Date of Publication:
December 2018

Cunninghamia
A journal of plant ecology for eastern Australia

The Royal Botanic Garden Sydney

ISSN 0727-9620 (print) • ISSN 2200-405X (Online)

The current status of exotic freshwater vascular plants in Australia - a systematic description

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Abstract: Freshwater systems are considered particularly vulnerable to human impact, through habitat modification, changes to water regimes and quality, invasion by exotic species and climate change. Using various records, we conducted a descriptive analysis of the naturalised freshwater plant species in Australia. There are 63 freshwater plant species belonging to 45 genera and 26 families naturalised in Australia with the dominant families being Cyperaceae, Poaceae and Plantaginaceae. More than 40% of these species are categorised as either invasive or declared weeds, the majority being perennial wetland marginal plants. They originated from all the inhabited continents with most of the species being native to Europe, South America and North America. The greatest number of species are currently found in New South Wales (90%), Queensland (68%) and Victoria (65%); the ornamental aquarium plant trade was identified as the main introduction pathway. Most species are clonal plants with flexible modes of reproduction and multiple dispersal vectors. We conclude that exotic plant species are now an important component of Australia's freshwater systems and that ongoing monitoring of their status, distribution and impact should be a high priority in light of the increasing influence of anthropogenic factors including climate change.

Key words: aquatic; ecosystem; flora; invasive; native; naturalised; ornamental

Cunninghamia (2018) 18: 123–133
doi:10.7751/cunninghamia.2018.18.008

Introduction

Freshwater ecosystems are estimated to cover about 3% of the Earth's land surface area (Downing *et al*. 2006) but they provide habitat to a disproportionately high number of specialised plant and animal species (Balian *et al*. 2008). Globally, these ecosystems are experiencing severe declines in biodiversity due to a mix of human-mediated threats such as pollution, overexploitation, flow modification, habitat degradation and invasive species (Dudgeon *et al*. 2006). These declines in many cases are more pronounced compared to terrestrial ecosystems (Sala *et al*. 2000); it has been argued that freshwater ecosystems are the most threatened of global ecosystems (Saunders *et al*. 2002; Dudgeon *et al*. 2006). Despite freshwater ecosystems being extremely species-rich and harbouring many threatened species (Abell *et al*. 2008), they do not receive the same conservation efforts and research attention as terrestrial ecosystems (Brundu 2015). For example, there is comparatively little information on freshwater plants, insects, molluscs and crustaceans in most parts of the world (Revenga *et al*. 2005) possibly due to the difficulty of monitoring freshwater ecosystems (Brundu 2015).

One of the most significant threats to freshwater ecosystems is the widespread introduction of exotic plant species into new areas as a result of increased international human travel and trade (Mack *et al*. 2000). Most species are introduced deliberately for ornamental or agricultural purposes, others passively find their way to new regions as contaminants of ballast water or as hitchhikers on other species (Champion *et al*. 2010). Although strengthened pre-border biosecurity measures have slowed the rate of introductions to Australia, the process is ongoing (Weber *et al*. 2008; Dodd *et al*. 2016), and it is inevitable that a proportion of these introduced species will become naturalised or even problematic invaders. Currently Australia is estimated to have around 2700 naturalised plant species, about 12% of its total flora (Randall 2007; Dodd *et al*. 2015).

Non-invasive naturalised species are those that establish self-perpetuating populations in the wild without having profound negative effects on the ecosystem (Richardson *et al*. 2000). It is estimated that, with time, about 10% of naturalised species will overcome reproductive and dispersal barriers, and become *invasive* (Williamson & Fitter 1996; Williams & West 2000). In future this proportion may increase as ongoing environmental and global climatic changes provide ecological opportunities in some regions for some of these species to become invasive (Groves 2006; Scott *et al*. 2008; Duursma *et al*. 2013; Sorte *et al*. 2013; Leishman & Gallagher 2015). When this occurs, the highly connected nature and dynamic disturbance regimes of freshwater ecosystems will further facilitate the spread of these species through the landscape (Dudgeon *et al*. 2006).

Invasive exotic freshwater plant species can exert dramatic negative impacts on native communities and ecosystems similar to their terrestrial counterparts (Evangelista *et al*. 2014). For example, a more than 50% decline in species richness of co-occurring native freshwater plant species was observed with increasing abundance of the invasive exotic *Alternanthera philoxeroides* in natural ponds (Chatterjee & Dewanji 2014), and *Myriophyllum spicatum* in Lake George, New York, USA (Boylen *et al*. 1999). Furthermore, this suppression of native plant communities by exotic plant species may modify trophic interactions (Richardson & van Wilgen 2004) by simplifying and rendering the native plant communities a poorer food source for herbivores and higher trophic level consumers (Havel *et al*. 2015). Thus, exotic plant invasions can have detrimental ecosystem-level effects on freshwater systems (Yarrow *et al*. 2009).

The naturalised flora in Australia is considered one of the most species rich in the world (Dodd *et al*. 2015) and a large effort has been made to establish a comprehensive inventory of the entire naturalised flora (Randall 2007). In addition, the Australian Virtual Herbarium (http://avh.chah.org.au/) has digitised occurrence records of extant plant species and created a publicly accessible online database (Haque *et al*. 2017). These records have been useful in assessing patterns of species endemism (Crisp *et al*. 2001), mapping species threats (Evans *et al*. 2011), predicting plant invasions (Duursma *et al*. 2013), analysing drivers responsible for patterns of naturalisation (Dodd *et al*. 2015), and identifying areas that have high richness of naturalised exotic species (Dodd *et al*. 2016). However, these outcomes are broad and generalised across different ecosystems. Therefore, it is important for ecosystem-level descriptions of naturalised non-invasive and invasive exotic species to be undertaken so ecosystem-specific monitoring and management practices can be devised. The aim of this study is to provide a systematic description of the distribution, origin and richness of naturalised non-invasive and invasive exotic freshwater plant species in Australia.

Methods

Compilation of species list

We searched ISI Web of Knowledge for information on naturalised plant species in freshwater ecosystems of Australia using the following combinations: (invasi*) OR (invader) OR (non-native) OR (exotic) OR (alien) OR (non-indigenous) OR (introduced) OR ("naturalised species") OR ("naturalized species") OR (biological invasion*) AND (plant) OR (macrophyte*) AND (freshwater) OR (aquatic) OR (river*) OR (pond*) OR (lake*) OR (dam*) OR ("farm dam") AND (Australia) OR ("New South Wales") OR ("NSW") OR (Queensland) OR ("Northern Territory") OR ("NT") OR ("Western Australia") OR ("WA") OR ("South Australia") OR ("SA") OR (Victoria) OR (Vic) OR (Tasmania) OR ("Australian Capital Territory") OR ("ACT"). In addition, a list of naturalised freshwater plant species in Australia was compiled from existing inventories and lists (e.g. Aston 1973; Sainty & Jacobs 2003; Randall 2007) and online databases (e.g. http://weeds.dpi.nsw.gov.au/; http://plantnet.rbgsyd.nsw.gov.au/; https://keyserver.lucidcentral.org/weeds/data/media/Html/index.htm#A; https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/weeds-diseases; https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT; https://florabase.dpaw.wa.gov.au/search/advanced?current=y&alien=y; http://www.pir.sa.gov.au/biosecurity/weeds_and_pest_animals/weeds_in_sa; http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds; https://dpipwe.tas.gov.au/invasive-species/weeds/weeds-index/declared-weeds-index).

We categorised plant species as 'freshwater' using the following definition: "closely bound to freshwater habitats whose vegetative parts actively grow either permanently or periodically (for at least several weeks each year) submerged below, floating on, or growing up through the water surface" (Lacoul & Friedman 2006; Chambers *et al*. 2008; Hussner *et al*. 2012). It should be noted that although we concentrate on *freshwater* species, many species in Australia have wide salinity tolerances and can occur across a wide part of the gradient from fresh to saline in variable habitats such as saltmarshes and estuaries.

Validity of the species names was checked using the Australian Plant Census website (https://biodiversity.org.au/nsl/services/APC) and species not found in the census or with unresolved nomenclature were excluded. Any species whose status as native or exotic was unclear according to the Australian Plant Census was also excluded from the analysis. We then checked the naturalisation status of each species using a comprehensive data set of the introduced flora of Australia - an updated version of Randall (2007) containing unpublished data, and excluded any that was not naturalised. We also excluded species that are associated more with saline water than fresh water.

Plant data collation

Data on the native regions of each species, introduction purpose, and their biology (growth habit, longevity and dispersal mechanisms) were compiled from multiple sources including regional floras, published literature and the online databases (e.g. https://www.cabi.org/ISC/search; http://ausgrass2.myspecies.info/content/fact-sheets; https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysimple.aspx). Eight broad regions of origin were identified as follows: Europe, North America (including Mexico), Central America (including the Caribbean), South America, Sub-Saharan Africa (including Madagascar), North Africa, temperate Asia (including the Middle East), and southern and south eastern Asia. Multiple sources of origin were assigned where a species had a wide native geographical region. For example, *Alisma lanceolatum* is native to Europe, North Africa and temperate Asia and was counted as a species of each of these regions. The current economic uses of the species were used to assign their purpose of introduction (Weber *et al.*, 2008) where such information was not explicitly available. We also conducted internet searches to determine if each species is currently available for purchase from aquarium suppliers.

The Australian Virtual Herbarium (http://avh.ala.org.au/) was used to determine presence or absence of each species in each of the Australian states and territories. Randall's (2007) list was used to categorise the species as naturalised non-invasive, invasive (*sensu* Richardson *et al*. 2000), or declared weeds. A declared weed was defined as a plant species that has been identified for control, eradication or prevention of entry into an Australian jurisdiction by a legislation of that jurisdiction.

Results

Taxonomy and status

After screening 255 titles returned by the literature search, 42 papers that were studies of freshwater plants were reviewed for collation of the naturalised species list (Appendix 1), in addition to data derived from existing inventories and online data sources. In total, 63 exotic species of freshwater plants (belonging to 45 genera and 26 families) were identified as naturalised in Australia (Figure 1; Appendix 2). Of these, 40 species (63%) were classified as naturalised non-invasive, 13 species (21%) were designated as invasive and 10 (16%) as declared weeds (Figure 2; Table 1). The plant families with the highest number of exotic naturalised species were Poaceae (9 species), Cyperaceae (9 species) and Plantaginaceae (5 species). Fourteen of the 27 families were represented by only one species.

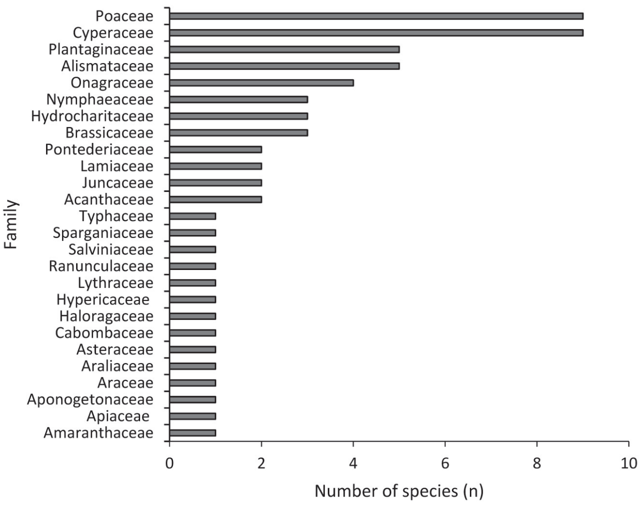

Fig. 1. Taxonomic diversity of the naturalised freshwater plant species in Australia.

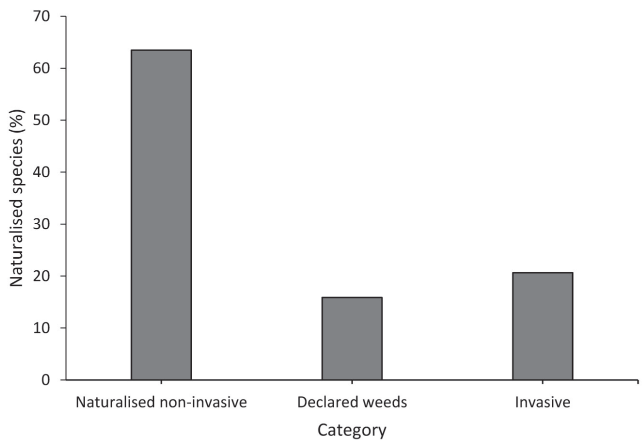

Fig. 2. The percentage of naturalised freshwater plant species in different categories of invasive status.

Table 1: Naturalised freshwater species that are considered invasive in Australia. An asterisk (*) indicates that the species is a Weed of National Significance (WONS) (http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html).

Species	Family
Hygrophila costata Nees	Acanthaceae
Alternathera philoxeroides (Mart.) Griseb.*	Amaranthaceae
Gymnocoronis spilanthoides (D.Don ex Hook. & Arn.) DC.	Asteraceae
Cabomba caroliniana A.Gray*	Cabombaceae
Myriophyllum aquatica (Vell.) Verdc.	Haloragaceae
Egeria densa Planch.	Hydrocharitaceae
Juncus articulates L.	Juncaceae
Ludwigia peruviana (L.) H.Hara	Onagraceae
Arundo donax L.	Poaceae
Hymenachne amplexicaulis (Rudge) Nees*	Poaceae
Eichhornia crassipes (Mart.) Solms*	Pontederiaceae
Salvinia molesta D.S.Mitch.*	Salviniaceae
Sagittaria platyphilla (Engelm.) J.G.Sm.*	Alismataceae

Growth habit

The majority of the species (94%) were perennial; 3% were annual and the remaining 3% have annual stems but perennial rhizomes. Most of the species were emergent marginal wetland species (59%). The emergent plants that grow through the water column constituted 24% while the submerged (8%), floating leaved (6%) and free-floating (3%) species made up the remainder.

Region of origin

Exotic naturalised freshwater species originated from a variety of regions, with Europe, South America and North America being the most widely represented (Figure 3). Species that are native to southern and southeast Asia were the most poorly represented with only two reported as naturalised in Australia. Only eight species (12%) did not have multiple places of origin. Of the 13 species that are classified as invasive in Australia, 10 are native to South America.

Fig. 3. Regions of origin of the naturalised freshwater plant species in Australia.

Distribution in Australia

New South Wales (NSW) was the most species-rich state with 90% of the exotic naturalised freshwater species being present, followed by Queensland (68%) and Victoria (65%) (Figure 4). Northern Territory had the lowest number of naturalised freshwater plant species (14 of the 63 species or 22%). Species that were present in every state include *Cyperus eragrostis* (Cyperaceae), *Arundo donax* (Poaceae), and *Polypogon monspeliensis* (Poaceae).

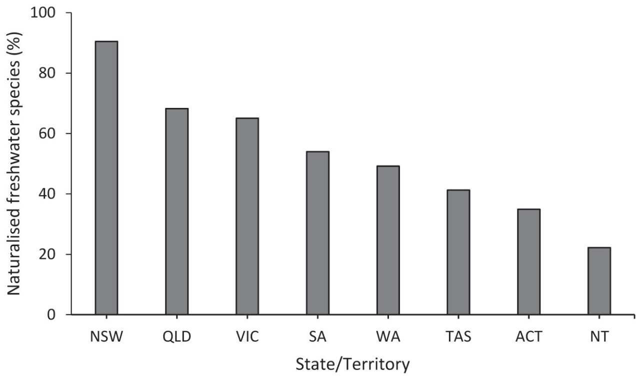

Fig. 4. Percentage of naturalised freshwater plant species present in the states and territories of Australia.

Introduction pathways

Almost two-thirds of the species (57%) were introduced for aquarium and ornamental water garden purposes while a further 25% were imported for agricultural purposes including as vegetables, for example *Alternanthera philoxeroides* and *Rorippa* spp., and pasture grasses. The introduction reason for the remaining 17% of species is unknown; there is no information available on their economic use (Figure 5). Currently 33% of the species are available for sale within Australia either by water garden nurseries or over the internet (Table 2).

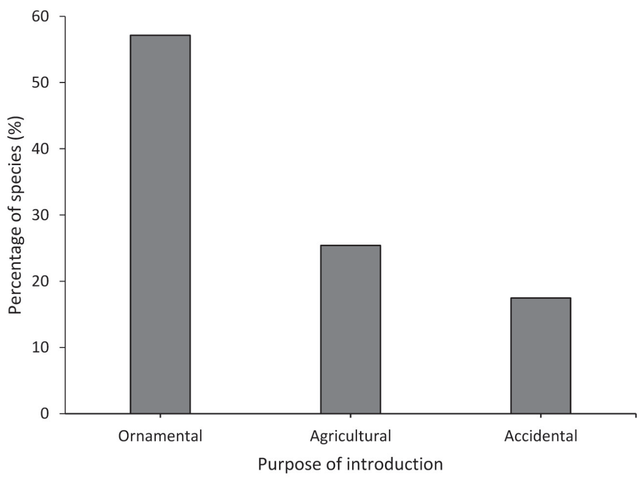

Fig. 5. Purpose of introduction of naturalised freshwater plant species

Table 2: Naturalised freshwater plant species available for sale in Australia. An asterisk (*) indicates that the species is a declared weed.

Species	Family
Aponogeton distachyus L.f.	Aponogetonaceae
Berula erecta (Huds.) Coville	Apiaceae
Bacopa caroliniana (Walter) B.L.Rob.	Plantaginaceae
Cyperus papyrus L.	Cyperaceae
Cyperus prolifer Lam.	Cyperaceae
Hydrocleys nymphoides (Humb. & Bonpl. ex Willd.) Buchenau	Limnocharitaceae
Hygrophila polysperma (Roxb.) T.Anderson	Acanthaceae
Hypericum elodes L.	Hypericaceae
Ludwigia palustris (L.) Elliott	Onagraceae
Ludwigia repens J.R.Forst.	Onagraceae
Mentha aquatica L.	Lamiaceae
Mentha pulegium L.*	Lamiaceae
Nymphaea caerulea Savigny	Nymphaeaceae
Nymphaea mexicana Zucc.	Nymphaeaceae
Phalaris arundinacea L.	Poaceae
Pontederia cordata L.*	Pontederiaceae
Rorippa nasturtium-aquaticum (L.) Hayek	Brassicaceae
Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	Lythraceae
Typha latifolia L.*	Typhaceae
Veronica anagallis-aquatica L.	Plantaginaceae
Zantedeschia aethiopica (L.) Spreng.*	Araceae

Reproduction and dispersal

Almost half (49%) of the 63 species reproduce both sexually and vegetatively (17 reproduce by both seeds and fragmentation, 14 by both seeds and rhizomes). 33% of the species (21 out of 63) reproduce exclusively by means of seeds. The remaining 17% reproduce exclusively by vegetative means. All the species that reproduce exclusively vegetatively, do so by stem fragmentation. Water currents, waterfowl, flood and watercraft were identified as the main dispersal agents of the seeds and stem fragments.

Discussion

Our search identified 63 exotic freshwater plant species that have become naturalised in Australia, a large proportion of which are perennial wetland marginal species. They belong to 26 families representing 16% of families of the naturalised flora. The majority of the species originated from Europe, South America and North America and are currently most widely distributed along the eastern coastal fringes of the country. They were mostly introduced for ornamental purposes via the aquarium and water garden plant trade. The majority of the species reproduce both sexually and vegetatively, with water currents, waterfowl and watercraft identified as their main dispersal vectors.

Given that there are about 2739 naturalised plant species in Australia (Randall 2007), freshwater plant species represent a very low proportion (slightly over 2%). However, despite their seemingly small number, they may have disproportionately strong environmental impacts as exemplified by the fact that nearly 20% of the Weeds of National Significance are freshwater species (6 out of 32) (http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html). This may be partly attributed to the widespread geographic distribution of many of these naturalised freshwater species, with most species found in multiple states within Australia. More than 40% of the naturalised freshwater plant species we identified are categorised as either invasive or declared weeds in Australia. This proportion is much greater than for the naturalised terrestrial flora of which around 14% have become invasive (Leishman *et al*. 2017).

Of the naturalised freshwater species in our analysis, a large majority are in the Poaceae, Cyperaceae and Plantaginaceae families. These families are among the twenty most commonly represented in the naturalised Australian flora (Dodd *et al*. 2015) and reflect the Australasian (Jacobs & Wilson 1996) and worldwide (Chambers *et al*. 2008) trends where Poaceae and Cyperaceae are the most species-rich freshwater plant families. Many plants belonging to Poaceae and Cyperaceae are important pasture crops on which livestock production in Australia relies heavily (Cook and Dias 2006), which may further explain their dominance compared to the other families.

The majority of the naturalised species we identified are perennial, clonal plants with the ability to exploit heterogeneous habitats. Clonality may explain the invasion success of some of these species as it enhances persistence and spread of plants at local scales (Santamaría 2002). The largest proportion (57%) of the species in our analysis were emergent species that fringe the margins of water bodies. This may be due to water margins being suitable for species that can withstand periodic submergence as well as helophytes that can cope with periodic draw-downs (Lacoul & Freedman 2006). In contrast, open water bodies provide a narrower range of environmental conditions, resulting in less species being suited to that habitat. The overrepresentation of the marginal species in our analysis may also have resulted from study biases since these species are conspicuous and easier to sample and identify, in contrast to, for example, submerged species. In addition, emergent species that occur along water body margins may be able to disperse their propagules not only by water but also by wind, allowing them to colonise widely across the landscape (Soomers *et al*. 2013).

Many naturalised freshwater plant species in Australia have originated from Europe, South America and North America. This is largely due to historical and trade linkages between Australia and these continents. However, these regions of origin are likely to have shifted through time, with invasion success of plant species from Europe strongly linked with European settlement in Australia (Phillips *et al*. 2010) and more recent successful introductions originating from South America now contributing the largest proportion of naturalised freshwater plant species. The majority of the naturalised freshwater plant species in our study had multiple broad regions of origin. Many freshwater plant species have broad distributions due to selective advantages provided by asexual reproduction and long distance dispersal of propagules (Santamaría 2002). Species with large native ranges tend to have broad environmental tolerances and thus may be effectively pre-adapted to their introduced range (Pyšek *et al*. 2009; Keller *et al*. 2011). This may explain why the naturalised freshwater species of Australia are small in number but a large proportion have spread extensively across the continent and are now considered as species of concern.

New South Wales, Queensland and Victoria, the most densely populated states (A.B.S. 2018), have the highest numbers of naturalised freshwater species. This is not surprising as there is a strong correlation between human population density and exotic species richness, due to humans being responsible for the deliberate or accidental introduction of exotic species (Weber *et al*. 2008; Dodd *et al*. 2016; Haque *et al*. 2017). Furthermore, a higher human population density also means a higher number of potential aquarium keepers, representing a greater propagule pressure (Hussner *et al*. 2010). Alternatively, biases in herbarium specimen collection may have painted a picture of relatively higher species numbers in the densely populated states than reality (Lavoie *et al*. 2012; Dodd *et al*. 2016; Haque *et al*. 2017). It has been observed that the intensity of herbarium specimen collection in Australia, on which our species regional distribution analysis relied, was higher in the densely populated areas (Dodd *et al*. 2016).

Our analysis revealed that almost 60% of the freshwater plant species naturalised in Australia were deliberately introduced for ornamental water garden and aquarium purposes. This is consistent with other studies globally reporting that importation and trade in ornamental plants is the most important pathway for freshwater plant introductions (Champion *et al*. 2010; Strayer 2010; Keller *et al*. 2011). Petroeschevsky & Champion (2008) suggested that 85% of aquatic weeds in Australia were traded as aquarium or water garden plants. We found that a third of Australia's naturalised freshwater plant species are currently available by trade for either ornamental or agricultural purposes. Surprisingly, among these actively traded species are four declared weeds (*Mentha pulegium*, *Pontederia cordata*, *Typha latifolia* and *Zantedeschia aethiopica*). Some of these species may be traded with misspelled or incorrect scientific names that mask their exotic status (Brunel 2009). For example, we found that an aquarium supplier had listed *Eleocharis* for sale without specifying the species; if these species escape into the wild they could well remain undetected for a long time. There are also reports of aquarium plant dealers who, mostly due to ignorance, misrepresent exotic plants as similar-appearing native ones (Kay & Hoyle 2001). A more serious practice that may contribute to infestation of waterways is the deliberate cultivation of exotic ornamental plants in natural waterways, by aquarium traders in order to meet customer demands (Petroeschevsky & Champion 2008).

Twenty-five percent of the naturalised freshwater species of Australia have been introduced deliberately for agricultural purposes. These include traditional vegetable species such as *Alternathera philoxeroides* and *Rorippa* spp., and garden herbs such as *Mentha aquatica*. However, the majority of the agricultural species are ponded pasture plants that were introduced for livestock grazing. Since commercial livestock production is a major contributor to the Australian economy, many state governments actively promoted introduction of exotic ponded pasture species through much of the 20th century (Cook & Dias 2006; Cook & Grice 2013). These species may have then spread across the broader landscape through natural dispersal mechanisms.

Almost a fifth of the naturalised freshwater plant species in Australia have no known economic uses and may have been introduced inadvertently in ballast water or as contaminants of other deliberately imported species, which is a common occurrence (Kay & Hoyle 2001). For example, Maki and Galatowitsch (2004) found that ten percent of freshwater plants that they obtained commercially contained exotic plant contaminants. Occasionally, some of these contaminants prove attractive and easy to grow and are therefore placed on the market. A good example is *Salvinia molesta*, which was introduced initially as a contaminant of other plants but was considered sufficiently attractive to be consequently traded as an ornamental species in Texas, USA for several years (Kay & Hoyle 2001).

Many of the naturalised plants in our analysis reproduce both sexually and vegetatively, and are easily dispersed by water currents and floods, wind, water birds and watercraft (Santamaria 2002). As vegetative spread and multiple dispersal vectors enhance establishment and therefore naturalisation success (Keller *et al*. 2011), these factors may also be drivers of invasion success of these naturalised freshwater plants.

From our study, we can conclude that although naturalised freshwater plant species form a very small proportion of the naturalised flora, they nevertheless are an important component of the Australian flora, being widespread across multiple regions. In spite of the existence of many statutory and regulatory measures to control trade in potential weeds in Australia at local, state and federal levels, a few declared weeds continue to be traded. A strict enforcement of these controls is therefore necessary through monitoring of the online aquarium market and periodically assessing compliance by nurseries through site visits. It is also important that we continue to assess the weed risk of naturalised species in light of ongoing environmental and climatic changes and to monitor potential spread of wild populations constantly (Champion *et al*. 2010). Finally, accessing information on naturalised freshwater plants ranging from the local to state level is difficult as data is contained within disparate sites. Therefore, a centralised system of storing data on ecology and management of naturalised freshwater plant species would be desirable for better knowledge sharing.

Acknowledgements

We thank Rachael Gallagher for the initial list of exotic freshwater plant species in Australia. Anthony Manea provided helpful comments on earlier versions of this manuscript, for which we are grateful. We also thank Doug Benson and anonymous reviewers whose inputs greatly helped improve the manuscript.

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Manuscript accepted 12 December 2018

Appendix 1: Titles reviewed for collation of the naturalised freshwater plant species list

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Appendix 2: List of the species included in the analysis of naturalised freshwater plants in Australia

Botanical name	Family
Hygrophila costata Nees	Acanthaceae
Hygrophila polysperma (Roxb.) T.Anderson	Acanthaceae
Alisma lanceolatum With.	Alismataceae
Hydrocleys nymphoides (Humb. & Bonpl. ex Willd.) Buchenau	Alismataceae
Limnocharis flava (L.) Buchenau	Alismataceae
Sagittaria calycina Engelm.	Alismataceae
Sagittaria platyphylla (Engelm.) J.G.Sm.	Alismataceae
Alternanthera philoxeroides (Mart.) Griseb.	Amaranthaceae
Berula erecta (Huds.) Coville	Apiaceae
Aponogeton distachyos L.f.	Aponogetonaceae
Zantedeschia aethiopica (L.) Spreng.	Araceae
Hydrocotyle ranunculoides L.f.	Araliaceae
Gymnocoronis spilanthoides (D.Don ex Hook. & Arn.) DC.	Asteraceae
Rorippa microphylla (Boenn. ex Rchb.) Hyl.	Brassicaceae
Rorippa nasturtium-aquaticum (L.) Hayek	Brassicaceae
Rorippa palustris (L.) Besser	Brassicaceae
Cabomba caroliniana A.Gray	Cabombaceae
Cyperus eragrostis Lam.	Cyperaceae
Cyperus involucratus Rottb.	Cyperaceae
Cyperus papyrus L.	Cyperaceae
Cyperus prolifer Lam.	Cyperaceae
Eleocharis minuta Boeckeler	Cyperaceae
Eleocharis pachycarpa Ã‰.Desv.	Cyperaceae
Eleocharis parodii Barros	Cyperaceae
Isolepis prolifera (Rottb.) R.Br.	Cyperaceae
Schoenoplectus californicus (C.A.Mey.) Sojak	Cyperaceae
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae
Egeria densa Planch.	Hydrocharitaceae
Elodea canadensis Michx.	Hydrocharitaceae
Lagarosiphon major (Ridl.) Moss	Hydrocharitaceae
Hypericum elodes L.	Hypericaceae
Juncus articulatus L.	Juncaceae
Juncus ensifolius Wikstr.	Juncaceae
Mentha aquatica L.	Lamiaceae
Mentha pulegium L.	Lamiaceae
Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	Lythraceae
Nymphaea alba L.	Nymphaeaceae
Nymphaea caerulea Savigny	Nymphaeaceae
Nymphaea mexicana Zucc.	Nymphaeaceae
Ludwigia longifolia (DC.) H.Hara	Onagraceae
Ludwigia palustris (L.) Elliott	Onagraceae
Ludwigia peruviana (L.) H.Hara	Onagraceae
Ludwigia repens J.R.Forst.	Onagraceae
Bacopa caroliniana (Walter) B.L.Rob.	Plantaginaceae
Callitriche brutia Petagna	Plantaginaceae
Callitriche stagnalis Scop.	Plantaginaceae
Veronica anagallis-aquatica L.	Plantaginaceae
Veronica catenata Pennell	Plantaginaceae
Alopecurus geniculatus L.	Poaceae
Arundo donax L.	Poaceae
Echinochloa polystachya (Kunth) Hitchc.	Poaceae
Echinochloa pyramidalis (Lam.) Hitchc. & Chase	Poaceae
Glyceria maxima (Hartm.) Holmb.	Poaceae
Hymenachne amplexicaulis (Rudge) Nees	Poaceae
Phalaris arundinacea L.	Poaceae
Polypogon monspeliensis (L.) Desf.	Poaceae
Urochloa mutica (Forssk.) T.Q.Nguyen	Poaceae
Eichhornia crassipes (Mart.) Solms	Pontederiaceae
Pontederia cordata L.	Pontederiaceae
Ranunculus sceleratus L.	Ranunculaceae
Salvinia molesta D.S.Mitch.	Salviniaceae
Sparganium erectum L.	Sparganiaceae
Typha latifolia L.	Typhaceae