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What do we do with the weeds of Canterbury? Emerging biosecurity risks for Canterbury's natural biota and timely responses

Colin D Meurk¹, Jon J Sullivan², Murray I Dawson¹, Jason Butt³, Alice Shanks⁴

¹ Manaaki Whenua – Landcare Research Associate; colinmeurk02@gmail.com
 ² Lincoln University; jon.sullivan@lincoln.ac.nz
 ³119 Forfar St, St Albans, Christchurch; Jasonbutt2@gmail.com
 ⁴ Central Canterbury rep, QEII National Trust; AShanks@qe2.org.nz

Summary

Canterbury's biodiversity, natural heritage and landscape character of forest, woodland, shrubland, grassland, and wetland is dependent on maintaining a critical mass of un-cultivated habitat (>10% of total area – Meurk and Hall 2006), protecting viable populations of all indigenous species by removing degrading factors and processes (browsing and predatory mammals, and competitive exotic plants), and promoting the positive (habitat restoration and landscape/habitat patch connectivity). A culturally necessary complement to this is a strong visibility of native species, vegetation and wildlife that engender identity and protectiveness. The continual invasive and deliberate spread of visually dominating exotic species undermines this outcome. This paper draws on our latest understanding of weed threats on a national and Canterbury regional scale. It extracts the ranked threat level of ca. 200 exotic species from the iNaturalist NZ – Mātaki Taiao citizen science website. We comment on priority and nuanced management of exotic plants based on well-established,

legally sanctioned, consensus-determined (or ecologically predicted) weed species, emerging threats, and attrition of natural character through deliberate designing of exotic species into prominent locations based on fashion and marketing rather than historic or ecologic connection to this land. This appears to fly in the face of one of Landscape Architecture's key tenets: legibility. We need to address all 200 of the species listed, but if we were to pick some special concerns that deserve renewed attention (whether it's mechanical, chemical, biocontrol, or through managed competition) our not-so-short list for Canterbury, in no particular order, is: sycamore, blackberry, holly, ivy, Russell lupin, *Myricaria*, hanging sedge, grey willow, barberry, cotoneaster, boxthorn, arum, veldt grass, hawthorn, irises, conifers, banana passionfruits, male and female ferns, common polypody, Chilean flame creeper, cherry laurel, Spanish heath, heather, sweet briar, aralia, onion weed, mayten, pig's ear (and other succulents), rowan, beggars' ticks, yew, silver birch, alder, ash, tree of heaven, bay, river lily, and horse chestnut.

Introduction

New plant pests are continually entering or establishing in the Canterbury Region from a large pool of naturalised exotic species (Meurk 1996; Meurk 2008, p. 221 and Table 2). Whereas blanket spraying or mechanical removal may work to remove weeds in agricultural or industrial landscapes (notwithstanding growing concerns about human and ecological health impacts), many native plant communities are being threatened by a Trojan Horse effect. This is where an initial exotic plant entry into tussockland, grey shrubland or forest understorey is undetected or ignored and a seed bank becomes established. Broadcast chemical or mechanical control, or fire, from then on creates (disturbance) conditions that usually favours further retreat of the sensitive indigenous component and proliferation or spread of continentally adapted weeds. This is typically happening with broom among high country matagouri, veldt grass in lowland forest, and hanging sedge along riverbanks. Scattered roadside remnants of native shrubs are being mistaken for shrub weeds and sprayed out - often leaving the exotics to prosper. Loss of local ecological authenticity is also being perpetuated by well-meaning but unknowing professionals and home gardeners who are operating with limited palettes of (indigenous) species or ecological knowledge. They promote plant aesthetics and fashions that have unintended consequences, propagate weed species through neighbourly sharing, or dig up attractive and vigorous exotic or non-ecosourced native species from their gardens for community restoration projects, school fairs, garage sales and roadside stalls.

Here we will touch on these emerging biosecurity threats (species-specific, ecological, socio-cultural and economic) to biodiversity and natural landscape character, and strategic actions needed to combat these ecological and cultural, even existential, threats.

What is a weed?

When is a weed a weed? There are both popular/sociological and ecological definitions of this concept. Socio-culturally a weed is a plant growing in the wrong place, that is, simply an "unwanted plant" from a particular cultural perspective (putting aside various other metaphorical applications). Ecologically a weed is a plant species that typically pioneers open, bare or disturbed ground. Weeds have been called ruderals (Grime 1979) or r-selected species, which have the characteristics of prolific seed production and rapid growth or colonising ability. Often they are light-demanding annuals, biennials or short-lived perennials that can quickly occupy a site and stabilise it or provide a substrate for later successional species (tall perennial grasses, shrubs and trees) (see Burrows 1990). Typically, such species are legumes (clovers, lupins, brooms), grasses, daisies, docks and chickweeds that like fresh soils, rich in mineral nutrients but low in organic matter and nitrogen (e.g. riverbeds), and the absence of competition (bare soil). They produce abundant, often wind or water-dispersed, seed.

The English ecologist, Philip Grime (1979), developed a model for plant strategies: the Competitor - Stress Tolerator - Ruderal (CSR) triangle. Application to the real world is a little problematic as many plant species have a little bit of everything. Take, for example, our native mountain beech (and many of our forest species). They are both colonising species, requiring light to stimulate growth to adulthood, and tolerating relatively cold conditions and low soil fertility in order to avoid competition, yet they are quite long-lived and competitive in their montane environment ("climax" species in old Clementsian terminology).

Whether a plant is in the "wrong place" is a matter of attitude, knowledge and human desire to power over the environment. In post-earthquake Christchurch the "weedy" rubble of the inner city has been condemned by city leaders espousing traditional values of tidiness, control, even sanitisation. In fact, it is likely that such fastidiousness is a minority view but one that has a loud voice. And yet, almost paradoxically, (west) Berlin instigated a no-spray regime in the city more than 30 years ago, and this allowed for many ruderal "weeds" to grow in footpath cracks and edges, rock walls, grass verges, and gutters - where rampant growth is contained mechanically. In a sense this mimics, in a semi-controlled way, the natural habitats of riverbeds, sand dunes, cliffs and crags. Such artificial alternatives have been termed "surrogate" habitats. Indeed, the whole discipline of urban ecology was largely instigated out of WWII rubble where these plant successions were given freedom to develop (mainly because of the enormity of control costs and therefore delays to reconstruction) and produce novel insights into plant ecology in general. To some extent it is being rediscovered in the international "urban wild" movement today. There are ways of accommodating the range of human aesthetics and sensitivities to landscape through what Joan Nassauer called "cues for care" in which "messy ecosystems" may be contained within "tidy frames" (Nassauer 1995).

Weeds are thus part of natural succession, but introduced species having evolved in continental, mammal-driven ecosystems are generally much more successful as

weeds than their indigenous counterparts. Nevertheless, we can, in cultural landscapes, engineer stressed (coarse or shallow) substrate and continually disturbed (grazed, mown, gardened) environments that reduce competition from exotic species and allow the indigenes to persist or co-exist. Landscape management to accommodate all these seral stages, and the greatest array of native species, needs therefore to operate across gradients of natural stress and disturbance (Meurk and Greenup 2003).

Introduced species may be categorised according to their relative benign-ness or invasiveness and their management profile; although with changing climates, adaptation, or new-found fertility, species may move from one (benign) category to another more aggressive one; or from a sterile to fertile state. All ecosystems in the world are now regarded as "recombinant" (Meurk 2011). We will never, nor would we want to, get rid of all alien species. As Meurk (2011) surmised, there are beneficial, benign, honorary native, invasive, and non-provenance introductions in any landscape. However, New Zealand has special value and high vulnerability in terms of its unique endemic biota due to its Gondwanic connections and long evolutionary isolation (Meurk 1995; 2007; see McGlone 2006 for contemporary thinking on the origins and formulation of our biota).

Management of these threats to productive or natural ecosystems in Canterbury comes from international or North Island experience of species, the latter being the entry point for many exotics. High priority is given to those where border control can prevent initial entry or establishment (**exclusion** species in national pest management terms), or **eradication** can be contemplated early in their establishment phase. Those that are widely established, but which are still spreading, come under a **sustained control** or **progressive containment** regime. **Site-led suppression** applies to places of high ecological value where local eradication is pursued.

However, there are many that are never going to be eliminated across a whole region with current technology and are relatively benign or even offer some values to, for example, native wildlife. The few that may fall into this category are either relatively low-growing, shade-intolerant, mammal-palatable, poorly dispersed, or non-exclusive competitors. These may be termed **co-existent** species. And then there are the **productive species** our economy depends upon and ideally are also dependent on our active management to maintain them. That is, they don't prosper in the wild. Among the worst combination of characteristics for alien forest species are those that are evergreen, shade-tolerant, unpalatable, and bird-dispersed. However, wind-dispersed pines invade non-forest areas and shade-tolerant Douglas fir can displace montane native forests (Meurk and Hall 2006).

A recent publication by Wotton and McAlpine (2013) collates current knowledge about the role of different exotic species as potential nurseries for native plant succession. The classic exemplar of this notion has been the management of the Hinewai Reserve on Banks Peninsula (Wilson 1994). They highlight the plant traits and environmental conditions associated with facultative versus disabling or suppressive, and therefore undesirable colonising species. In general exotic forbs are least competitive. Some exotic trees/shrubs provide shelter for regeneration. However, shade-intolerance in nursery canopy species is vital to facilitate native forest succession. In addition, a nearby native seed source with frugivorous bush birds within a moist climate and low browsing regime, and permanent suppression of fire are prerequisites for this concept to work for conservation.

Of the more than 30,000 exotic vascular plant species in New Zealand (cf. to about 2,600 indigenous; http://www.nzpcn.org.nz/) most are regarded as non-naturalised so have only a passive expression in the (internal, protected garden) landscape. These include indoor pot plants, sterile species or hybrids, cultivars or crop plants that require continual human support to survive. The wild exotic plants in New Zealand now outnumber the native flora (https://www.mfe.govt.nz/environment-aotearoa-2019-summary). Of these, 43 are officially declared pests of Canterbury (Table 1 from ECan), and an additional 58 are classed as "Species of Interest" (including unwanted plants, Table 2). These latter category names are somewhat euphemistic when they present a "serious problem" but are so embedded, ecologically and/or socio-culturally, that they pose an insurmountable challenge to control. This doesn't mean we should give up. The consequences of giving up are serious not just because of economic impacts, but because it would undermine the whole Aotearoa - NZ identity and further fuel the extinction of experience that our urban and rural culture already suffers. With likely smaller discretionary budgets in future, if we aren't proactive, we may never again have the resources to act. This will strip away one of the tenets of well-being: a sense of place and point of difference, perhaps also the basis for future low impact tourism.

The following lists (Tables 1 and 2) are based on national concerns, compiled by biosecurity experts, drawing on international or national knowledge of species invasiveness. Table 1 is largely (apart from gorse, broom, boneseed and banana passionfruit) species that have not yet established in Canterbury and are intended to be prevented from entering the region, or will be eradicated if already present in small numbers.

Table 1: Declared pests of Canterbury in alphabetical order by common name (Total= 43; source Environment Canterbury).

African feather grass (*Cenchrus macrourus*), African love grass (*Eragrostis curvula*), baccharis (*Baccharis halimifolia*), banana and other passionfruit (*Passiflora tripartita* var. *mollissima*, *P. tripartita* var. *azuayansis*, *P. tarminiana*, *P. pinnatistipula*, *Passiflora* x rosea, *P. caerulea*), bell heather (*Erica cinerea*), boneseed (*Chrysanthemoides monilifera*), broom (*Cytisus scoparius*, *C. multiflorus*, *Teline monspessulana*), bur daisy (*Calotis lappulacea*), cathedral bells (*Cobaea scandens*), Chilean needle grass (*Nassella neesiana*), coltsfoot (*Tussilago farfara*), Darwin's barberry (*Berberis darwinii*), egeria (*Egeria densai*), entire marshwort (*Nymphoides*)

geminata), gorse (Ulex europaeus), Japanese, giant and Indian/Himalayan knotweed (Fallopia japonica, F. sachalinensis and Persicaria wallichii), nassella tussock (Nassella trichotoma), moth plant (Araujia sericifera), old man's beard (*Clematis* vitalba), phragmites (Phragmites australis), puna grass (Achnatherum caudatum), purple loosestrife (Lythrum salicaria), saffron thistle (Carthamus lanatus), spartina (Spartina anglica), wilding conifers (Pinus contorta, P. nigra, P. sylvestris, P. uncinata, P. mugo and Larix decidua), wild Russell lupin (Lupinus polyphyllus), white-edged nightshade (Solanum marginatum), wild thyme (Thymus vulgaris), yellow bristle grass (Setaria pumila), yellow water lily (Nuphar lutea).

Table 2: Species of Interest in Canterbury (Total = 58; * = unwanted organisms; source Environment Canterbury). Plant species that are largely already established in Canterbury but are in a control and containment category because of their known propensity to spread.

Ash (Fraxinus excelsior), barberry (Berberis glaucocarpa), Bathurst bur (Xanthium spinosum), beggars' ticks (Bidens frondosa), Bermuda buttercup (Oxalis pes-caprae), blackberry agg. (Rubus fruticosus agg.), boxthorn (Lycium ferocissimum), buddleja (Buddleja davidii, excluding hybrids), burdock (Arctium minus), reed canary grass (Phalaris arundinacea), Cape honey flower (Melianthus major), Cape ivy (Senecio angulatus), hanging sedge (Carex pendula*), Chilean flamecreeper (Tropaeolum speciosum^{*}), Chilean glory vine (Eccremocarpus scaber^{*}), Chilean mayten (Maytenus boaria*), common polypody (Polypodium vulgare), false tamarisk (Myricaria germanica), German ivy (Senecio mikanioides), goat's rue (Galega officinalis), hawthorn (Crataegus monogyna), hemlock (Conium maculatum), hawkweed (*Hieracium spp.**), Himalayan balsam (*Impatiens glandulifera*), Himalayan honeysuckle (Leycesteria formosa), holly (Ilex aquifolium), horsetail (Equisetum hyemale), horehound (Marrubium vulgare), mistflower (Ageratina riparia), nardoo (Marsilea mutica), parrot's feather (Myriophyllum demersum), perennial nettle (Urtica dioica), pig's ear (Cotyledon orbiculata), plectranthus (Plectranthus grandis*), plumeless thistle (Carduus acanthoides), Chinese privet (Ligustrum sinense), ragwort (Senecio jacobaea), red flowering currant (Ribes sanguineum), rowan (Sorbus aucuparia), rum cherry (Prunus serotina), sagittaria (Sagittaria platyphylla), Senegal tea (Gymnocoronis spilanthoides), sheep's bur (Acaena agnipila), birch (Betula pendula), Spanish heath (Erica lusitanica), spur valerian (*Centranthus ruber*), spurge laurel (*Daphne laureola*), St John's wort (*Hypericum perforatum*), sweet briar (*Rosa rubiginosa*), sweet reed grass (*Glyceria maxima*), sycamore (*Acer pseudoplatanus*), tree lucerne (*Chamaecytisus palmensis* / *Cytisus proliferus*), tree lupin (*Lupinus arboreus*), variegated thistle (*Silybum marianum*), viper's bugloss (*Echium vulgare*), wild cotoneaster (*Cotoneaster glaucophyllus and C. franchetii**), wild elaeagnus (*Elaeagnus x reflexa*).

Information from iNaturalist NZ – Mātaki Taiao

We have another source of information via the citizen science platform iNaturalist NZ – Mātaki Taiao (Sullivan et al. 2019). The Project – "Pest Plants (weeds) of NZ" (see https://inaturalist.nz/projects/pest-plants-weeds-of-nz) records community-reported occurrences of plants deemed by the observer to be "pesky" in some weedy way. That is, it is accumulated wisdom, or a kind of consensus, among 377 observers around the country who have judged a species to be invasive and therefore potentially transformative to ecosystems.

The 991 species from 10,220 New Zealand observations made by 377 people (as at 22 October 2019) have been arranged according to the number of times they occur in this national database (Table 3, p.45). When the data are filtered for species reported as weeds in Canterbury there are 2,967 observations of 417 species recorded by 125 people; see https://inaturalist.nz/observations?place_id=82108&project_id=pest-plants-weeds-of-nz&verifiable=any). The species order is much the same although some species move up or down in prominence, reflecting the regional rather than national situation. For instance, old man's beard is the most frequently recorded weed on the national list (Table 3), but in Canterbury it is ranked second behind the highest ranked grey willow, which is ninth on the national list. The names of the species reported as weeds in Canterbury are shown in bold, along with their rank order number for Canterbury (Table 3).

The species that are currently confined to other, typically more northern, districts could arrive in Canterbury through normal migration, possibly accelerated by climate change. For instance, kahili ginger does not rank at all in Canterbury but comes seventh in the national Pest Plants (weeds) of NZ list (Table 3). Sullivan et al. (2019) document examples of recent incursions reported on iNaturalist NZ.

Table 3. Weed species occurrences throughout New Zealand as recorded in the iNaturalist NZ – Mātaki Taiao database as at 22 October 2019 arranged according to the number of times they have been reported from 10,220 observations (most frequent first). The **bolded species names** and **numbers** indicate species reported as occurring problematically in Canterbury and the rank order of the respective species in the region (as distinct from the order based on national data).

≥17 records in New Zealand

Old man's beard 2 (Clematis vitalba), ivy 5 (Hedera helix), wandering willy 12 (Tradescantia fluminensis), Japanese honeysuckle 37 (Lonicera japonica), gorse 6 (Ulex europaeus), blackberry 7 (Rubus fruticosus agg.), kahili ginger (Hedychium gardnerianum), sycamore 3 (Acer pseudoplatanus), grey willow 1 (Salix cinerea), tree privet 217 (Ligustrum lucidum), Moreton Bay fig (Ficus macrophylla), Scottish **broom 4** (*Cytisus scoparius*), woolly nightshade (*Solanum mauritianum*), climbing asparagus 60 (Asparagus scandens), Darwin's barberry 70 (Berberis darwinii), lily 33 (Zantedeschia aethiopica), montbretia 38 (Crocosmia arum Х crocosmiiflora), brush wattle 87 (Paraserianthes lophantha), boneseed 8 (Osteospermum moniliferum), common pampas grass 163 (Cortaderia selloana), 102 (Agapanthus praecox), Krauss's spikemoss (Selaginella agapanthus kraussiana), ragwort 36 (Jacobaea vulgaris), veldt grass 30 (Ehrharta erecta), Himalayan honeysuckle 66 (Levcestaria formosa), Chinese privet 230 (Ligustrum sinense), European holly 22 (Ilex aquifolium), hawthorn 15 (Crataegus monogyna), stinking iris 11 (Iris foetidissima), boxthorn 18 (Lycium ferocissimum), moth plant 396 (Araujia hortorum), Chilean rhubarb 26 (Gunnera tinctoria), tuber ladder fern (Nephrolepis cordifolia), tree lupin 34 (Lupinus arboreus), Mexican daisy 48 (Erigeron karvinskianus), tutsan 62 (Hypericum androsaemum), elderberry 10 (Sambucus nigra), blue corn lily (Aristea ecklonii), European spindle tree 9 (Euonymus europaeus), butterfly bush 58 (Buddleja davidii), banana passionfruit 27 (Passiflora tripartita), kikuyu (Pennisetum clandestinum), large bindweed 23 (Calystegia sylvatica), periwinkle 21 (Vinca major), German ivy 51 (Delairea odorata), Monterey pine 106 (Pinus radiata), male fern 16 (Dryopteris filix-mas), hanging sedge 14 (Carex pendula), Chilean flame creeper 32 (Tropaeolum speciosum), common polypody 13 (Polypodium vulgare), phoenix palm 71 (Phoenix canariensis), wine raspberry 351 (Rubus phoenicolasius), coral tree (Erythrina x sykesii), spear thistle 96 (Cirsium vulgare), tall flat sedge 31 (Cyperus eragrostis), cherry laurel 40 (Prunus laurocerasus), Spanish heath 115 (Erica lusitanica), blue morning glory 216 (Ipomoea indica), aluminium plant 42 (Lamium galeobdolon), sweet briar 19 (Rosa rubiginosa), pink jasmine 381 (Jasminum polyanthum), great barberry 77 (Berberis glaucocarpa), fennel 61 (Foeniculum vulgare), Japanese aralia 41 (Fatsia japonica), giant hogweed 17 (Heracleum mantegazzianum), Himalayan corokia 44 (Corokia simonsii), crack

willow 24 (Salix fragilis), yellow flag iris 25 (Iris pseudacorus), bulbil bugle lily (Watsonia meriana), onion weed 90 (Allium triquetrum), red valerian 29 (Centranthus ruber), creeping buttercup (Ranunculus repens), mayten 20 (Maytenus boaria), cape honey flower 233 (Melianthus major), pink ragwort (Senecio glastifolius), Douglas fir 145 (Pseudotsuga menziesii), pig's ear 28 (Cotyledon orbiculata), giant reed 323 (Arundo donax), prickly hakea (Hakea sericea), flowering currant 64 (*Ribes sanguineum*), monkey musk 45 (*Erythranthe guttata*), rowan 46 (Sorbus aucuparia), large-leaf cotoneaster 118 (Cotoneaster glaucophyllus), elaeagnus 395 (Elaeagnus x reflexa), Himalayan balsam 49 (Impatiens glandulifera), cape ivy 240 (Senecio angulatus), beggars' ticks 55 (Bidens frondosa), foxglove (Digitalis purpureus), Russell lupin 43 (Lupinus polyphyllus), purple loosestrife 35 (Lythrum salicaria), Chusan palm 132 (Trachycarpus fortunei), bear's breeches 99 (Acanthus mollis), yew 54 (Taxus baccata), hemlock 68 (Conium maculatum), stonecrop 39 (Sedum acre), Madeira vine 133 (Anredera cordifolia), bangelow palm (Archontophoenix cunninghamii), inkweed 178 (Phytolacca octandra), variegated thistle 78 (Silybum marianum), common honeysuckle (Lonicera periclymenum), Cape weed 57 (Arctotheca calendula), bridal creeper 84 (Asparagus asparagoides), queen palm (Syagrus romanzoffiana), velvety nightshade 52 (Solanum chenopodioides), Cretan brake (Pteris cretica), greater birdsfoot trefoil 142 (Lotus pedunculatus), mouse-ear hawkweed 50 (Pilosella officinarum), lodgepole pine 67 (Pinus contorta), African ice-plant 89 (Carpobrotus edulis), purple pampas 80 (Cortaderia jubata), silver birch 59 (Betula pendula), nasturtium (Tropaeolum majus), thorn apple 108 (Datura stramonium), marram grass 130 (Ammophila arenaria), Sydney golden wattle (Acacia longifolia), loquat 337 (Eriobotrya japonica), red-purple ragwort 101 (Senecio elegans), black nightshade (Solanum nigrum), monkey apple (Syzygium smithii), Chilean glory creeper 53 (Eccremocarpus scaber), pride of Madeira 46 (Echium candicans), Franchet's cotoneaster 85 (Cotoneaster franchetii), evergreen buckthorn 117 (*Rhamnus alaternus*), banana passionfruit (*Passiflora mollissima*), mile a minute (*Dipogon lignosus*). Total = 125 species.

≥10 records in New Zealand

Species shown only those relevant to Canterbury at present.

Alligator weed (*Alternanthera philoxeroides*), heather (*Calluna vulgaris*), **late** cotoneaster 121 (*Cotoneaster coriaceus*), Californian thistle 91 (*Cirsium arvense*), moth plant (*Araujia sericifera*), California poppy 62 (*Eschscholzia californica*), plums & cherries 92 (*Prunus spp.*), coastal banksia 372 (*Banksia integrifolia*), lantana 252 (*Lantana camara*), French broom 105 (Genista monspessulana), European alder 81 (*Alnus glutinosa*), black locust 73 (*Robinia pseudoacacia*),

impatiens (*Impatiens walleriana*), nodding thistle 86 (*Carduus nutans*), mist flower (*Ageratina riparia*), gooseberry 82 (*Ribes uva-crispa*), tree of heaven 74 (*Ailanthus altissima*), Mexican devil (*Ageratina adenophora*), caper spurge 170 (*Euphorbia lathyris*), green daphne laurel 176 (*Daphne laureola*), bay laurel 107 (*Laurus nobilis*), parrot's feather (*Myriophyllum aquaticum*), reed canary grass 69 (*Phalaris arundinacea*), Australian sheep's burr 76 (*Acaena agnipila*), myricaria 72 (*Myricaria germanica*), lady fern 79 (*Athyrium filix-femina*), wild parsnip 98 (*Pastinaca sativa*). Total = 27 species.

≥5 records in New Zealand

Species shown only those relevant to Canterbury at present.

Common rhododendron (*Rhododendron ponticum*), giant vipers-bugloss 168 (*Echium pininana*), heath rush (*Juncus squarrosus*), lesser burdock 112 (*Arctium minus*), karo 136 (*Pittosporum crassifolium*), lesser celandine 119 (*Ficaria verna*), common cordgrass 88 (*Sporobolus anglicus*), white poplar 122 (*Populus alba*), field & rough horsetail 94 (*Equisetum arvense & E. hyemale*), Chilean ice plant 127 (*Carpobrotus chilensis*), blue sedge 179 (*Carex flacca*), river lily 182 (*Hesperantha coccinea*), slender winged thistle 194 (*Carduus pycnocephalus*), ivy-leaved toadflax 200 (*Cymbalaria muralis*), kiwifruit 285 (*Actinidium sinense*), pellitory of the wall 304 (*Parietaria judaica*), cutleaf blackberry 173 (*Rubus laciniatus*), Canadian pondweed 169 (*Elodea canadensis*), evening primrose 209 (*Oenothera glasioviana*, *O. stricta*), crisp-leaved pondweed 116 (*Potamogeton crispus*), American pokeweed (*Phytolacca americana*), hornwort (*Ceratophyllum demersum*), red fescue 113 (*Festuca rubra*), Asiatic knotweed (*Reynoutria japonica*). Total = 25 species.

<5 records in New Zealand

Species not often seen or recognised ("under the radar" species) or not judged a danger, but potentially so. Nassella is an exception; it has its own control programme.

Tall oat grass 165 (Arrhenatherum elatius), grey sedge 166 (Carex divulsa), common privet 174 (Ligustrum vulgare), European larch 159 (Larix decidua), horse chestnut 140 (Aesculus hippocastanum), European ash 141 (Fraxinus excelsior), gravel groundsel (Senecio skirrhodon), serrated tussock 236 (Nassella trichotoma), giant Himalayan lily 241 (Cardiocrinum giganteum), salt marsh lavender 184 (Limonium campanyonis), rockspray cotoneaster 370 (Cotoneaster microphyllus), Portuguese laurel 228 (Prunus lusitanica), Brazilian waterweed (Egeria densa), honey locust (Gleditsia triacanthos), Bathurst burr (Xanthium spinosum), caterpillar grass 315 (Paspalum dilatatum). Total = 16 species.

The above list (Table 3) does not deal strongly with montane wildling conifers (iNaturalist NZ which has other projects identify these threats https://inaturalist.nz/projects/wilding-conifers), nor with aquatic weeds. There are also many Mediterranean succulents and shrubs (not so diligently recorded or identified), which are increasingly occupying rocky ledges and cliffs and squeezing out often the last native species in the landscape – having previously escaped fire and grazing and only recently being invaded by exotic competitors – e.g. pig's ear, Crassula alata, stonecrop, red valerian, pink dew plant, Mexican daisy, the shrubs boneseed and boxthorn, and common polypody fern. These are a particular problem in eastern Canterbury (Port Hills), which have a somewhat Mediterranean climate that suits these species, and which are also home for several restricted and endemic rock ledge species.

Those not indicated in bold (Table 3) are either so far found only in the northern part of New Zealand, or are of little perceived consequence in the south. Partly they are co-existent recombinants (Meurk 2011).

Sadly, some exotic weeds pose a threat because native species are confused with them, e.g. nassella control sometimes unwittingly results in elimination of similar looking native short tussocks, such as *Carex comans*, *C. flagellifera*, silver tussock and fescue tussock. And roadside remnant native broom, matagouri and pohuehue have been frequently mistaken for Scottish broom or exotic thorny shrub weeds and have disappeared from the rural landscape quite recently.

Some particular species to look out for and deal with as soon as possible are *Berberis aquifolium*, arum lily (Fig. 1, p. 49), Cape gooseberry, *Brugmansia*, bay laurel, spindle-berry, wild cherries/plums, Chilean glory vine, the four passion vine species, holly (despite there being some sterile cultivars), and *Juncus squarrosus* and *Nardus stricta* (in bogs). *Carex pendula* and river lily pose major threats along waterways and water races across Canterbury – they are just too beautiful – and the ferns *Cystopteris fragilis* and lady fern are increasingly intrusive. It seems we have given up on *Myricaria* in river beds, which could add to the already serious transformation caused by Russell lupins, gorse and broom.

Finally, the role of exotic trees and shrubs as nurseries for natural regeneration has gained some attention in recent times (Wotton and McAlpine 2013). This has been promoted for old growth pine forests, willows, and gorse/broom ("Fools and Dreamers" – what a wonderful model Hugh Wilson has provided at Hinewai). Like all things, there are 'horses for courses' and we need to apply these wisdoms with some caveats. It is desirable to use nature to help us restore nature. Shade-intolerant willows are great and can eventually be succeeded by native seed dropped by kereru that feed on the young spring shoots. But we need to make sure they are male willows (or single sex populations) that won't themselves spread all over the landscape. There are four prerequisites for the gorse model (Wilson 1994): fire must be kept out of the regenerating forest, browsing mammals must be fully excluded or they will remove palatable native seedlings; there must be a nearby natural seed source (within 2-3 km); and it really only works well in moist/warmer climes (cf. Lee et al. 1986). And

certainly don't encourage gorse amongst species-rich and rare natural grey scrub thinking this will be a great nursery for the future! It will just be a Trojan Horse leading to disappearance of that precious ecosystem and the natural landscape character.



Figure 1. Plants that are semi-shade tolerant like the pictured arum lily, *Zantedeschia aethiopica* 'Green Goddess', which is found in damp gullies and seeps on Banks Peninsula, male fern, ivy and veldt grass, are dominating the understorey of native woodland. (Photo: Alice Shanks)

Discussion and Recommended Actions

There is a lot of information there and a lot of chewing, swallowing and digestion still to go. The following actions are some steps towards deactivating those ticking time bombs in the landscape (Meurk 1996). It's often hard to go past the old wise proverbs: "one year's seeding, seven year's weeding" and "a stitch in time saves nine".

Start with commitment to no further loss of primary habitat – all the compromises have been made in Canterbury! We can't afford to lose any more. Even degraded habitat on uncultivated soils are important seed, subterranean faunal, and microbial sources and starting points for recovery of ecosystem health, landscape integrity and natural character across the Region.

Use citizen science to report/map distributions of weeds on https://inaturalist.nz/projects/pest-plants-weeds-of-nz so new incursions can be spotted, and localities targeted and communicated to local authorities, landowners or community volunteers via URLs.

Avoid adding to the threat load by not "nipping known risks in the bud" – like letting gorse/broom become a Trojan Horse in high country grey scrub (Fig. 2), arum in the woods (Fig. 1, p.49), or pink dew and gazanias in beach gravel (Fig. 3, p. 51) where they haven't been before, and...

Avoid inappropriate landscape planting of exotic species for amenity and show, or for spurious climate resilience reasons – as has been recently promoted for *Lomandra*, bee blossom and Australian dianella in our rain gardens – even if they are promoted as sterile cultivars now, as fertility may be restored!

Provide more ecological education and literacy for the general public, schools, landscape architects, arborists, planners, farmers, etc. about the existential threat to the natural character and place-making within Aotearoa – New Zealand cultural landscapes: follow Leonard Cockayne's dictum on planting **local** native species in schools. Visibility and continual daily experience and connection to our flora is vital to its survival. There is literature to support richer, functional, and more historically legible landscapes (Meurk and Hall 2006; Ignatieva et al. 2008).



Figure 2. The Trojan Horse effect of broom or gorse and elderberry establishing in grey scrub in Castle Hill Basin. A few years ago there were only a few scattered yellow bushes here. Now there is a substantial seedbank which will require more than seven years weeding! The danger now is that it will take over and even be encouraged as a nursery. Alternatively, it might be burnt or blanket sprayed, which will only serve to further promote the yellow stuff. (Photo: Colin Meurk).



Figure 3. Colourful garden escapes, like the intruders pink dew plant (possibly *Lampranthus*) and *Gazania*, are displacing leafless pohuehue (*Muehlenbeckia ephedroides*) in an endangered habitat type at Birdlings Flat. (Photo: Alice Shanks).

Educate landscape maintenance operators about ring-barking, spray drift, and species differentiation (Fig. 4, p. 52). Do we need fines or loss of contract in cases of negligence and/or lack of training/supervision?

Some form of plant nursery registration and training is needed to stem the flow of non-ecosourced native plants and of species from the North Island, Chatham Islands, Marlborough or West Coast that hybridise with local gene pools; and non-native ferns need to be taken off the shelf. There are plenty of local New Zealand species to do the job. Aesthetics has to be a secondary criterion for plant promotion after due diligence on risk to biodiversity.

Promote a more relaxed attitude to "urban wild" that allows for co-existence of native and some exotic "weed" species in the rubble and waste places - surrogates of riverbeds, dunes and crags. Weed control in such places needs to be strategic, targeted, and surgical.

Consider the full range of gradient management for the widest array of (positive) outcomes for biodiversity – competitive exclusion (fencing option), grazing (controlled disturbance), biocontrol, and engineered (stressed) substrates (Meurk and Greenep 2003; Meurk 2004).

Embark on prioritised weed eradication based on the lists and evolving information presented here, continually updated through institutional and citizen science.



Figure 4. Poorly trained and poorly informed maintenance contractors are eliminating often the last visible individuals of a species on the Plains. Note the live scotch broom in the now dead *Carmichaelia* in this Canterbury Plains roadside picture. (Photo Jason Butt)

Establish rapid reaction teams that can be deployed to immediately deal with identified incursions.

Preserve water races – these are the cumulative repositories of much lowland wetland flora and fauna of Canterbury (almost the only remaining "natural" wetlands of the Plains) and indeed are historic (1880s) artefacts in their own right. Industrial strength, scorched earth "weed" control needs to be suspended until there is better knowledge of how to maintain and manage their biota and control serious but beautiful weeds such as river lily and Chilean rhubarb.

Provide support to landowners through subsidies and/or rates relief.

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Crowdsourcing the discovery of new plant naturalisations in Canterbury using iNaturalist NZ

Jon J Sullivan¹, Colin D Meurk², Murray I Dawson², and Melissa AS Hutchison³

¹ Department of Pest-Management and Conservation, PO Box 84, Lincoln University, Lincoln, New Zealand, jon.sullivan@lincoln.ac.nz
² Manaaki Whenua – Landcare Research , Lincoln, New Zealand
³ Wildland Consultants Ltd, Christchurch, New Zealand

Introduction

"The new flora and vegetation are in their making. The future of glorious New Zealand plants and the beautiful primitive vegetation lies not in the lap of the gods but in the good sense of us New Zealanders and in our love for beautiful New Zealand." Cockayne (1967, p. 201)

Weeds are on the march in New Zealand and their impacts on New Zealand's indigenous vegetation will be felt over centuries to come (e.g., Williams and Braithwaite 2003; Williams and Cameron 2006). New plant species continue to naturalise from New Zealanders' gardens and spread across the country (Gatehouse 2008). The much older human history in Europe indicates that this invasion will take millennia to complete; it can take more than a century before woody garden plants are first discovered in the wild (Kowarik 1995), and naturalised plants that have "only" been in Europe for a thousand years are on average less widespread than those that naturalised earlier (Pysek and Jarosík 2005). The weed invasion of New Zealand has just begun, and our actions today have the potential to make a big difference to New Zealand's future vegetation.

Climate change may accelerate this process. It's likely to make southern regions like Canterbury suitable for weeds of more northern parts of NZ (Williams and