Invasion of sandy beachfronts by ornamental plant species in Queensland

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Summary

This study encompasses the east coast of Queensland from the Gold Coast to Thursday Island. Data were derived from both past and recent coastal studies (1980–1997) by the senior author, herbarium records and through liaison with field officers. The ornamental vascular plants recorded as invasive weeds along the sandy beachfronts of Queensland include 103 species belonging to 48 families and 88 genera. Herbaceous lifeforms and succulence are frequent characteristics of invasive ornamental species along these sandy shores.

An increase in the proportion of weeds of sandy beachfronts from north to south along the east coast of Queensland is reported. This distribution is possibly associated with human population densities rather than climatic conditions. In this study the most important factors contributing to ornamental weed invasions are human assisted plant introductions through the dumping of garden plants into native vegetation. The most abundant invasive ornamental weeds of Queensland beachfronts are *Agave* spp. (sisal or agave), *Asparagus densiflorus* (asparagus fern), *Bryophyllum* spp. (mother-of-millions), *Catharanthus roseus* (pink periwinkle), *Euphorbia cyathophora* (dwarf poinsettia), *Gloriosa superba* (glory lily), *Lantana camara* (lantana), *Opuntia stricta* (prickly pear), *Sanseviera trifasciata* (mother-in-law's tongue), *Schinus terebinthifolia* (Brazilian pepperina tree) *Senna pendula* var. *glabra* (Easter cassia) and *Wedelia trilobata* (Singapore daisy). The proportion of naturalized exotic species of the Queensland sandy beachfront flora is three times greater than the state average.

To prevent the further degradation of beachfront vegetation and the possible loss of native species richness through weed encroachment, urgent action is required. We recommend restoration of affected beachfronts through removal of invasive ornamental weed species and replanting with indigenous seashore species. Education, policing and 'polluter pays' fines are also seen as a method of weed management along sandy beachfront areas of Queensland.

Introduction

As early as last century Charles Darwin (1839) commented on the spread of introduced exotic plant species in South America and New Zealand. In Australia, since the early days of European settlement, ornamental exotic plant species have been deliberately introduced by acclimatization societies and commercial interest groups for agricultural, horticultural, silvicultural and reclamation purposes (Parsons and Cuthbertson 1992, Carr 1993). Many of these species have since become naturalized. We define 'naturalized' flora as including adventive or invasive exotic and non-indigenous Australian plant species introduced from elsewhere that are able to maintain populations without assistance from humans, irrespective of dispersal history. Invasive weed species refers to any exotic plant which can freely colonize 'disturbed' habitats (Harris and Woolf-Harris 1994). It is known that of 233 exotic plants described by Parsons and Cuthbertson (1992) that have been proclaimed as noxious in Australia, at least 46% were intentionally introduced (Panetta 1993).

The rapid urbanization of large parts of Queensland coastlines has resulted in high numbers of ornamental plants growing in close proximity to native seashore vegetation (Batianoff and Franks 1997). As such, sandy beachfronts are seen as being vulnerable to introduced ornamental plants. Amenity plantings in seaside areas are characterized by hardy and vigorous plant species, many of which are easily propagated vegetatively or by seed. This paper examines some characteristics of these ornamental species, and discusses factors responsible for the proliferation of ornamental plants along sandy beachfronts of Queensland.

Methods

Data on plant naturalizations and invasive species collated for this report comes from Sunshine Coast (Batianoff 1987, Batianoff and Elsol 1989), Capricorn Coast (Batianoff and McDonald 1980), Port Curtis (Batianoff and Dillewaard 1988), Mulgrave Shire (McDonald 1984) and Mackay Coast (Batianoff *et al.* 1996) studies and Queensland sandy beachfronts in general (Batianoff 1997). Additional information on current naturalizations was gained from field botanists in Mareeba, Cairns, Townsville and Rockhampton. Further data and nomenclature were gained from Queensland Herbarium records (Henderson 1997).

An introduced flora was compiled for Queensland sandy coastlines (Batianoff 1997). The adventive and invasive ornamental species were extracted from this introduced flora. This list was analysed in terms of floristics, abundance, lifeforms and distribution. In the case of the Sunshine Coast a temporal study was achieved by revisiting transects used in past coastal studies by the senior author. The occurrence of species are defined as abundant (occurs in more than 30% of sites and dominates in many locations), frequent (occurs between 15–30% of sites only occasionally forms dominant stands), infrequent (occurs between 1–15% of sites and forms small populations) or rare (occurs in less than 1% of sites and are mostly found as individuals).

Vegetation pattern along the seashore was separated into three major zones which frequently grade into each other. These are the seaward areas which includes the strand herbland zone, the *Casuarina* woodland zone and the hind-dune zone. The hind-dune zone in south-east Queensland is identified by the dominance of *Banksia integrifolia*. In tropical areas the hind-dune zone may include a narrow band of rainforest species of beach-scrubs and/or other types of open forest or scrubs.

Floristics

Appendix I lists 105 ornamental plant species presently naturalized on sandy seashores in Queensland. These represent 89 genera and belong to 48 families. They include 45 herbaceous species (43%), 22 species of trees (21%), 27 species of shrubs (26%) and 11 species of vines (10%). The seven most prominent families based on the number of species are Asteraceae (7 species), Crassulaceae (7 species), Agavaceae (6 species), Poaceae (6 species), Liliaceae (5 species), Euphorbiaceae (4 species) and Solanaceae (4 species). More than a third of these species are succulent plants (having fleshy water storage tissue in roots and/or stems (Forster 1996)). All the recorded species of Agavaceae and Crassulaceae are succulent. These succulent plants are easy to maintain in cultivation due to their tolerance of salt spray and prolonged dry conditions. Hardy, succulent plants appear to be commonly chosen for amenity plantings for seashore housing. They also appear to be well suited for colonizing native coastal vegetation.

Patterns of dispersal

Potentially invasive weed species can exist in an area for a considerable time before becoming troublesome (Braithwaite *et al.* 1989). Fox (1991), reported that some

invasive weed species may require favourable environmental triggers to build up population sizes to a threshold required for 'successful' colonization. The factors responsible for widespread exotic invasions are particularly relevant to ornamental plant introductions along Queensland's sandy seashores.

Three phases are normally associated with acclimatization from an adventive to an invasive stage as illustrated in Figure 1. A threshold population is defined in this study as an invasive plant population that maintains positive growth despite seasonal fluctuations. Environmental triggers may include factors such as lack of natural predators, increased fertility, or availability of space and resources. Genetic adjustment over time includes natural selection towards varieties and forms of species favouring the seashore environment. Figure 1 indicates two stages of population growth of glory lily (*Gloriosa superba* L.) along the south-east Queensland seashore. According to Queensland Herbarium records it took twenty years from the time of naturalization in the 1950s (Shelly Beach, Caloundra) until population expansion was noticeable. A further twenty years passed before populations reached weedy proportions between the Gold and Sunshine Coasts and in northern New South Wales (Conran 1987). Another example is asparagus fern (*Asparagus densiflorus* (Kunth) Jessop). Along the south-east Queensland coast, asparagus fern was first noticed as expanding into natural bushlands in 1972, at Goat Island, Moreton Bay, and is now considered one of the major invasive ornamental weed species on dunes between Noosa National Park and the Gold Coast (Bowden and Rogers 1996). Data presented in this study agree with Braithwaite *et al.* (1989) and the model illustrated in Figure 1 that species may exist for considerable time before reaching pest proportions (e.g. *Agave* spp., introduced to Australian horticulture as early as 1843 (Forster 1987), and *Schinus terebinthifolius*).

The rapid expansion of these species coincides with increased human development along the south-east Queensland coast. In our opinion, the most important environmental triggers which assist invasive ornamental weed include human-induced disturbances and introductions. In many instances spread of seeds is facilitated by native fauna. For example, *Asparagus* spp. are known to have their seeds dispersed by silvereyes (*Zosterops lateralis*) (Conran and Forster 1986, Barker and Vestjens 1989).

Available data for percentage weediness of seashore flora from north to south (year sampled in parenthesis) are as follows: Cairns coast 35.0% (1980), Mackay coast 41.5% (1996), Capricorn coast 38.9% (1980), Sunshine Coast 57.6% (1997) and Gold Coast 65.1% (1997). The naturalized exotics account for about 48% of the total flora on sandy seashores of Queensland today. This is more than three times greater than the proportion of naturalized species of the total Queensland flora (14%). Disregarding time anomalies, the above data show an increase in weediness from north to south. This possibly reflects climatic patterns. However, we suggest that the increased weediness is related more to population densities and longer lengths of human settlement than any other factors. Data presented in Appendix I also indicates that about 80% of naturalized ornamental plants occur in densely populated areas of south-east Queensland. Only 18% of invasive ornamental plants are recorded in sparsely populated northern Queensland.

Temporal studies of the Sunshine Coast seashore flora between 1987 (Batianoff and Elsol 1989) and 1997 (Batianoff 1997) indicate an increase of 68 (17.8%) weed species, i.e. about seven new weeds per year. Twenty two (38%) of these new introductions are naturalized ornamental plant species.

Anthropogenic factors

According to Hobbs (1991), disturbance is identified as the most important factor responsible for invasion by weed species. Although coastal areas experience high natural cycles of disturbance it is our view that anthropogenic (associated with human activity) weed introductions and subsequent dispersal by humans are the most important factors responsible for the success of weed invasion into beachfront vegetation. Queensland Herbarium records illustrated in Figure 2 demonstrate the rate of spread of three exotic plants along the Queensland coast from their point of introduction. Guinea grass (*Panicum maximum* Jacq.) (a pastoral plant introduction) covered a distance of about 3000 km in 80 years, averaging about 37 km per year. Searocket (*Cakile edentula* (Bigelow) Hook.) (an accidental introduction) migrated approximately 1000 km by ocean currents from south to north in 70 years, averaging about 14 km per year. However, Singapore daisy (*Wedelia trilobata* (L.) Hitchc.) (an ornamental introduction) with the direct assistance of human transportation was able to cover 2500 km in 15 years, averaging some 167 km per year.

It is also important to note that along the Sunshine Coast more than twice as many non-indigenous plant species were recorded along beachfront native vegetation near (5–100 m) housing than beachfront situated distant (200–2000 m) from housing (Batianoff and Franks in press). Detailed examination of non-indigenous flora along Sunshine Coast foredunes indicate at least 44% are ornamental escapees (Batianoff and Franks 1997). During our field studies we observed numerous sites where dumping of garden refuse into native seashore vegetation was evident. Through this indiscriminate dumping, local residents have unintentionally introduced many ornamental plants. In some instances these illegal garden dumping areas resembled compost pits. At these regular dumping sites soil fertility and organic matter increases, further favouring the establishment of invasive ornamental species.

In Queensland, it is desirable to increase the understanding of the importance of native seashore vegetation in assisting the stability of sand dunes and

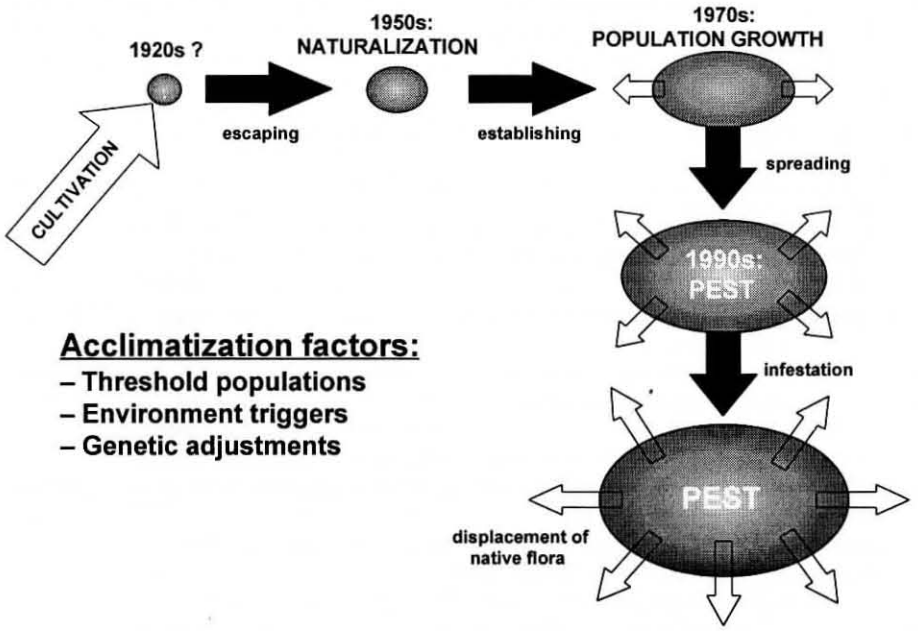

Figure 1. Probable temporal dispersal pattern of the invasive ornamental species glory lily (*Gloriosa superba* L.) along south-east Queensland seashores. Based on Queensland Herbarium records.

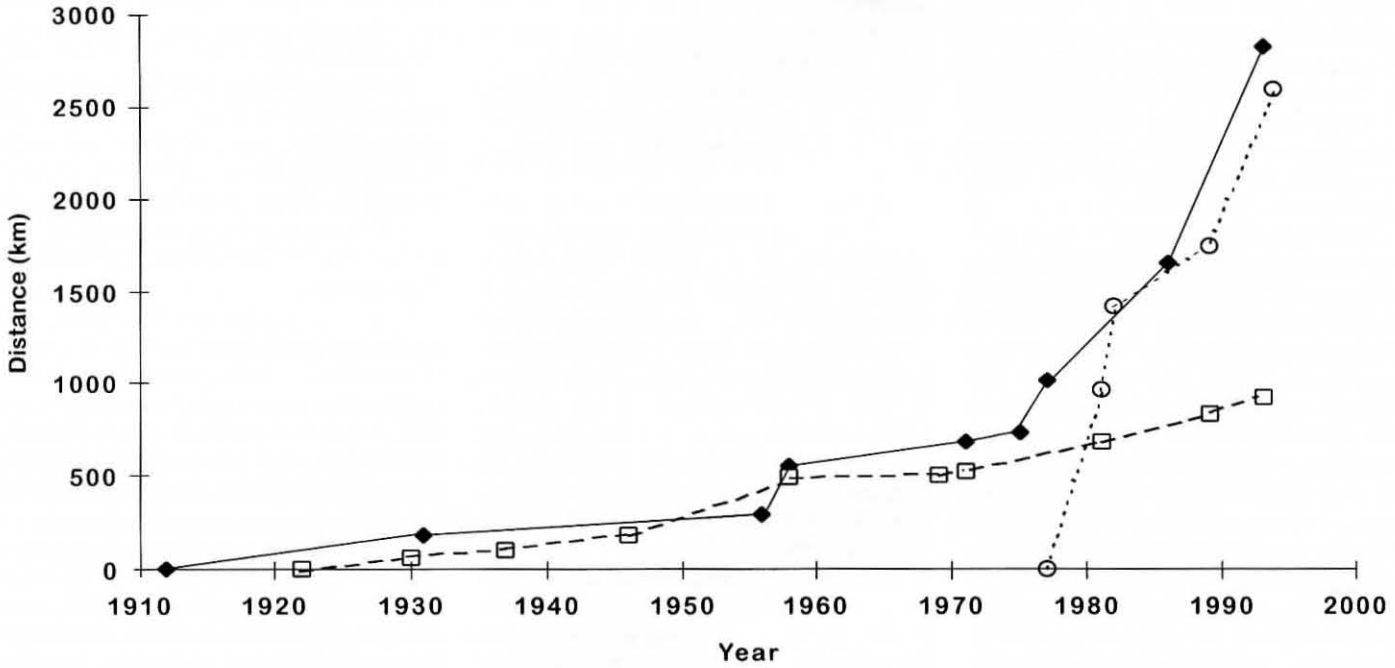

Figure 2. Migration histories of three weedy plants occurring along the Queensland seashore naturalizing from first recorded site. Queensland Herbarium records, 1997. ◆ *Panicum maximum*, □ *Cakile edentula* and ○ *Wedelia trilobata*.

protection of beachfront areas from sea exposure particularly among adjacent residents. Specialist native species play an important role in trapping mobile sands, building up dunes and stabilizing the entire beachfront ecosystem (Saltmann personal communication 1997). Importantly, most locally indigenous species are able to respond more successfully to the natural cycles of beach erosion and accretion on the unstable foredunes and maintain their populations without any assistance which is not the case with the common amenity plantings. During severe cycles of natural erosion, there is very little evidence to suggest that introduced ornamental plants are able to successfully stabilize moving foredunes, with the possible exception of bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata* (DC.) Norl.).

A serious consequence of the introduced flora is the apparent loss of native species richness in very weedy seashore areas. For example, temporal studies over ten years indicate that on average up to seven fewer indigenous species were recorded in 0.1 ha plots along heavily infested weedy beachfronts on the Sunshine Coast compared to relatively natural communities (Batianoff and Franks 1997). Dispersal mechanisms of coastal ornamental weed species are listed in Appendix I. The data indicate that 96% of species are assisted in their dispersal by human vectors, with 58% of species totally dependant on anthropochory (human dispersal of plants). As a result many ornamental species could be prevented from entering native vegetation by altering established human practises such as garden plant selection, the dumping of garden waste and by education of land-managers and owners.

Management considerations

Appendix I indicates that 3% of ornamental naturalized species are abundant, 16% are frequent, 45% are infrequent and 37% are rare in their distribution. The most invasive ornamental plants of Queensland foredunes are listed in Table 1. The ornamental weed problem along most seashores may be restricted to a few highly successful and widely distributed species. By managing these species, the

Table 1. The twelve most invasive ornamental plants of coastal Queensland foredunes based on Batianoff and Franks (1997).

Plant name	Preferred habitat
Sisal or agave (*Agave* spp.)	Landward of frontal dune, *Casuarina* zone and beach scrubs along entire Queensland coast
Asparagus fern (*Asparagus densiflorus*)	Increasing densities from exposed areas to wooded areas in south-east Queensland
Mother-of-millions (*Bryophyllum* spp.)	Sandy and rocky shores and estuaries, increasing densities from seaward to landward areas along entire Queensland coast
Pink periwinkle (*Catharanthus roseus*)	*Casuarina* zone and beach scrub areas along entire Queensland coast
Dwarf poinsettia (*Euphorbia cyathophora*)	*Casuarina* zone and beach scrub areas along entire Queensland coast
Glory lily (*Gloriosa superba*)	Increasing densities from exposed areas to wooded areas in south-east Queensland
Lantana (*Lantana camara*)	*Casuarina* zone and beach scrub areas along entire Queensland coast
Prickly pear (*Opuntia stricta*)	From frontal dunes to wooded areas along entire Queensland coast
Mother-in-law's tongue (*Sanseviera trifasciata*)	*Casuarina* zone and beach scrub areas along entire Queensland coast
Brazilian pepperina tree (*Schinus terebinthifolius*)	Landward of frontal dune in *Banksia/Casuarina* zones in south-east Queensland
Easter cassia (*Senna pendula* var. *glabra*)	Landward of frontal dune in *Banksia/Casuarina* zones along entire Queensland coast
Singapore daisy (*Wedelia trilobata*)	From beach margins through to wooded areas mainly in south-east Queensland

weed problem may be reduced. Conversely, removal of these highly successful species may result in space becoming available for colonization by other weed species. We recommend in these instances that indigenous species restoration programs be undertaken concurrently with weed removal.

Queensland Herbarium records indicate that approximately 4000 plant species are used in cultivation consisting of mainly introduced ornamental plants with some non-indigenous Australian natives and only a few indigenous species. Williamson and Fitter (1996), predict that 10% of all introduced species may become naturalized and of these, only 10% become weedy. In our situation, 25 species of the recorded 103 naturalized exotics have successfully invaded Queensland sandy beachfronts. By applying Williamson and Fitter's (1996) 'tens rule' we estimate that 40 (including the 25 species already identified in this study) of the 4000 cultivated species in Queensland (10% of 10%) may become problem weeds of Queensland sandy beachfronts. However Williamson and Fitter's (1996) model is based on broad historical data but we agree with their central premise that more ornamental species are capable of naturalizing along Queensland's coastline.

Conclusion

Some coastal dwellers may argue that it matters very little that some of our beachfronts are becoming more weedy and losing their local character and naturalness. We argue, however, that it is important from a national point of view that our public lands are maintained for naturalness and performance standards in weed management (Deakin and Thorpe 1994). Other reasons for removing some naturalized ornamental plants may be related to native species diversity and ecosystem integrity and functioning. Furthermore public health and safety issues need to be considered. For example, spiny plants, such as sisal and yucca may cause injury to members of the public. Toxic plants, such as glory lily and oleanders (*Nerium oleander* L. and *Cascabela thevetia* (L.) Lippold), may play a part in local government liability scenarios. We therefore recommend restoration of affected beachfronts by the effective management of the invasive ornamental weeds identified in this study and active replanting of native species in the more degraded areas. As well as restoring weed infested sites, efforts should be made to prevent the continued spread of exotic and non-indigenous plants. Local authorities should be committed to maintaining indigenous seashore vegetation through education of the public, policing and imposing 'polluter pays' fines for repeated garden refuse dumping.

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Appendix I. Checklist of naturalized ornamental plants of coastal Queensland.

Plant name (common name)	L/f	Occ.	Study Areas				D/m
			SE	CE	NQ	FN	
Agavaceae							
* *Agave americana* (agave)	S	I	+	+	+	+	1,4,6
* *Agave sisalana* (sisal)	S	I	+	+	+	+	1,4,6
* *Agave vivipara* (agave)	S	I	-	+	+	-	1,4,6
* *Sansevieria dawei* (snake plant)	H	R	+	-	-	-	1,2,4
* *Sansevieria trifasciata* (mother-in-law's tongue)	H	F	+	+	+	+	1,2,4
* *Yucca aloifolia* (dagger plant)	S	R	+	+	-	-	1,2,4
Anacardiaceae							
* *Mangifera indica* (mango)	T	R	-	+	+	+	2,4
* *Schinus terebinthifolia* (Brazilian pepperina)	ST	F	+	+	-	-	2,3,4,6
Apiaceae							
* *Hydrocotyle bonariensis* (pennywort)	H	R	+	-	-	-	1,2,4
Apocynaceae							
* *Cascabela thevetia* (yellow oleander)	ST	R	+	+	+	-	2,4
* *Catharanthus roseus* (pink periwinkle)	H	F	+	+	+	+	2,3,4
* *Nerium oleander* (oleander)	S	R	+	+	-	-	2,4,5
Araceae							
* *Philodendron giganteum* (philodendron)	H	R	+	-	-	-	1,4
* *Syngonium podophyllum* (syngonium)	H	R	+	+	-	-	1,4
Araliaceae							
* *Schefflera actinophylla* (umbrella tree)	T	F	+	-	-	-	2,3,4
Araucariaceae							
* *Araucaria heterophylla* (Norfolk Island pine)	T	I	+	-	-	-	2,4
Arecaceae							
* *Cocos nucifera* (coconut)	T	F	+	+	+	+	2,4,6
* *Phoenix dactylifera* (date palm)	ST	R	-	+	-	-	2,4
* *Syagrus romanzoffiana* (queen palm)	T	R	+	-	-	-	2,3,4
Asclepiadaceae							
* *Calotropis gigantea* (calotrop)	S	I	-	-	-	+	2,5
* *Cryptostegia grandiflora* (rubber vine)	V	I	-	+	-	-	2,5
Asteraceae							
* *Baccharis halimifolia* (groundsel)	S	F	+	-	-	-	2,5
* *Chrysanthemoides monilifera* ssp. *rotundata* (bitou bush)	S	R	+	-	-	-	2,3,4,6
* *Gaillardia pulchella* (blanket flower)	H	I	-	+	-	-	1,2,4
* *Gazania rigens* (treasure flower)	H	I	+	+	-	-	1,2,4
* *Helianthus argophyllus* (dwarf sunflower)	H	I	-	+	-	-	2,6
* *Hypochoeris radicata* (spotted cat's ear)	H	I	+	+	-	-	2,4,5
* *Wedelia trilobata* (Singapore daisy)	H	F	+	+	+	+	1,2,4
Basellaceae							
* *Anredera cordifolia* (Madeira vine)	V	I	+	+	-	-	1,2,4
Bignoniaceae							
* *Tecoma stans* (yellow bells)	ST	R	-	+	+	-	2,4,5
Cactaceae							
* *Acanthocereus tetragonus* (sword pear)	S	R	+	-	-	-	1,2,4,6
* *Opuntia stricta* var. *stricta* (prickly pear)	S	F	+	+	+	+	1,2,4,6
Caesalpiniaceae							
* *Delonix regia* (poinsiana)	T	R	-	+	-	-	1,4,6
* *Senna pendula* var. *glabrata* (Easter cassia)	ST	F	+	+	-	-	2,3,4
* *Tamarindus indica* (tamarind)	T	I	-	+	+	+	2,3,4
Cannaceae							
* *Canna indica* (arrowroot)	H	I	+	-	-	-	2,4
Commelinaceae							
* *Callisia fragrans* (inch plant)	H	I	+	+	+	-	1,4
* *Tradescantia spathacea* (oyster plant)	H	I	+	+	+	-	1,4
* *Tradescantia zebrina* (spider lily)	H	I	+	+	+	-	1,4
Convolvulaceae							
* *Ipomoea cairica* (mile-a-minute)	V	F	+	+	+	-	1,2,4,6
* *Ipomoea indica* (blue morning glory)	V	R	+	+	+	-	1,4

Appendix I continued/...

Plant name (common name)	L/f	Occ.	Study Areas				D/m
			SE	CE	NQ	FN	
Crassulaceae							
* *Bryophyllum daigremontianum* (mother-of-millions)	H	R	-	+	-	-	1,4
* *Bryophyllum daigremontianum* × *B. tubiflorum* (devil's backbone)	H	I	-	+	+	-	1,2,4,6
* *Bryophyllum pinnatum* (mother-of-millions)	H	I	+	+	+	-	1,2,4,6
* *Bryophyllum tubiflorum* (mother-of-millions)	H	F	+	+	+	-	1,2,4,6
* *Crassula ovata* (dollar plant)	H	R	+	-	-	-	1,4
* *Kalanchoe fedtschenkoi* (kalanchoe)	H	R	-	+	+	-	1,4
* *Kalanchoe longiflora* (kalanchoe)	H	R	-	+	-	-	1,4
Cucurbitaceae							
* *Citrullus lanatus* (water melon)	H	I	+	+	+	-	2,4
* *Momordica charantia* (bitter gourd)	H	I	-	+	-	-	2,4
Cyperaceae							
* *Cyperus papyrus* (papyrus)	H	R	-	+	-	-	1,4
Euphorbiaceae							
* *Acalypha wilkesiana* (beefsteak plant)	S	I	+	+	+	-	2,4
* *Euphorbia cyathophora* (dwarf poinsettia)	S	F	+	+	+	+	2,4,6
* *Pedilanthus tithymaloides* ssp. *smallii* (Jacob's ladder)	H	I	+	+	+	-	1,2,4
* *Ricinus communis* (castor oil plant)	S	I	+	+	+	+	2,4,6
Fabaceae							
* *Clitoria ternatea* (pigeon wings)	V	I	-	+	+	-	2,4
* *Dalbergia sissoo* (sissoo)	T	I	-	+	-	-	1,2,4
Iridaceae							
* *Belamcandra chinensis* (leopard lily)	H	R	+	-	-	-	1,2,4
* *Sisyrinchium* sp. (blue-eyed grass)	H	R	+	-	-	-	1,2,4
Lamiaceae							
# *Westringia fruticosa* (westringia)	S	I	+	+	-	-	2,4
Lauraceae							
* *Cinnamomum camphora* (camphor laurel)	T	I	+	-	-	-	2,3,4
Liliaceae							
* *Aloe arborescens* (octopus plant)	S	I	+	+	-	-	1,4
* *Asparagus densiflorus* (asparagus fern)	H	A	+	+	-	-	1,2,3,4,6
* *Aspidistra elatior* (cast-iron plant)	H	R	+	-	-	-	1,2,4
* *Gloriosa superba* (glory lily)	V	A	+	-	-	-	1,2,4,6
* *Habranthus robustus* (habranthus)	H	R	+	-	-	-	1,2,4
Malvaceae							
* *Malvaviscus alboreus* (wax mallow)	S	R	+	-	-	-	2,4
Moraceae							
* *Ficus elastica* (rubber plant)	T	R	+	+	-	-	1,4
Myrtaceae							
* *Eugenia uniflora* (Brazilian cherry)	ST	I	+	+	-	-	2,3,4
# *Leptospermum laevigatum* (tea tree)	S	I	+	-	-	-	2,4
* *Metrosideros* sp. (rata)	S	I	+	-	-	-	2,4
* *Psidium guajava* (guava)	ST	I	-	+	+	-	2,3,4
Nephrolepidaceae							
# *Nephrolepis hirsutula* (ladder fern)	H	I	+	-	-	-	1,4
# *Nephrolepis obliterata* (fishbone fern)	H	I	+	-	-	-	1,4
Nyctaginaceae							
* *Bougainvillea glabra* (bougainvillea)	S	R	+	+	-	-	1,4
* *Mirabilis jalapa* (marvel of Peru)	S	R	+	-	-	-	2,4
Ochnaceae							
* *Ochna serrulata* (mickey-mouse plant)	S	I	+	-	-	-	2,3,4
Orchidaceae							
* *Epidendrum* × *obrienianum* (crucifix orchid)	eH	R	+	-	-	-	1,4
Passifloraceae							
* *Passiflora foetida* var. *foetida* (stinking passion flower)	V	F	+	+	+	+	1,2,3,4
* *Passiflora suberosa* var. *suberosa* (corky passion flower)	V	F	+	+	+	+	1,2,3,4

Appendix I continued/...

Plant name (common name)	L/f	Occ.	Study Areas				D/m
			SE	CE	NQ	FN	
Phytolaccaceae							
* *Rivina humilis* (baby pepper)	H	I	+	+	+	-	2,3,4
Piperaceae							
* *Peperomia marmorata* (radiator plant)	H	R	+	-	-	-	1,4
Pinaceae							
* *Pinus elliottii* (slash pine)	T	R	+	-	-	-	2,4,5
Poaceae							
* *Axonopus compressus* (broad leaf carpet grass)	H	I	+	+	+	-	1,4
* *Axonopus fissifolius* (narrow leaf carpet grass)	H	I	+	+	+	+	1,4
* *Cynodon dactylon* (Bermuda grass)	H	F	+	+	+	+	1,4
* *Digitaria didactyla* (crab grass)	H	F	+	+	+	+	1,4
* *Phyllostachys aurea* (fishpole bamboo)	S	R	+	-	-	-	1,4
* *Stenotaphrum secundatum* (buffalo grass)	H	I	+	+	+	-	1,4
Polygonaceae							
* *Antigonon leptopus* (coral vine)	V	I	+	+	-	-	1,2,4,5
Portulacaceae							
* *Portulacaria afra* (elephant bush)	H	R	+	-	-	-	1,4
Proteaceae							
# *Grevillea banksii* (red-flowered silky oak)	T	R	+	+	-	-	2,4,5
# *Grevillea robusta* (silky oak)	T	R	+	+	-	-	2,4,5
Rhamnaceae							
* *Ziziphus mauritiana* (chiny apple)	ST	I	-	+	+	-	2,3,4
Rosaceae							
* *Raphiolepis indica* (Indian hawthorn)	S	R	+	-	-	-	2,4
Solanaceae							
* *Lycopersicon esculentum* (tomato)	S	R	-	+	-	-	2,4
* *Physalis minima* (ground cherry)	H	I	+	+	-	-	2,4
* *Physalis peruviana* (cape gooseberry)	H	I	+	-	+	-	2,4
* *Solanum seaforthianum* (Brazilian nightshade)	V	I	+	+	+	+	2,3,4
Tamaricaceae							
* *Tamarix aphylla* (tarfa)	T	R	-	+	-	-	2,4
Tropaeolaceae							
* *Tropaeolum majus* (nasturtium)	H	R	+	-	-	-	2,4
Verbenaceae							
* *Clerodendrum heterophyllum* forma *baueri* (clerodendrum)	S	R	+	+	-	-	2,4
* *Lantana camara* (lantana)	S	A	+	+	+	+	2,3,4
* *Lantana montevidensis* (creeping lantana)	S	R	-	+	+	-	1,2,4
Vittaceae							
* *Parthenocissus quinquefolia* (Virginia creeper)	V	R	+	-	-	-	2,4

Lifeforms (L/f): T = Tree, ST = small tree/tall shrub, S = low shrub, H = herb or forb, V = vine or liana.
Occurrence (Occ): A = abundant, F = frequent, I = infrequent, R = rare (see Methods section for definitions).
Study areas: SE = south-east Queensland, CE = central Queensland, NQ = north Queensland, FN = far north Queensland, + = present, - = not present.
Dispersal mechanism (D/m): 1 = vegetative, 2 = seed, 3 = animal (zoochory), 4 = human (anthropochory), 5 = wind (anemochory), 6 = water/ocean currents (hydrochory).
* = Naturalized exotic.
# = Australian species not indigenous to region.