Successes and lessons from olive risk management in South Australia

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Introduction

Olea europaea L. spp. *europaea*, the culinary olive, was introduced to South Australia (SA) in 1836 by John Hindmarsh, the State's first Governor (Stevenson 1839). More varieties were introduced and in the 1870–1890s there was substantial commercial production in what are now the eastern suburbs of Adelaide (Reichelt and Burr 1997), as well as Clare and the Riverland (Smyth 2002). However, high costs and low demand for olive oil saw a decline in the industry from the 1900s, with fruit no longer being harvested. The abandonment of these early orchards facilitated the beginnings of a feral olive invasion, with the first naturalized specimen taken in 1901 (Kloot 1986). The Adelaide foothills adjacent to the former orchards now contain high density populations of olive.

Olive has naturalized widely across SA and in New South Wales and Victoria (Crossman *et al.* 2002). It is SA's worst invasive tree and one of the highest impact environmental weeds in the state. It ranks highly for the three criteria determining weed risk. Its stress tolerant seedlings, high fecundity and efficient vertebrate dispersal of seeds gives it a high invasiveness score. In terms of impacts, it is highly competitive and stands can trend towards monocultures with significant impacts on native plant biodiversity (Crossman 2002), accessibility and fire intensity. Olive pollen is also known to be a significant allergen in the Mediterranean Basin (Wheeler 1992). It has a wide potential distribution in South Australia, being adapted to a dry Mediterranean climate and being tolerant of a wide range of soil textures and soil pH, with the main soil limit being waterlogging (APCC 1999).

Crossman (2002) investigated the biodiversity impacts of feral olive. Native species richness and abundance in *Eucalyptus microcarpa* Maiden woodland was 50% lower where there were dense feral olives. Native shrubs and trees were vulnerable, with *Acacia pycnantha* Benth. and *Eucalyptus* spp. cover reduced by 70% and 80% respectively in woodland containing dense olive.

Plantings of olives slowly increased in urban and horticultural areas following increased post-WW2 migration from southern Europe. However, the mid 1990s saw a significant revival in the olive industry in SA, driven in part by a government push to diversify food production and by investment schemes with attractive tax offsets. Usage of olive oil in the Australian diet also increased as Mediterranean cuisine became more popular and the health benefits of monounsaturated oils were promoted. However, the prospects of a significant expansion in olive plantings across SA was a concern to conservationists and weed managers, who already faced a difficult feral olive problem.

Olive risk management

In 1998 the former SA Animal and Plant Control Commission (APCC) convened the Olives Working Group, with representatives from SA Government Departments (both primary industries and environment agencies), the olive industry, the University of Adelaide (which was undertaking research into the genetic potential of feral olive populations), the Local Government Association and the non-government Conservation Council (Jupp *et al.* 1999). There was considerable debate within the Olives Working Group, which hindered consensus. Nonetheless, the APCC was able to develop a discussion paper in consultation with the Group, which became the basis of a state-wide policy (APCC 1999). This policy had four main components: state-wide declaration of feral olives, a risk assessment system for local government planners examining new orchard proposals, a code of practice for orchards to limit seed dispersal and an olive orchard register. Concurrently, APCC funded a University of Adelaide honours project on feral olive dispersal by birds (Mladovan 1998).

Olive dispersal research

Mladovan's (1998) research found that density of feral olive plants declined exponentially with distance from the trunks of tall trees, indicating bird movement as a key vector of seed dispersal. Whilst seven bird species were observed to disperse olive seed, the common starling (*Sturnus vulgaris* L.) was the most frequent. Starlings usually swallowed olives whole and regurgitated the seeds 20–50 minutes later. Larger fruits, typically produced by irrigated, commercially managed orchards, were harder for starlings to handle and swallow. While feeding on olives, starlings tended to move between the parent trees and perch sites within 100 m where they regurgitated olive seed, so that seed dispersal was mostly short-distance. However, seed could be transported many kilometres when flocks returned at night to their communal roosts. The European fox (*Vulpes vulpes*) has also been recorded as a disperser of olives (Paton *et al*. 1988).

Declaration for control

The State government declared feral olives for enforced control at landholder expense in all regions of South Australia in 1999, including on road verges. However, it is likely that this only marginally increased the level of control. There were already many tens of thousands of feral olives in the landscape, which were expensive to control and often not perceived as a threat (especially at low densities). In the Mid North region alone, approximately 11 000 trees were mapped on roadsides (Crossman 2004). In native vegetation with limited accessibility and risks of off-target damage, cost estimates of herbicidal control have ranged from $750 to $3000 ha^{-1}, even higher where mechanical removal is also required (Interdepartmental Taskforce on Feral Olives 2004). The majority of feral olive control is still undertaken by contractors (with funding from governments – Australian, SA and local) or volunteers, targeting priority biodiversity sites. APCC policy (APCC 1999) included the provision that an orchard that remained unharvested for two consecutive years could be considered abandoned, which could then be cause for removal. However, this has rarely been enforced.

Risk assessment and management guidelines

A risk assessment system for new olive orchards was developed as a simple MS-Excel spreadsheet to assist local governments in determining whether to approve a proposal (APCC 1999). Under the SA *Development Act 1993*, if land is not already being used for horticulture then establishing an olive orchard is a change of land use that requires approval from local government authorities. Risk to native vegetation was assessed using two criteria: i) the likelihood of olive spread; and ii) the consequences of spread. The *likelihood* criterion was split into two sub-criteria: a) non-management factors; and b) management factors. Non-management factors ranked the probability of spread of feral olives based on rainfall, surrounding land use and the incidence of soil waterlogging. Management factors considered steps the

orchardist planned to follow to minimize dispersal of fruit. These related to bird and fox control, fruit maturity and size at harvest, visibility of fallen fruit, and a buffer zone around the orchard in which olive seedlings are removed. The *consequences* criterion had factors considering the distance to significant native vegetation, the presence and control of feral olives in the surrounding landscape, and the presence of existing orchards. A new orchard would not greatly increase the weed risk if there were already many feral olives that were not being controlled and/or if existing orchards were in the area. A risk rating was determined by simply adding the likelihood and consequence scores (each ranging from 0 to 100), with low risk orchards scoring 50 or less, medium risk 51–100, high risk 101–150 and very high risk >150.

Guidelines for local government planners recommended that very high risk orchard proposals should not be approved. High risk orchards should only be approved with compulsory management conditions to limit spread. If these were not maintained then the orchard should be removed. Medium risk orchards were recommended to have a memorandum of understanding to abide by an industry code of practice to limit olive spread. Low risk orchards would have no formal agreements with local government but would still be encouraged to use the code of practice.

The risk assessment system was adopted by some local governments, especially where the authorities had a close working relationship with the local Animal and Plant Control Boards (APCB). In many cases a local government would defer the assessment to the APCB and follow their recommendation. Over 100 new orchard proposals were assessed across SA, with greater use in areas where feral olives were already a significant problem and where there was strong community support for protection of native vegetation. However, use of the system has declined with time. The merging of APCBs into larger Natural Resource Management Boards disrupted some of the close working relationships between weed officers and local government planners. A turnover in local government planners has meant that new employees do not have knowledge of the risk assessment system. There has also been declining interest in small-scale olive production due to low profit margins. Some local governments still have olive orchard planning guidelines on their websites, but it is difficult to judge how often they are applied. There was no legal obligation for local governments to use the risk assessment system as part of their approval process. For orchards that were approved, there is limited evidence that formal requirements for management of spread have been monitored and maintained.

Code of practice for orchards

This code (APCC 1999) detailed information on bird and fox management. A buffer zone between orchards and native vegetation (preferably at least 200 m) was also recommended, with the provision of perch sites (e.g., planted native trees) within this zone to act as a 'sink' for any bird-dispersed seeds. Olives germinating within this zone would then be controlled as seedlings. It is difficult to judge to what level the code of practice was adopted within the industry. The code has not been promoted since its publication in 1999. It has been recommended that the code be resurrected as a formal planning approval tool under the Natural Resources Management Act, 2004 (Interdepartmental Taskforce on Feral Olives 2004), which would increase its use.

Olive grove register

A register of current and new olive orchards was proposed to monitor their locations and adherence to management conditions. Unfortunately there was a poor level of collaboration between local governments, APCBs and the APCC to establish the register. Interestingly, such a register is now seen as important to the industry to monitor production (Anon. 2006).

Potential for risk maps

Crossman (2004) and Crossman and Bass (2008) demonstrated that olive risk management could be more sophisticated than a simple additive scoring system, by using predictive habitat modelling and spread models to develop risk maps. Overlaying GIS-based models of the probabilities of: i) suitable habitat (based on climate and soil variables); ii) olive dispersal to native vegetation; and iii) establishment (based on land use intensity) produces a threat surface of risk of olive spread. Maps have been produced for the Adelaide Hills Council to use in new olive orchard proposals, and there is wider potential for such risk maps to be used as a decision tool.

Conclusions

Olive risk management in SA remains a novel approach to dealing with conflicts of interest over invasive economic crops. There have been two key successes. Firstly, feral olives gained prominence as a serious weed issue in SA, with a greater understanding of the extent and impacts of the weed. Management of feral olives continues to raise political and media interest, with support for regional control programs. The olive industry is also more aware of the risks of feral olives, from both environmental and biosecurity perspectives (Anon. 2006). Secondly, the number of inappropriately sited new olive orchards has been reduced. The APCC policy (APCC 1999) aimed to concentrate new orchards in areas with existing orchards and/or feral populations, where approval would not add greatly to the existing weed risk. Local government planners and Animal and Plant Control Officers appreciated having an informed policy and process to manage the risk of feral olives in their areas.

However, it cannot be said that the feral olive problem has been significantly diminished through the risk management approach. Feral olives were already widespread in 1999 and the approach would have been much more appropriate for a new industry or for a state where olives did not have a long history of cultivation and naturalization. A key lesson has been that the limited resources put into the initial implementation and ongoing liaison with local governments and industry meant that there was inconsistent uptake across SA. Awareness of the olive risk management policy is diminishing with turnover in local government planners and changed focus of weed managers. For a risk management approach to be successful, ongoing communication and policy revision is needed, which adapts to changing government planning and natural resource management frameworks. There is no guarantee that compulsory management conditions or codes of practice will be followed in perpetuity, and stronger legal backing is recommended (Interdepartmental Taskforce on Feral Olives 2004). GIS modelling to develop risk maps are potentially a better planning and communication tool than case-by-case assessments.

Industry expects limits on the siting of new olive orchards to be accompanied by control of feral olives (i.e. 'practice what you preach'). However, cost is a major constraint on control programs. Research into cheaper, more effective control options is required. It is evident that the olive risk management approach has not been a significant constraint to development of the olive industry, as there are now more than 2 million trees planted in SA (Sweeney 2006). Clearly feral olives will be a long-term management issue for SA.

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Role of government in management of commercial weeds

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Introduction

We have a long history of government involvement in weed management in Australia. Colonial governments made weed management one of their earliest priorities for legislative action, recognizing the impact of weeds on primary production. For example, one of the first pieces of legislation introduced by the South Australian colonial government in 1851 was an Act to prevent the further spread of Scotch thistle. Despite this legislative commitment, weeds have continued to spread over much of Australia in the last century and a half.

Weeds have become established and spread in Australia: naturally, accidentally and by deliberate action, to the extent that 8–12 new plant species have until recently been established each year. At least 1–2 of these species are likely to become serious weed problems. While farmers have often been acutely aware of the problems caused by weeds to agricultural production, many have been largely oblivious to, or willing to ignore, the range of impacts that their activities have had on the spread and introduction of new weeds and of the fact that their potential new crops could become weeds impacting on either their own enterprises or on other interests.

Pressure to make Australia more suitable for the European style of farming and living inevitably meant that new species would be sought for introduction. Those that out-competed other plants and that produced a lot of palatable biomass or seed were usually pursued for agriculture, horticulture or for amenity. The possibility that these plants may have undesirable characteristics, or cause harm to the environment, was only rarely raised as an objection to their introduction and spread if they had desirable qualities.

Perhaps the most famous example was the role of Victoria's first Government botanist, Baron Sir Ferdinand von Mueller, in introducing blackberry to suitable habitat in Australia. I have not seen any evidence of any risk assessment in his role in promoting blackberry and in fact he was subsequently honoured by a number of countries in part for his role in introducing other species to their environments!

Ornamentals are our biggest source of declared weeds in Australia, but plants introduced for agronomic reasons are also a major source of our weed burden, making up at least 15% of the total.

Recent examples of commercial introductions can be found in a study by Mark Lonsdale in 1994. He found that of 463 exotic pasture species introduced into northern Australia between 1947 and 1985, 13% turned out to be weedy and less than 5% were useful pasture species. Cases such as this have traditionally involved government agencies in introducing, evaluating and promoting new species, often without any reference to negative impacts on other sectors.

A recent case has been the promotion of gamba grass (*Andropogon gayanus*) as a useful pasture species in northern Australia, despite overwhelming evidence of its negative impacts on savannah woodlands by altering the intensity of fire and thus on the survival of key species. Gamba grass was introduced into Australia in the 1950s and developed by the Northern Territory government as a cattle feed. This led to the plant being released in 1978 and subsequently sown on properties from 1983 until 1993. This grass can support 40 times more cattle than the native grasses it replaces, leading to high weight gains for cattle. However when it becomes established in woodlands, its extreme height (up to 4 metres) and high biomass mean that any fires spread rapidly, burn more intensely and burn to a greater height than a similar fire in native grasses. This leads to scorching of the canopies and eventual death of the trees, with the predicted demise of most trees in woodlands across the north of Australia where gamba grass is allowed to spread. This could well lead to one of the most extensive vegetation clearance schemes in Australia, with native woodlands being transformed in to introduced grasslands with massive loss of biodiversity. Fortunately, the Queensland Government announced on 4th April that it was declaring the weed and thus banning its sale and requiring it to be controlled.

Government in this case has been an agent for weed spread both by its promotion of the species in the past and by current inaction. This raises the question as to what should government's role be in situations where a plant has both beneficial and deleterious impacts?