SLEEPER WEEDS

Richard Groves
CSIRO Plant Industry and CRC Weed Management Systems,
GPO Box 1600, Canberra, ACT 2601

Abstract I define sleeper weeds as those invasive plants that have naturalised in a region but not yet increased their population size exponentially. They thus fall between recent incursions and major weeds of national significance and represent a numerically large proportion of the total introduced flora of Australia. Some ecological factors which interact to determine status as a sleeper weed are discussed using Australian examples; two that seem to have most predictive value are time from naturalisation and re-location to a more favourable site. I conclude that sleeper weeds, one of the three major categories of weeds, require enhanced attention from research scientists and resource agencies so that overall weed impact in Australia can be reduced.

INTRODUCTION

A plant population goes through certain phases as it increases in numbers - it is introduced to a new site, it establishes and becomes naturalised, it increases in numbers slowly and, after a period of time, its rate of increase becomes higher until some factor in the environment limits further increase. This limiting factor may be imposed either naturally or as a result of human intervention (some form of management), after which the rate of population increase slows (Figure 1). A few naturalised plant species increase exponentially almost immediately after arrival and become major weeds. Most naturalised plant species, however, increase initially only to a limited extent, after which they show no further apparent population increase in their new environment for many years. Only after an extended period of time does the rate of population growth for such species increase and they begin to interfere with human activities in some way. These so-called 'sleeper' weeds comprise a numerically large subset of the invasive biota of Australia, and little is known about them at present.

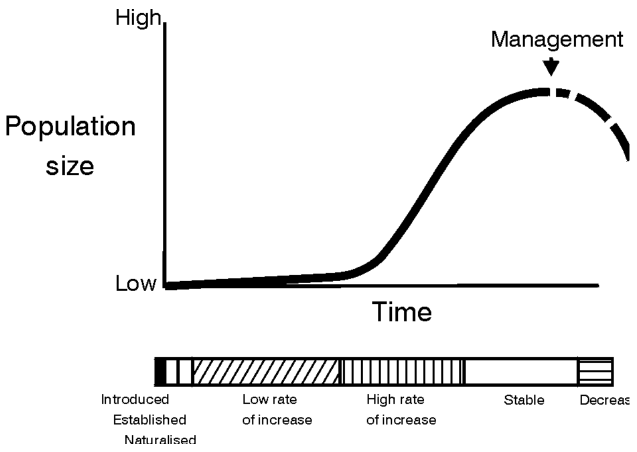

Figure 1. Phases in the population increase of a weed. Sleeper weeds are those invasive plants showing a low rate of increase in population size, i.e. they occupy the time period between naturalisation and the start of a high rate of increase in population size

ECOLOGY OF SLEEPER WEEDS

Elsewhere (Groves 1999), I have discussed several biological and ecological attributes of sleeper weeds that may influence the time between naturalisation and rapid population increase, and hence 'sleeper weed' status. These factors include the favourability of the arrival site for establishment of a population, the possession by the species of biological attributes enabling its persistence at a particular site and the species possibly being pre-adapted to the ecological conditions of the 'new' site. But two factors seem to be especially important in determining sleeper weed status, viz. time from naturalisation and re-location of a naturalised species to a more favourable site, each of which I shall discuss separately but in each case using the European genus *Hieracium* as my example.

Time from naturalisation Scott and Panetta (1993) investigated the status of some southern African plants that have become agricultural weeds in Australia over the last 150 years. Of a number of predictor variables they looked at, the longer the time from introduction (correlated with time from naturalisation?), the more likely it was that the species became an agricultural weed in Australia. Species introduced most recently (since 1950) had weed ratings that could not be predicted. Sleeper weeds include not only agricultural weeds, however, and it is noteworthy that Scott and Panetta found no variable (even a long time from introduction) to be a suitable predictor of non-agricultural weed status.

At least 260 species of *Hieracium* have been described for Europe, togather with many subspecies, apomictic lines and hybrids (Sell and West 1976). In Australia only one *Hieracium* species (*H. aurantiacum* L., syn. *H. brunneocroceum* Pugsley?) is known to be naturalised, with populations currently present in Tasmania (Curtis 1963) and Victoria (Groves, unpublished). In New Zealand, nine species of the genus and one naturalised hybrid occur currently and their known times of naturalisation are given in Table 1. The most invasive species in New Zealand at the moment is the one that naturalised earliest, viz. *H. pilosella* L.

The fact that the *Hieracium* species that naturalised first and over a century ago in New Zealand is now the most weedy bears out the conclusion of Scott and Panetta (1993) for agricultural weeds of southern African origin. Whilst some of the other *Hieracium* taxa present in New Zealand are also considered as weeds, can some of the more recent arrivals be regarded as sleeper weeds that will become major weeds over time?

At two sites in southeastern Australia *H. aurantiacum* seems to be a garden escape that is behaving currently as a sleeper weed. When will it become a major weed of subalpine grassland areas in this region? What is limiting its current low rate of population increase? What will change with time?

Table 1. *Hieracium* species and their dates of naturalisation in Australia and New Zealand (from Curtis 1963 and Webb *et al.* 1988 respectively).

Taxon	Date of Naturalisation
Australia	
H. brunneocroceum	
(syn. *H. aurantiacum* ?)	1963
New Zealand	
H. pilosella	1878
H. sabaudum	1904
H. aurantiacum	1911
H. praealtum	1924
H. argillaceum	1940
H. caespitosum	1940
H. murorum	1940
H. lepidulum	1946
H. pollichiae	1988
H. × *stoloniferum*	1988

Re-location to a more favourable site The history of spread of *H. pilosella* in the South Island of New Zealand (Groves 1999) suggests that for about 80 years it behaved as a sleeeper weed in South Canterbury. The species increased its rate of population growth only when it was re-located to the montane grasslands of the Mackenzie Basin, where over the last 40 years it has become a major pasture weed. In a manner similar to that evidenced by *H. pilosella,* the two populations of *H. aurantiacum* in southeastern Australia may be behaving as sleeper weeds until their re-location to sites more favourable for rapid population increase. Thereafter *H. aurantiacum* could become yet another aggressive rosette weed of major significance to Australian pastoral regions.

One Australian example which definitely shows a pattern of significant increase in population size as a result of geographic re-location is *Mimosa pigra*. This species is known to have been planted in the Darwin Botanic Garden since at least 1891, and probably earlier (Miller and Lonsdale 1987). It was naturalised only in the Darwin area as a sleeper weed until 1952 when material was re-located to an inland site at the headwaters of the Adelaide River. Its water-borne seeds could then spread down-river to the floodplains where it is currently one of northern Australia's major weeds of seasonally flooded wetland areas.

The two ecological factors I have discussed above will interact, as is obvious from the example of *H. pilosella*. Clearly, naturalised plants that have been in Australia for a longer period will have had a greater chance or time to be relocated to more favourable conditions that will forster their further spread. These two factors will also interact with other ecological factors such as rate of spread and the availability of dispersal vectors. Just as there seems to be no one attribute or set of attributes characteristic of invasive plants overall, neither does the subgroup of sleeper weeds necessarily have attributes in common. Rather, there seems to be a range in response of sleeper weeds to new geographic and ecological situations, knowledge of which is limited by the paucity of examples available at present and the inadequate documentation of the history of introduction and spread of other potential examples.

RESOURCE CONSIDERATIONS

The majority of resources for weed control (in terms of both money and time) in Australia goes towards reducing the impacts of major known weeds of cropping and grazing lands. Such weeds reduce the value of production, often in a direct way, and their costs to the community can be calculated and compared with the benefits of controlling those weeds. Benefit/cost ratios for control programs are often shown to be highly favourable, a situation that further promotes flow of resources to this category of weed. Less resources are directed currently at managing weeds invading natural vegetation, partly because the impact of such weeds is largely indirect in monetary terms and is more difficult to assess economically, especially those aspects related to biodiversity loss. A small but significant level of resources is also spent controlling, and even attempting to eradicate, some recent incursions in those cases where the species is known to be weedy outside Australia, such as the recent examples of *Chromolaena odorata* and *Kochia scoparia* var. *scoparia*.

Williams (1997) showed diagrammatically the relative costs (both in monetary terms but also in terms of the presumed environmental costs) of limiting weed populations at three different phases of the invasion process (Figure 2). The costs for eradicating a new incursion (A) are less than those associated with controlling it when it is already widespread geographically (B), although the total population may be limited and much less than when its rate of population size has increased and it has acquired the status of a major weed (C). The costs of eradicating or controlling sleeper weeds lie somewhere between (B) and (A), presumably.

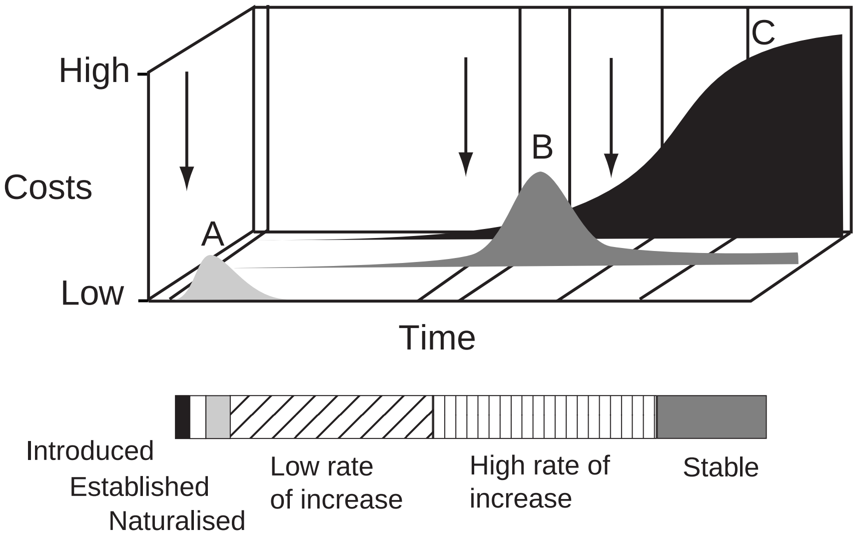

Figure 2. Costs of undertaking an eradication program on a recent incursion (A) relative to those for control at either an early (B) or a late (C) phase of a plant invasion (from Figure 4 of Williams 1997)

Csurhes and Edwards (1998) considered a total of 289 weed species that were in the early phases of invasion, of which 274 were definitely introduced to Australia. Of the latter total, 119 species were not known as environmental weeds outside Australia. Csurhes and Edwards then took a subsample of 30 of the 155 species known to be weedy outside Australia and assigned each species a relative probability of eradication; they found that 10 species had a 'high', 5 a 'medium' and 15 a 'low' probability of eradication. Their predictions refer mainly to environmental weeds and not to known weeds of agricultural systems.

Many of the 274 species considered by Csurhes and Edwards (1998) seem to fall into the sleeper weed category as defined in this paper. Others are not yet naturalised and may not therefore comply with my earlier definition. Their 10 introduced species known to be weedy outside Australia and predicted by them to have a high probability of success for eradication would be a useful short list on which to start limiting the number of non-naturalised sleeper weeds in the Australian introduced flora. Taxa on this short list include *Acacia* spp. (especially *A. catechu, A. karroo, A. sieberiana), Aloe ferox, Clerodendrum* spp. (though *C. chinense* is not yet known to be naturalised in Australia), *Miconia calvescens, Mikania* spp., *Myrica faya, Mimosa dulcis, Rhus radicans* (the latter three not yet known to be naturalised, though grown in some Botanic Gardens in Australia), *Sesbania punicea* (not naturalised but probably still in some private gardens in Australia) and *Ziziphus mucronata* (as one plant in Melbourne Botanic Gardens). Whilst some success may already have been attained in Australia with controlling and/or eradicating *Acacia karroo* and *Mikania* spp., eradication of the other taxa specified by Csurhes and Edwards seems an urgent priority for Australian land managers. Certainly, most of them meet the conditions for eradication as specified by Williams (1997).

At present, almost no resources are allocated for the eradication of sleeper weeds, and certainly not on a national basis. Logically, however, a limited amount of money and time spent when a weed population is small and confined geographically should yield considerable benefit in that the overall cost of controlling that weed will be much less than when the same weed has increased significantly in population size and distribution (Figure 2). This is the same logic, after all, that is applied to the allocation of scarce resources to control or eradicate recent incursions of weeds of already known agricultural potential. The different situation with sleeper weeds presumably arises because their potential to multiply and affect human values is less simple to predict as that for recent incursions of known agricultural weeds.

The deficiency in programs targetting sleeper weeds needs to be addressed if the overall impact of weeds on Australian land systems is to be reduced. Bureaucratic structures are in place to allocate resources and to implement management of weeds of national significance and of recent incursions. No such resources or structures exist at present, however, to reduce the present or future impact of sleeper weeds. Perhaps it is time for this numerically large third class of weeds to receive more attention from all sections of the weed management community, including those who allocate already scarce funds on a national basis. Involvement of the nursery industry seems essential, because many sleeper weeds (including *H. aurantiacum* in New South Wales - see Dellow and Groves, these Proceedings) are still being sold and actively promoted by members of that industry.

CONCLUSIONS

There is a spectrum of responses to new environments shown by plants introduced to Australia from elsewhere. There appear to be no hard boundaries between the biological attributes shown by unsuccessful arrivals, by naturalised but localised plants and those shown by major invasive weeds which are currently characterised by large population sizes and extensive distributions. Sleeper weeds fall somewhere between those recent incursions with a high invasive potential known from their behaviour in other regions and the species that have already become major weeds of national significance.

Sleeper weeds are thus an important and hitherto-overlooked third category of invasive plants that have been little studied to date but for which benefit/cost ratios of eradicating or containing them may be highly favourable. They comprise an unknown but probably numerically large proportion of the introduced flora of Australia and are worthy of an enhanced level of study and research funding. The benefit/cost ratios arising from an eradication program for a recent incursion may be considerable in the short term, as in the case of *Chromolaena odorata* in northern Queensland. The benefit/cost ratios from more effective control of some major weeds of agricultural and natural ecosystems may be higher and even longer term. Control or eradication of the intermediate, third category of invasive plants we call sleeper weeds may also be highly cost-effective in the medium- and long-terms (Figure 2).

The important category of sleeper weeds cannot continue to be overlooked by weed scientists and funding agencies in Australia if we wish to avoid an inexorable increase in the number of major weeds and the resources spent on their control in the future. The subject is too important to have been overlooked nationally for so long!

ACKNOWLEDGMENTS

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REFERENCES

Csurhes, S. and Edwards, R. (1998). 'Potential environmental weeds in Australia. Candidate species for preventative control'. (National Weeds Program, Environment Australia, Canberra).

Curtis, W.M. (1963). 'The Student's Flora of Tasmania', Part 2. (Tasmanian Government Printer, Hobart)

Groves, R.H. (1999). Meeting the challenges posed by 'sleeper' weeds. In 'Managing Exotic Insects, Weeds and Pathogens', ed. S. Dempsey, in press. (Bureau of Rural Sciences, Canberra).

Miller, I.L. and Lonsdale, W.M. (1987). Early records of *Mimosa pigra* in the Northern Territory. *Plant Protection Quarterly* 2, 140-2.

Scott, J.K. and Panetta, F.D. (1993). Predicting the weed status of southern African plants. *Journal of Biogeography* 20, 87-93.

Sell, P.D. and West, C. (1976). *Hieracium* L. In 'Flora Europaea', Vol. 4, eds. T.G. Tutin *et al.*, pp. 358-410. (Cambridge University Press, Cambridge).

Webb, C.J., Sykes, W.R. and Garnock-Jones, P.J. (1988). "Flora of New Zealand', Vol. IV. (DSIR Botany Division, Christchurch, NZ).

Williams, P.A. (1997). Ecology and management of invasive weeds. Conservation Sciences Publication No. 7. (New Zealand Dept of Conservation, Wellington, NZ).