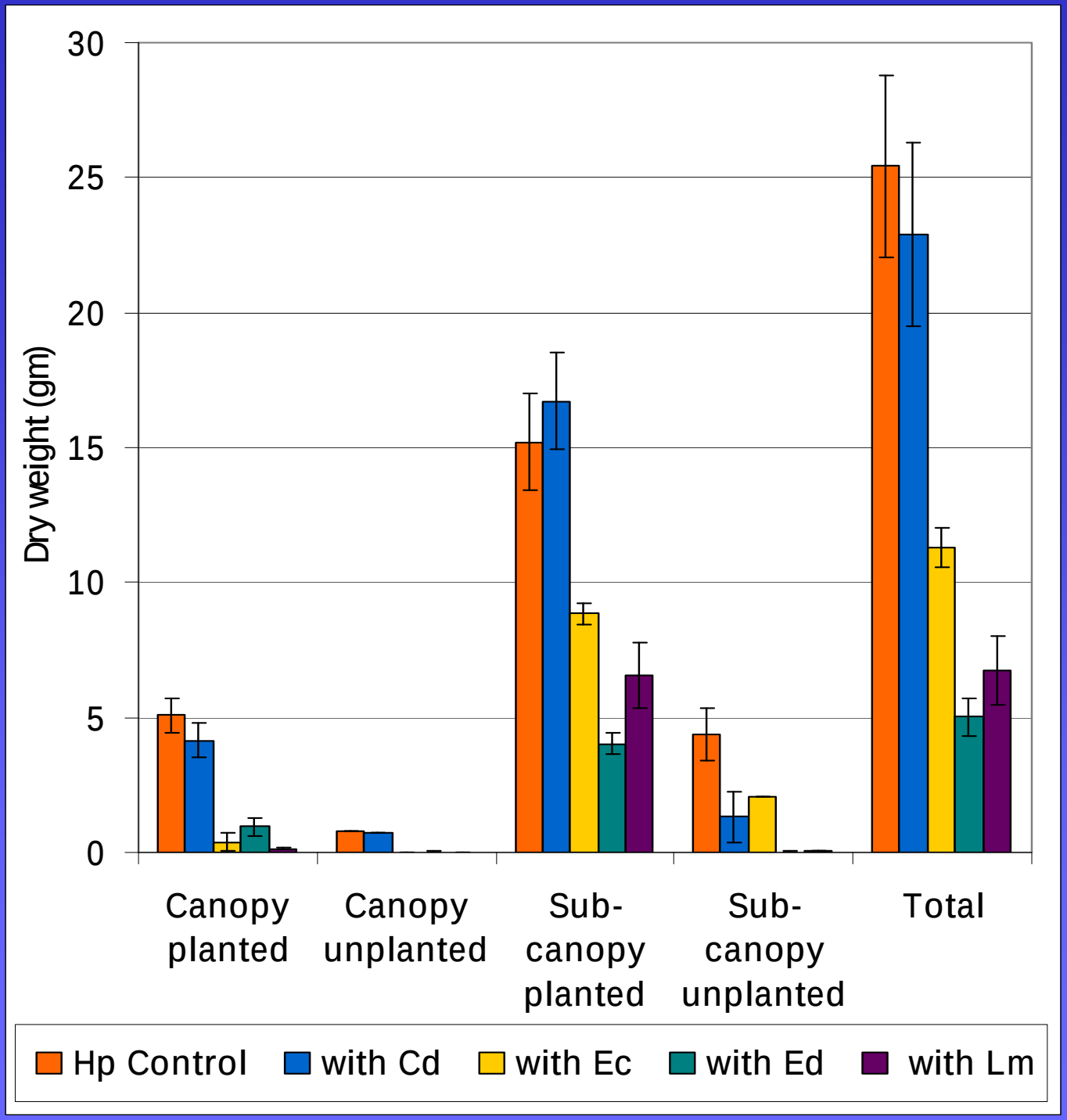
- Compare competitive ability pairwise with native species and introduced species of known weediness (e.g. Hofstra et al. 1999; Champion et al. 2007)

Controlled temperature experiments

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

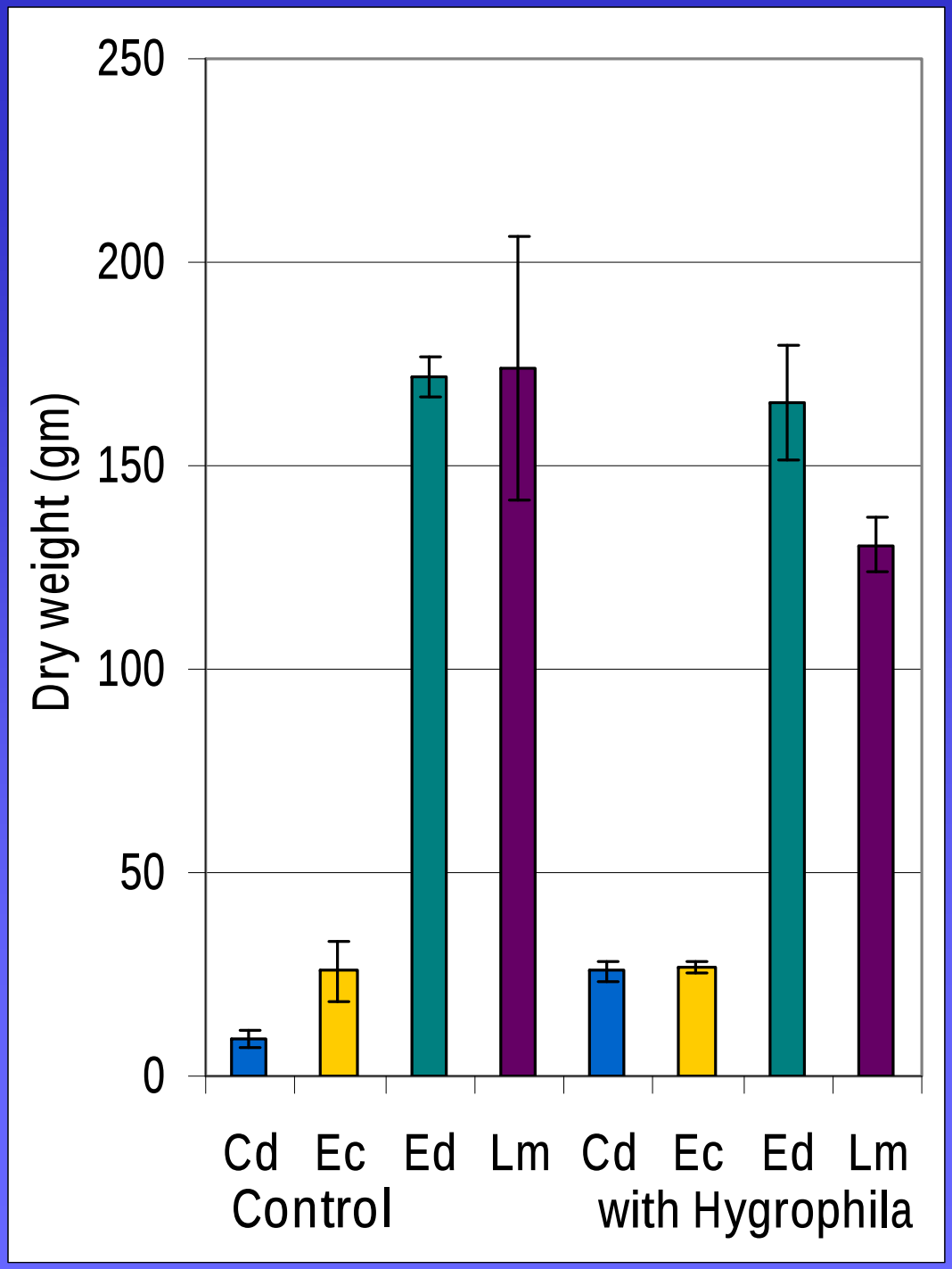
Other environmental variables

- Compare growth of candidate species under different nutrient conditions (e.g. Hastwell et al. 2007)



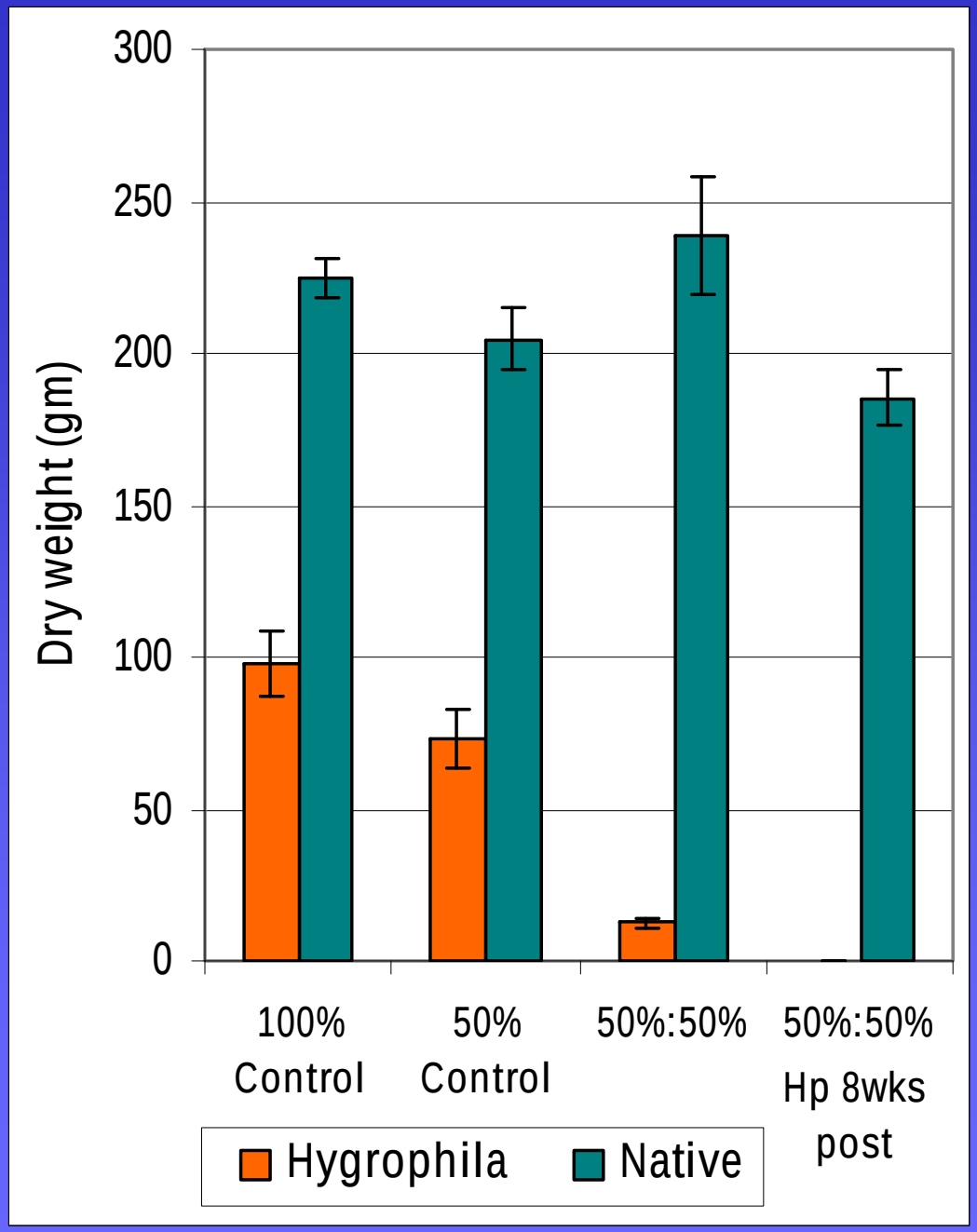
Hygrophila performance

- Best with ceratophyllum
  - same as control
- Worst with egeria and lagarosiphon
  - restricted to the sub-canopy where it was planted



Known Weed performance

- Biomass not negatively impacted by hygrophila

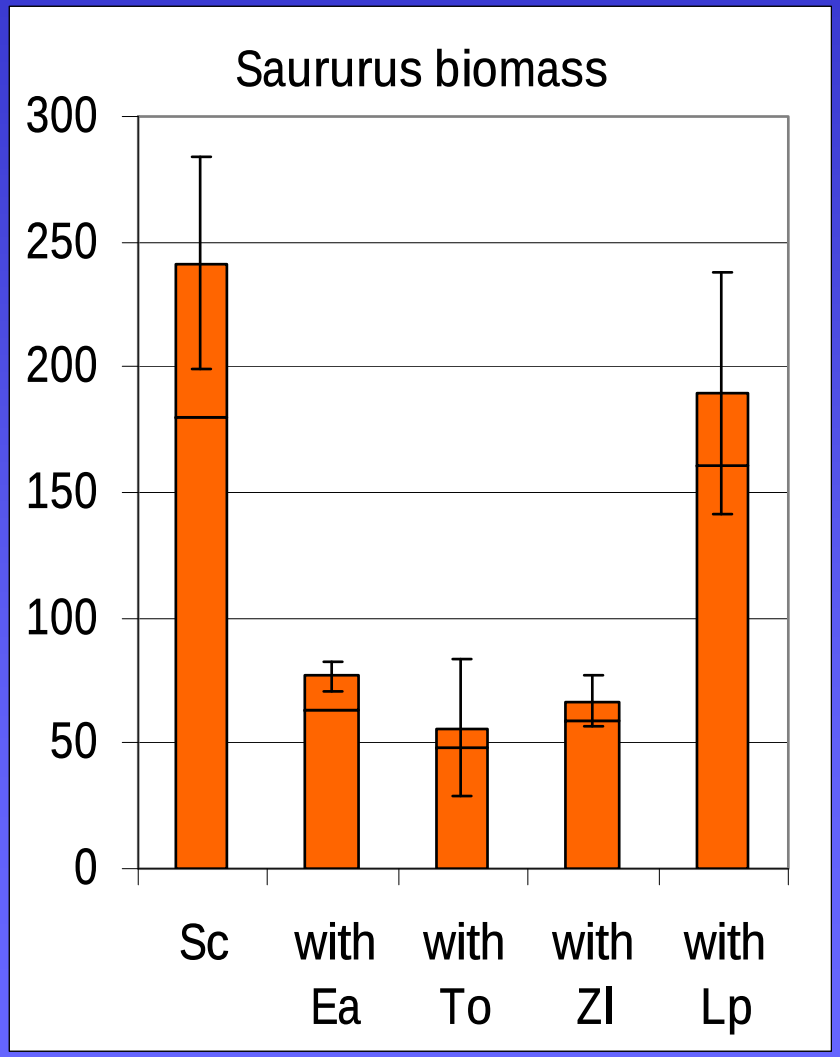


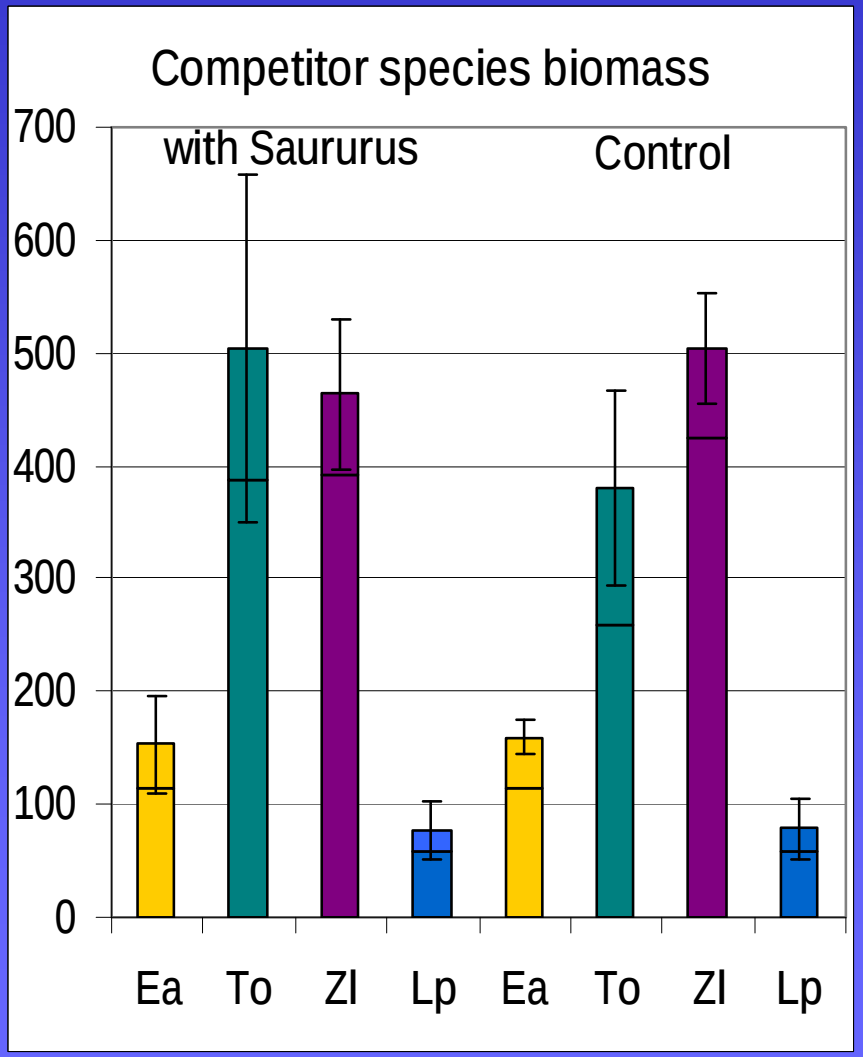
Hygrophila

Performance vs Natives

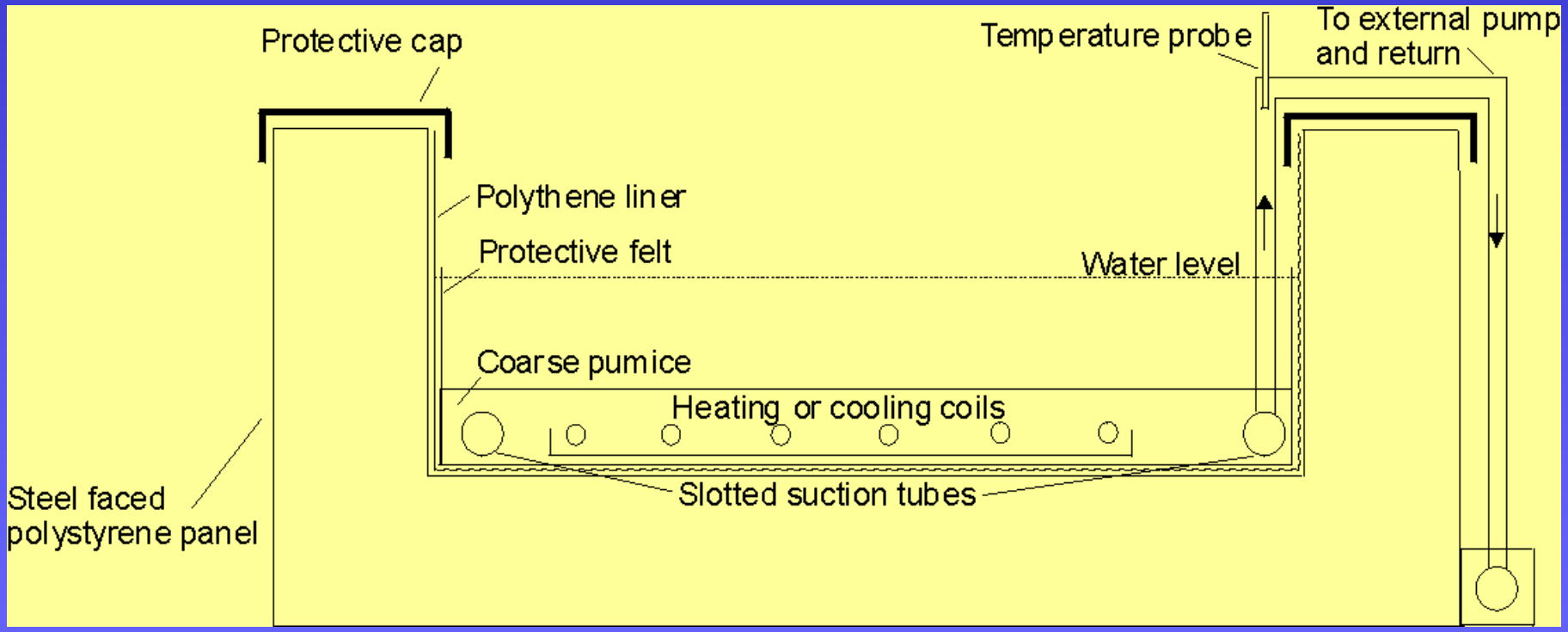
- Native biomass not negatively impacted by hygrophila
- Hygrophila biomass was significantly lower in tanks with native plant

Saururus vs Competitor species





Temperature chamber construction



Experimental testing of aquatic plants in Australia

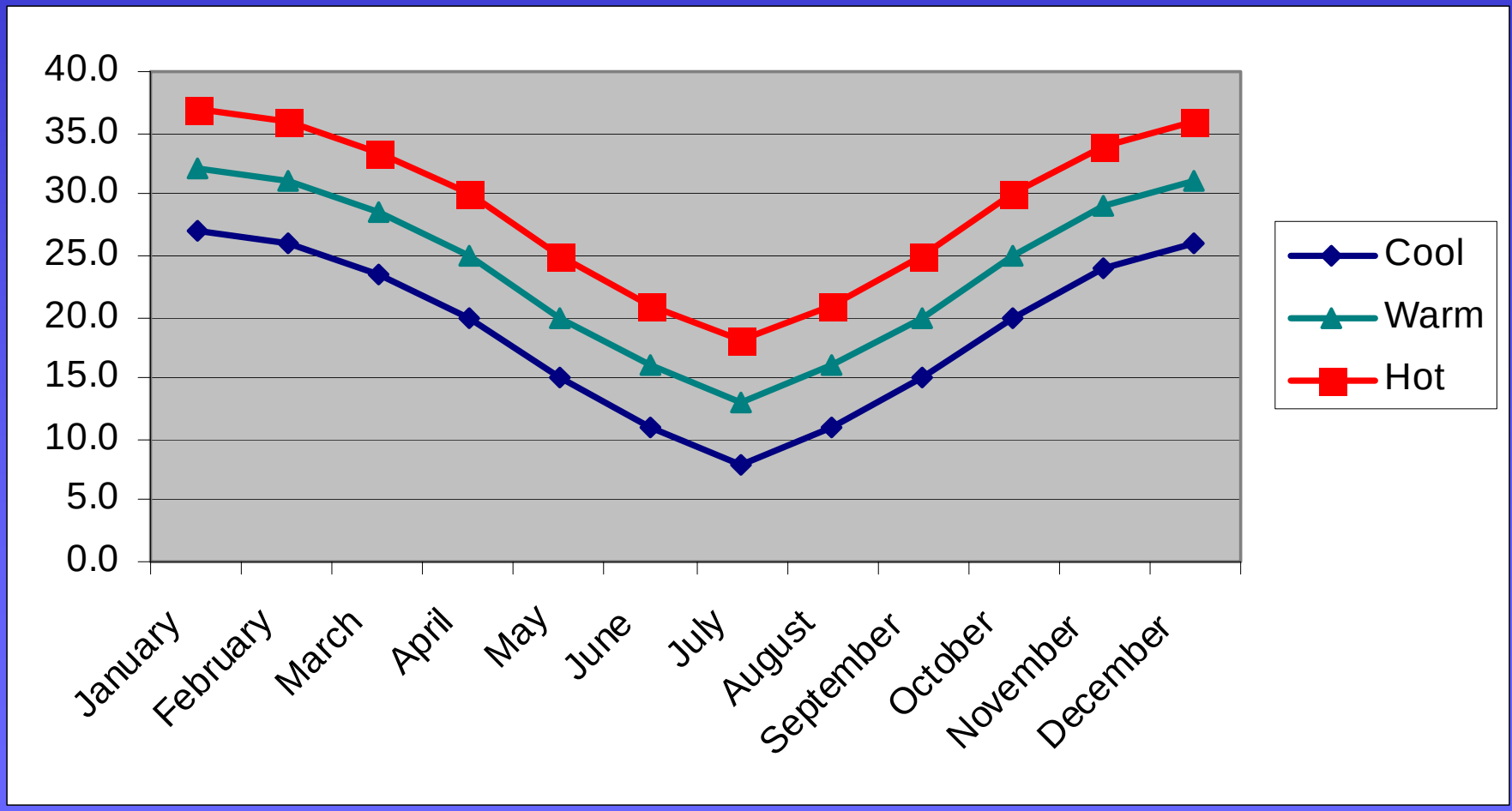
14 tanks: Tropics (Mid Queensland), Warm (NSW)

7 tanks: Cool (Central Victoria) set up in Hamilton, NZ

Matching water temperature to the range experienced in Australia (literature and data search)

Submerged and sprawling emergent spp. tested

Temperature regimes



A selection of plants requiring further evaluation

Ammannia senegalensis
Bacopa caroliniana
Myriophyllum pinnatum
Nelumbo lutea
Echinodorus cordifolius
Elodea canadensis
Heteranthera reniformis
Houttunyia cordata
Hydrocotyle leucocephala
Hygrophila polysperma
Hygrophila triflora (difformis)
Limnophila sessiliflora
Lysichiton americanum
Blyxa japonica
Butomus umbellatus
Neptunia oleracea
Nuphar lutea
Pontederia cordata
Rotala rotundifolia
Sagittaria graminea
Thalia dealbata
Typha laxmannii
Limnobium laevigatum
Zosterella dubia

Experimental testing of aquatic plants

Species chosen:

Test spp.	*Hygrophila polysperma, H. triflora* (NZ only), *Heteranthera reniformis* (Australia only), *Limnophila sessiliflora*
WONS spp.	*Alternanthera philoxeroides, Cabomba caroliniana*
Native spp.	*Ludwigia peploides, Hydrilla verticillata*

Candidate spp. were chosen with high volume in trade &/or indications of weediness overseas

This approach provides:

- a way to allay the concerns of aquatic plant traders that some states/territories declare aquatic plants in an ‘ad hoc’ manner and ‘without scientific process’

- a protocol to evaluate new species proposed for importation

- a partnership approach with aquarium and nursery industry, researchers and management/policy agencies


Heteranthera reniformis

Key Points

- Banning the importation of potential aquatic weeds keeps risks off-shore
- Banning from sale is a highly effective management tool by restricting the dispersal of potential aquatic weeds
- An Aquatic Weed Risk Assessment Model is an important decision support tool
- To implement a ban from sale for species already traded, the decision must be defensible and science-based
- It is advisable to involve all affected parties in the process
- It needs to be a dynamic process able to respond to new information and new species as they appear

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