THE WEED SOCIETY
OF NEW SOUTH WALES Inc.

PAPERS AND PROCEEDINGS

For

NSW OLIVE FORUM

Wednesday 9 August 2006

Conference Centre
Orange Agricultural Institute

Organised by

The NSW Olive Council
on behalf of

AUSTRALIAN OLIVE ASSOCIATION LTD.

and

NSW DEPARTMENT OF PRIMARY INDUSTRIES

Copies of this publication are available from:

THE WEED SOCIETY
OF NEW SOUTH WALES Inc.
PO Box 438 WAHROONGA NSW 2076
Website: www.nswweedsoc.org.au

PROGRAM

Forum on the Olive industry and feral olives

- 9.00 for 9.30 am — Registration and coffee.
- 9.30-9.40 am — Introduction and purpose outline
  Dr Stephen Johnson and Mr Peter Dowling

Session 1 Chair – Mr Peter Dowling

- **9.40-10.20 am** — **Key note speaker - Feral olive issues**
  Dr Neville Crossman, CSIRO Land and Water
- **10.20-10.30 am** — **Q and A session.**
- **10.30-11.00 am** — **The Olive Industry**
  Mr Nelson Quinn, President NSW Olive Council
- **11.00-11.10 am** — **Q and A session.**

End of Session 1

- 11.10-11.40 am — Morning tea

Session 2 Chair – Mr Nelson Quinn

- **11.40-12.00 pm** — **Olive identification and biology**
  Mr Peter Cuneo, Mount Annan Botanic Gardens and
  Dr Stephen Johnson, NSW DPI
- **12.00-12.10 am** — **Q and A session.**
- **12.10-12.30 pm** — **Olive management and legislation**
  Mr Jim Dellow, NSW DPI and
  Dr Stephen Johnson, NSW DPI
- **12.30-12.40 pm** — **Q and A session.**
- **12.40-1.00 pm** — **Feral olives and local government**
  Cr Reg Kidd, Orange City Council and Chairman,
  Noxious Weeds Advisory Committee with
  Mr Geoff Hudson, NRM facilitator, Local Government and
  Shires Association of NSW
- **1.00-1.10 pm** — **Q and A session**

End of Session 2

- 1.10-2.10 pm — Lunch

Session 3 Facilitator – Mr Lloyd Kingham

- **2.10-2.40 pm** — **Brief Q and A and Issue identification exercise.**
- **2.40-3.45 pm** — **Facilitated discussion exercise** (including review of key information, identification of gaps and charting of future directions)
- 3.45 – 4.00 pm — Concluding remarks – Dr Stephen Johnson

End of Session 3

- Afternoon tea

CONTENTS

Papers delivered at the Forum on the Olive Industry and Feral Olives

Background papers/Further reading

(the following papers have been reprinted with the Authors/Organisations permission)

25-28 Hanson, C. S. T. (2002). A weed risk minimisation strategy for the European olive, *Olea europaea* ssp. *europaea*, in Tasmania. Proceedings of the 13th Australian Weeds Conference, Perth, September 2002. Eds. H. Spafford-Jacob, J. Dodd and J. H. Moore. Plant Protection Society of Western Australia, Perth, Western Australia. pp. 100-103.

29-33 South Australian Government (n.d.). Declared plant policy. Olive (*Olea europaea*). Online at www.dwlbc.sa.gov.au/files/lbsap_olive_policy.pdf 5 pp.

34 South Australian Government (2005). Infestation level of *Olea europaea* (Olive) by hundreds in the state of South Australia. Online at www.dwlbc.sa.gov.au/files/lbsap_olive.pdf 1 pp.

35-36 South Australian Government (1999). Risk Assessment for new olive orchards. Online at www.dwlbc.sa.gov.au/files/oliv_wra.xls 2 pp.

37-38 South Australian Government (n.d.). Weed control notes. Olives. Online at www.mitchamcouncil.sa.gov.au/webdata/resources/files/olive_control1.pdf 2 pp.

39-55 South Australian Government (2003). Feral olives in South Australia. Department of Water, Land and Biodiversity Conservation report DWLBC 2004/12. Online at www.dwlbc.sa.gov.au/files/feralolives_report.pdf 17 pp.

57-69 Laity, M. and Young, K. (2005). Olives – new industry or environmental threat. Proceedings of the 2nd Biennial Victorian Weeds Conference, Bendigo, August 2005. Ed. R. G. Richardson. R. G. and F. J. Richardson publishers, Meredith, Victoria. 13 pp.

71-72 Weed Management Society of South Australia (n.d.). Position statement on management of feral olives in South Australia. 2 pp.

74-75 Information on *Olea* species in NSW and how to submit herbarium specimens.

The Olive industry and the feral olive issue

This one day forum will discuss the olive industry and the issues posed by feral olives. It has been organised by the Weed Society of New South Wales in cooperation with the NSW DPI, the NSW Olive Council and the Australian Olive Association. Information on the olive industry, the threats posed by feral olives, the identification of olive species, the interaction of local government and the management of feral olives will be presented. A facilitated discussion session during the afternoon will draw together the issues discussed and plan a cooperative direction forward.

WHO IS INVITED

Everyone who has an interest in the olive industry and/or the issues posed by weedy or feral olives.

In particular the forum will be of interest to

- **Olive growers**
- **Local Council staff including those involved in noxious weed management and development applications**
- **State Government Authorities responsible for weed management and policy and**
- **Weed management companies.**

WHERE

The forum will be held at the Conference Centre of NSW DPI's Orange Agricultural Institute, Forest Road, Orange. A map of Orange can be found at the website
http://www.orange.nsw.gov.au/

Orange is a 3-4 hour drive from both Sydney and Canberra, and many parts of inland NSW. A number of direct flights from Sydney operate daily. Further information on accommodation, transport to, and attractions in Orange can be found at the above website.

WHEN

Wednesday 9 August 2006

9.00am (for a 9.30 am start) – 4 pm

THE WEEDS SOCIETY OF NEW SOUTH WALES Inc.

NSW DEPARTMENT OF PRIMARY INDUSTRIES

The NSW Olive Council on behalf of

AUSTRALIAN OLIVE ASSOCIATION LTD.

ISSUES

Olives are widely grown across much of southern Australia. Continued strong growth for olive products, particularly in NSW, should result in over 8000 hectares planted by 2010 with production worth in excess of $100 million.

Varieties of European olive are the mainstay of the olive industry today. In the past however, varieties of African olives have been planted. These have escaped from cultivation and become feral in NSW. Widespread escapes of European olives have not yet occurred in NSW but have occurred in other states. This forum examines the potential of olives to continue to become feral in NSW and explores what approaches may be needed to prevent this.

EXPECTED OUTCOMES

Participants will receive an overview of information on the following: -

- **the current state of the olive industry and the many issues that the industry encounters;**
- **the impact of feral European olives in southern Australia;**
- **identification of, biology and current distribution of feral olive species;**
- **perspectives on local government decision making for planning;**
- **current management and legislation surrounding feral olives; AND**
- **participate in facilitated discussion to identify issues and plan a cooperative direction forward.**

COST TO ATTEND

Weed Society/AIAST/NSW Olive council members* $60

Others $80

* Olive growers are encouraged to contact Mr Nelson Quinn, NSW Olive Council President to discuss payment.

This cost includes lunch, morning and afternoon teas and a printed summary of the proceedings.

REGISTRATION AND FURTHER DETAILS

For further information and to RSVP please contact
Stephen Johnson, NSW DPI on (02) 6391 3146
or email stephen.johnson@dpi.nsw.gov.au
by the close of business Wednesday 2 August 2006

THE WEEDS SOCIETY
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ASSOCIATION LTD.

FERAL OLIVES IN SOUTH AUSTRALIA: IMPACTS AND MANAGEMENT

Dr Neville Crossman
Research Scientist
Policy and Economic Research Unit, CSIRO Land and Water
PMB 2, GLEN OSMOND, SA, 5064

Introduction

The olive (*Olea europaea* L.), imported into Australia and subsequently cultivated for economic purposes, has spread into native vegetation in several regions of southern temperate Australia. The impacts of olives going 'feral' have only recently been quantified. It is reported that native plant species diversity and canopy cover was 50% and 80% lower, respectively, in native eucalypt woodland heavily invaded with feral olives. Consequently, feral olives are considered an environmental weed as well as being proclaimed a Pest Plant in SA.

Distribution

Olives have naturalised across a wide range of habitats in South Australia. Occurrences are predominantly within the 400mm to 600mm median annual rainfall range. The highest concentrations occur on the western foothills of the southern and central Mount Lofty Ranges, directly to the east and south of Adelaide. These populations are likely to be the direct descendants of the orchards planted in the late-1800s/early-1900s. Other large concentrations in SA can be found in the Barossa and Clare valleys. The occurrence of a small number of feral olives in drier locations suggests that the species can survive in regions that receive less than 500mm average annual rainfall. Populations of feral olives are also found in Western Australia, Victoria, New South Wales and south-east Queensland. There are no known populations of feral olives in Northern Territory and Tasmania.

Dispersal

Dispersal of olive seed is almost wholly dependent on birds. In South Australia, the Common Starling (*Sturnus vulgaris*) is the most prevalent disperser. A common sized flock of 100 could disperse thousands of seeds in a day. They usually swallowed olives whole, regurgitating the stones 20-50 minutes later. Most seeds were likely to be dispersed within 100 m of the parent trees. The exception was at dusk when starlings returned to nocturnal roosts, so that some seeds could be dispersed kilometres away from parent trees. Starlings had difficulty in handling and swallowing large fruits, and showed a strong preference for intermediate sized fruits. Many other birds have also been noted ingesting fruit and dispersing seeds of olives (Table 1). The European Fox (*Vulpus vulpus*) consumes olives and disperses seed in the southern Mount Lofty Ranges with seeds frequently found in fox scats during the winter months. Foxes may disperse olive seed up to 5 km away from the parent tree.

Impacts

A recent study (Crossman 2002) suggests feral olives have an impact on native canopy cover and diversity in native Eucalypt woodland. This comparative study (Crossman 2002) found that the dense cover of feral olive canopy coincides with reduced cover of native plants in heavily invaded woodland. Grey box eucalypt (*Eucalyptus macrocarpa* Maiden) upper-stratum cover and golden wattle (*Acacia pycnantha* Benth) mid-stratum cover was 80% and 75% lower, respectively, at a heavily invaded site (Crossman 2002). Native species richness and abundance were found to be significantly lower at the sites heavily invaded by feral olives. Species most at risk were herbaceous and shrub forms found in the lower- and mid-strata. Crossman (2002) reported that native plant species richness and abundance was more than 50% lower at one heavily invaded site.

Table 1. Occurrence of common avian feral olive dispersers in southern Australia.

Disperser	WA	SA	Vic	NSW	Qld	Tas
Pied Currawong			✔	✔	✔	
Red Wattlebird	✔	✔	✔	✔	✔	
Crested Pigeon	✔	✔	✔	✔	✔	
Black-faced Cuckoo Shrike	✔	✔	✔	✔	✔	✔
Golden Whistler	✔	✔	✔	✔	✔	
Silvereye	✔	✔	✔	✔	✔	
Common Starling		✔	✔	✔	✔	✔
Common Blackbird		✔	✔	✔		
House Sparrow		✔	✔	✔	✔	

Risk Assessment

The risk assessment system for olives (APCC 1999) was designed as a decision tool for local government planners to rate the risk that a proposed olive orchard poses to native vegetation. The process has the potential to reduce the conflicts between the commercial use and conservation threats of olives. The scoring system had two criteria: 1) the likelihood of olive spread from the orchard, and; 2) the consequences of this spread. The *likelihood* criterion was split into two sub-criteria; non-management factors and management factors. The *consequences* criterion had factors considering the distance to significant native vegetation, the presence and control of feral olives, and the presence of existing orchards. A risk rating was determined by simply adding the likelihood and consequence scores. Local government planners were recommended to reject planning approval for orchards posing **very high** risk. For **high** risk orchards, compulsory management conditions to limit seed dispersal were recommended as a condition of approval, or the approval could be denied. For **medium** risk orchards, a voluntary land management agreement or a memorandum of understanding between local government and the grower was advised, to encourage compliance with an industry code of practice on minimising seed dispersal. Local governments are not currently legally obliged to use the olive risk assessment system but many have voluntarily done so.

Control

Olives have a tremendous capacity for regrowth following physical damage. As a result herbicide control is the most widely used technique. The recommended herbicide is triclopyr which is usually mixed with diesel and applied to cuts made in the trunk of trees near the ground. Glyphosate is preferred for treatment of feral olives in and near watercourses due to the risk of off-target damage. Follow up treatment within two years is usually necessary to retreat trees and monitor regrowth. Trees partially killed may lay apparently dormant after initial treatment and then densely resprout. Seedlings are best grubbed from the soil when soil moisture levels are high. A soil seed bank and continual seed dispersal ensures that seedlings will continue to germinate at a treated site. Regular follow up treatment is integral to successful control. Alternative application techniques involve either 1) felling trees and then frilling the stump with an axe with herbicide applied to the fresh vertical cuts or 2) drilling holes into trunk near the ground and filling the holes with herbicide. It can cost up to $15,000 per hectare to remove a dense infestation of feral olives.

References

APCC, 1999. *Risk Assessment and Management of Olives*. Animal and Plant Control Commission, South Australia.

Crossman, N.D., 2002. The impact of the European olive (*Olea europaea* L. subsp. *europaea*) on grey box (*Eucalyptus microcarpa* Maiden) woodland in South Australia. *Plant Protection Quarterly* 17, 140-146.

THE OLIVE INDUSTRY

Mr Nelson Quinn
President, NSW Olive Council

The Olive Industry in Australia – the Weeds Issue

'The spread of the Australian olive industry in the 1990s poses a major weed threat.'
Spenneman and Allen 2000

'(A) survey indicates that olives have naturalised in New South Wales. Victoria, South Australia and Western Australia, and are considered to be a problem in South Australia, the only State that has taken formal action on control or determination as a noxious plant.'
RIRDC report *The Olive Industry – An environmental management systems framework* 2004

'To date (the olive) is an occasional weed in Canberra however with the establishment of olive plantations it is almost certain to become a major weed in the future.'
Jumping the Garden Fence: Invasive Garden Plants in Australia 2005

The RIRDC report recommended continuing action on the 'olives as weeds' issues.

Olives are a long term feature of the Australian landscape, e.g. Sydney, Adelaide, Yass, New Norcia, Roma and Rutherglen.

Estimates of scale of industry – 7-8 million trees planted or in prospect.

Geographic coverage – all States, similar to grapes.

Economic prospects – still looks good, provided developed as a 'niche' product and exports continue.

Strengths of the industry:

- great diversity of operations
- high consciousness of need for research and development
- already innovative, e.g. harvesting
- most groves supported by off farm income
- vertical integration
- consciousness that marketing is critical
- strong industry support
- recognition by Governments
- not tradition bound
- active in international developments
- Code of Conduct

Weeds issue

- work already in South Australia and Tasmania
- agreement to develop a national framework for the issue
- identify issues and get working on them

OLIVE IDENTIFICATION AND BIOLOGY

Mr Peter Cuneo
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Mount Annan Botanic Garden
MOUNT ANNAN, NSW, 2567
and Dr Stephen Johnson
NSW Department of Primary Industries,
Locked Bag 21, ORANGE, NSW, 2800

Summary
This paper provides information on the identification and biology of olives (*Olea europaea*). The botany and identification of both subspecies is examined before briefly examining the climatic preferences and distribution of each in NSW. The focus of this paper is African olive, in particular, the biology and the environmental impacts of the species.

Botanical overview of olives
The Olive (*Olea europaea*) is the cultivated or European olive first described by the famous taxonomist Carl Linnaeus in 1753. Olive has been long cultivated throughout the Mediterranean region, with some records dating back to 3700 BC (Zohary 1995). The precise wild origin and history of cultivation from these times is not known. In recent times it has not been possible to find an exact match for the domesticated olive at a wild location in any country (Green and Wickens 1989). The species is of considerable economic and historical importance, with many cultivars of *Olea europaea* now grown commercially throughout the world. The *Olea europaea* complex extends from the Canary Islands and Madeira westwards across the Mediterranean and south-west Asia to the Sino-Himalayan region and south through eastern Africa to southern Africa (Green and Wickens 1989). *Olea* occur across a very wide geographic range with 33 species and nine subspecies now described (Green 2002), including one species *Olea paniculata* a rainforest tree which is native to eastern Australia.

In Australia, the Olea subspecies introduced into cultivation and now attracting interest as environmental weeds are:

- *Olea europaea* subsp. *europaea* (European olive) and the numerous cultivars
- *Olea europaea* subsp. *cuspidata* (African olive)

European olive (Figure 1)
Olea europaea subsp. *europaea*

Dense multi – trunked tree with dark green/silver underside foliage sheen.

Leaf characteristics
3-7 cm long
8-10 mm wide
Undersurface whitish – silver grey
Hooked leaf apex absent
Leaf margins slightly recurved

Fruit
Fruit – purple/black oval drupe 15-25 mm long x 6 mm diameter.

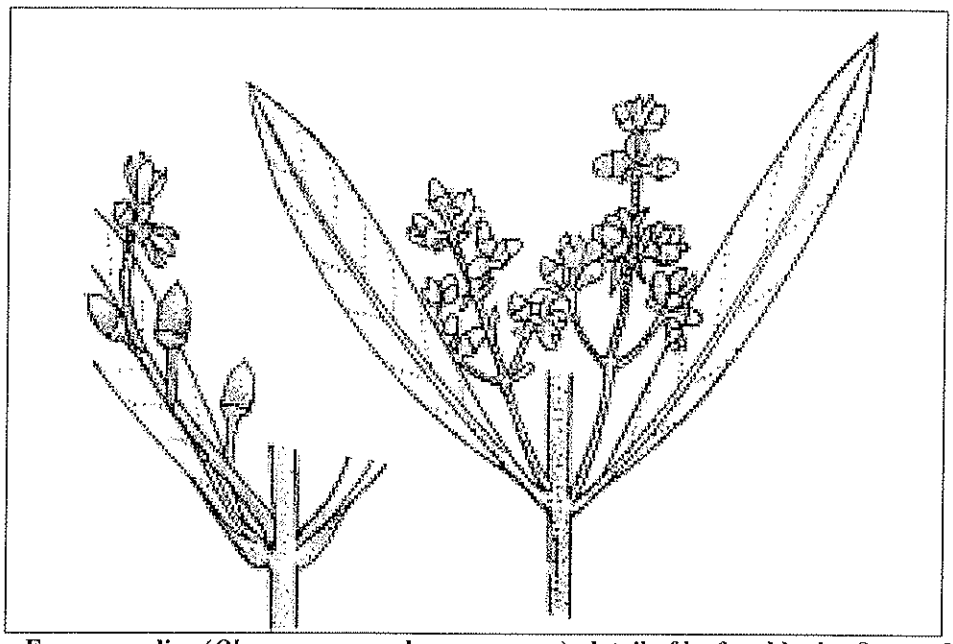

Figure 1. European olive (*Olea europaea* subsp. *europaea*), detail of leaf and buds. Source: Hardin (2006).

African olive (Figure 2)
Olea europaea subsp. *cuspidata*

Dense multi – trunked tree with dark green glossy foliage.

Leaf characteristics
6-10 cm long
10-25 mm wide
Undersurface pale green – yellowish brown
Leaf tip with hooked apex
Mid veins yellowish green

Fruit
Purple-black thinly fleshed drupe, round 6-7 mm diameter.

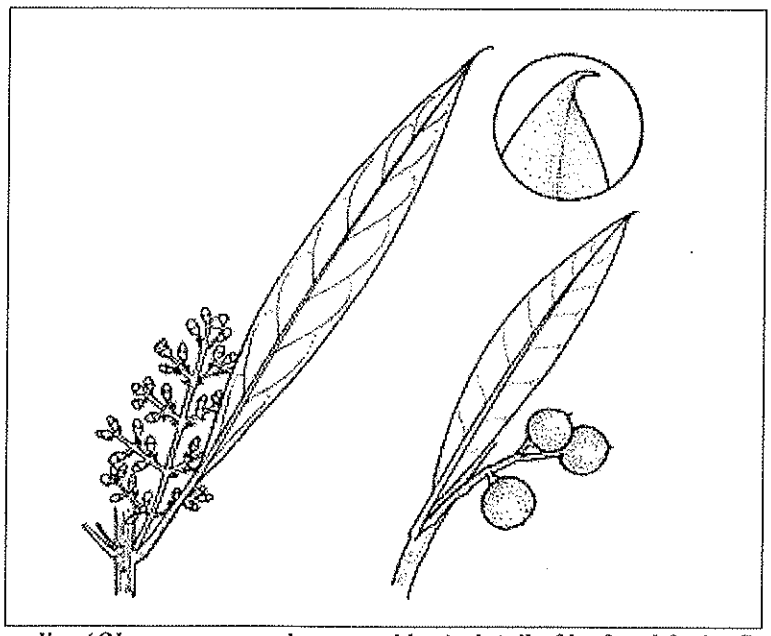

Figure 2. African olive (*Olea europaea* subsp. *cuspidata*), detail of leaf and fruit. Source: Hardin (2006).

Distribution and climatic preferences

Whilst these two olives grouped botanically under *Olea europaea*, their natural distribution and climatic preference is quite distinct. The European olive originated from the Mediterranean basin and is adapted to the Mediterranean climate, so much so that climatologists consider olive cultivation as a reliable indicator of this environment (Zohary 1995). In Australia the region of Mediterranean climate, providing optimal conditions for the cultivation of European olive is most of southern Australia with a minimum of 500 mm rainfall and adequate night chilling in winter (Parsons and Cuthbertson 1992).

European olive

Although more in-depth information on the biology of European olive can be found in the papers by Crossman and others (this volume, pp. 1-2 and 11-19), this section examines what is known about the distribution of feral plants of the subspecies in NSW.

European olive is relatively common near some older orchards but has, as yet, only been recorded as occasionally naturalised outside these situations. Populations of the subspecies have been collected from Inverell (on the North West slopes) to Wagga Wagga (on the South West Plains) with records from Cowra, Grenfell and Camden. More collections are needed so that an accurate picture of the current locations of feral populations can be gained.

African olive

African olive is a dense – crowned small to medium tree (up to 15 metres) and is part of the tropical wild olive group. The major area of natural distribution for African olive is eastern Africa, where it extends throughout the eastern African states from the southern tip of Africa to the north-east regions. African olive extends into the Middle East region with occurrences in Yemen and Saudi Arabia. A significant Asian centre of African olive distribution is northern India, Afghanistan, Pakistan and Kashmir. The most easterly natural distribution is China, particularly the drier parts of Yunan and Sichuan (Green 2002). African olive naturally occurs in a wide range of habitats from rocky hillsides to river banks, and grows in rainfall zones from ~100mm near the Red Sea to ~1200mm in the Ugandan highlands.

African olive was introduced into cultivation in NSW as a hedging plant and rootstock during the mid-1800's and is closely linked to agricultural pioneers John and William Macarthur and the development of the famous Camden Park estate, near Camden NSW. A well-established nursery operated at Camden Park during the mid-1800's, and catalogues at the time listed many species from Africa which had proven to be well adapted to Australian conditions. African olive was subsequently planted at properties throughout the Camden district, which now a major centre of African olive spread. African olive is still occasionally used as a rootstock for European olive, however the fruit has no commercial value and does not produce extractable oil. African olive is a protected species in its native Africa, due to over exploitation of its dense, hard and durable timber.

African olive thrives on the clay soils of the Cumberland Plain region west of Sydney, eventually forming a dense and continuous mid-canopy which excludes the regeneration of native species. African olive seed is spread along roadsides and into bushland areas via bird perch sites such as powerlines and large trees. African olive is an aggressive woody weed and is now established in the following regions which receive rainfall in the range 440mm to 1325mm:

Major infestations

- Camden – Campbelltown region, NSW
- Hunter Valley NSW, Lochinvar – Maitland Vale district
- Illawarra region, NSW
- Norfolk Island
- Hawaiian Islands of Maui and Kaua'i
- Raoul Island, New Zealand

Localised/scattered infestations

- Tamworth and Attunga State Forest
- Tocumwal
- Lismore
- Ulladulla/Shoalhaven region
- Inverell
- Wellington
- Cowra
- Tumut
- Adelaide Hills, SA

Key aspects of African olive biology and environmental impacts

African olive in its native range occurs across a wide range of habitats and has established as a long lived, persistent and adaptable woody weed in NSW. African olive produces flowers in mid-summer, followed by small green fruits which progressively turn purple-black as they ripen throughout the winter months. Flowers are mainly pollinated by wind and seed crop development is dependent on favourable late summer rain. Plants are capable of producing fruits at age five years, with mature trees capable of bearing >25,000 fruits. At an average size of 7mm, the sweet black fruits are smaller than European olive and readily consumed by a wide range of native and introduced bird species. The black fruits contain a woody endocarp which is voided by birds for distances of several kilometres. Through bird dispersal, African olive seed is highly mobile in the landscape and is able to invade Eucalypt woodlands as seedlings establish below large 'perch' trees. It is not known whether ingestion by birds increases germination of African olive seed, however ripe seed is dormant and germination from whole olive fruits does not usually occur until ~15 months. Once established in bushland areas around perch trees, African olive is able to progressively spread with mature fruiting plants establishing a dense 'carpet' of olive seedlings at the edges of the canopy. When African olive is not controlled it is able to develop (over 10 years+) a dense mid-canopy in woodland areas and will out compete native understorey species for light and moisture. Where African olive has been able to establish over the long term, pure olive stands develop which permanently exclude the regeneration of most native seedlings.

African olive and the future of feral olives in NSW

African olive is proven to be highly invasive and can no longer be regarded as a 'sleeper' weed in NSW. African olive is highly adaptable and readily dispersed through the landscape, and is has impacted on native plant diversity in coastal regions of NSW. Dispersal of seed by birds remains the key issue with feral olives, and with the increasing popularity of European olive cultivation into coastal NSW it must be assumed that there is potential for hybridisation with existing populations of African olive. Hybridisation between European olive and African olive will most likely result in trees that produce smaller fruits capable of being spread by birds into bushland areas. Whilst it is possible to botanically distinguish between European and African olive, plants in the Camden region are observed to 'intergrade' between both subspecies. It would be very worthwhile conducting research into the genetic status of

feral olives in NSW to better understand the origin and further spread potential. Weed risk assessment modelling and mapping for both European olive (similar to that done for South Australia) and African olive in NSW is recommended in view of the expansion of the olive industry. The use of African olive as a rootstock needs to be carefully considered by the olive industry as there is potential for rootstocks to regenerate from failed or abandoned trees providing a weed seed source.

Any consideration of feral olives in NSW needs to take into account predicted climate change which is now a reality, and the fact that we have olive subspecies adapted to both sub-tropical and Mediterranean climates. NSW has experienced an average rainfall decline of 14.3mm/decade since 1950, with most climate models predicting an overall expansion of a Mediterranean climate. Modelling of future rainfall for coastal regions of NSW is more complex, however it is clear that changes will favour opportunistic exotic species such as olives that are readily dispersed in the landscape.

References

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CONTROL OF OLIVE, *OLEA* SPP.

Mr James J. Dellow
NSW Department of Primary Industries,
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Abstract
Olea species can be controlled and selectively removed from eucalypt parkland by the application of a mixture of triclopyr and distillate in autumn as either a basal bark or cut stump treatment.

Introduction
There is increasing concern about the spread of *Olea* spp. into bushland and the unwelcome consequences of this spread on the native flora. There is a need to explore the selective control options of these incursions with herbicide applications. It would need to be demonstrated that the herbicides used and methods of application would have little effect on nearby vegetation. In trials conducted at "Camden Park" Camden in 1985, Dellow *et al.* (1987) showed that *Olea* spp. could be selectively controlled without damage to other desirable species growing in close proximity. Conventional high volume herbicide application was seen as impractical and undesirable due to the risk of off-target damage. Consequently, alternative application methods were used.
The *Olea* spp. present in the trial site at "Camden Park" had a wide variation in both leaf form and colour, and in size and shape of the fruit. The National Herbarium, Sydney, identified two *Olea* spp. in the trial site. Both *O. europaea* and *O. europaea* ssp. *africana* were identified (Dellow *et al.* 1987).

Methods
The trial was located in a paddock with heavy infestations of olive, under mature narrowleaf ironbark (*Eucalyptus crebra*) stands.
Various rates and types of herbicides (Table 1) were applied as both a basal bark application and cut stump treatment in May 1985. Glyphosate (360 g/L) was applied at two application rates mixed with water while triclopyr (480 g/L) was applied at one rate mixed with distillate (Table 1). At the time of application the olives varied from 3 to 25 cm in basal diameter and 1 to 7 m in height. The basal bark treatment was applied with a low pressure hand-held pneumatic sprayer to the base of the stems (from ground level to 30 cm). The cut stump treatment involved cutting the stumps close to the ground and immediately swabbing the cut stumps with the herbicide mixture. Soil moisture was excellent at time of treatment.
There were four replications for each treatment. Results were assessed 13 and 20 months after treatment and compared to untreated control plots.

Table1. Effect of herbicide and method of application on control (% mortality) of *Olea* spp. 20 months after treatment (Dellow *et al.* 1987).

Herbicide	Treatment	Method	% kill
Glyphosate + water 1 : 2	1	Cut stump	13 c
	2	Basal bark	68 b
Glyphosate + water 1 : 10	3	Cut stump	0 c
	4	Basal bark	13 c
Garlon +distillate 1 : 10	5	Cut stump	100 a
	6	Basal bark	98 a
Control (untreated)	7	Cut stump	0 c
	8	Basal bark	0 c

LSD ($P<0.05$) 17.12

Results and Discussion

The triclopyr (Garlon 480 g/L) and distillate mixture was outstanding in controlling olive as either a cut stump or basal bark application treatment regardless of plant size. Glyphosate gave unsatisfactory results (Table 1).

The basal bark treatment is simple to apply and is the most cost effective treatment. Although the cut stump treatment using triclopyr and distillate gave comparable results, it requires the stems to be cut and the disposal of the large amounts of plant material. This is a considerable disadvantage. In the untreated control plots, regrowth of the cut stump treated plots after 20 months was 1 to 2 m high.

In all treatments there was no observed effect on adjoining off-target species.

Using a mixture of triclopyr and distillate as a basal bark or cut stump treatment, olive can be selectively controlled in autumn.

(Triclopyr (600 g/L) and distillate mixture (1:15) is registered in New South Wales as a basal bark and cut stump application technique for olive control.)

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NOXIOUS WEED LEGISLATION AND OLIVES

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Legislation can be used to achieve management outcomes. In New South Wales, this may occur through the *Noxious Weeds Act 1993*. There are a number of criteria that need to be satisfied before a plant is declared noxious, including impact on at least one of the following – the economy, community or environment, a reasonable and enforceable means of control and that the benefits of imposing control on the community exceed the costs.

Only one Local Control Authority (LCA) has any olive declaration, this being African olive in Ryde (see http://www.dpi.nsw.gov.au/agriculture/noxweed). Other LCAs are interested in declaring feral olives including those in Sydney, the Central west and Riverina areas. Since NSW DPI is responsible for recommending declarations to the Minister, we are interested in cooperatively working with industry and relevant stakeholders to develop a "Feral olive management strategy".

Such a strategy may involve two components, these being an industry code of practice to prevent the establishment of, and manage the occurrence of feral olives, and a state management plan where any new declarations are made to strategically support on-ground works. Exemptions for managed olive orchards are likely if an LCA successfully requests declaration of European olive, and demonstration of an industry code of practice would help this exemption process. Scientific and common name synonyms are included in declarations as are varieties and cultivars of named species or subspecies.

FERAL OLIVES AND LOCAL GOVERNMENT

Cr. Reg Kidd
Orange City Council
and Chairman,
Noxious Weeds Advisory Committee

Forum on the Olive Industry and Feral Olives

The Role of Local Government

Cr Reg Kidd, Orange City Council and Chairman Noxious Weeds Advisory Committee
(Mr Geoff Hudson, NRM Facilitator, LGSA)

Why is Weed Management regulated?
The market fails to deal with costs imposed on the community by unmanaged weed spread.

- The market includes - market forces and the common law
- Weed spread means - the establishment of weeds in new areas

Why is a plant declared Noxious?
Where a plant is, or is likely to, cause significant negative impact on the economy, community or environment of NSW it may be considered a candidate for declaration if:

- Weed potential
- Harm causing potential
- Reasonable means of control
- LCA Intent to enforce declaration
- Net community benefit from declaration
- Limited distribution

Legislation Framework

- Noxious Weeds first legislated in NSW (Local Government Extension Act 1906)
- Major expansion of noxious weed responsibilities (Local Government Act 1919)
  - Split responsibility between two Ministers
- Noxious Weeds Act 1993
  - One Minister made responsible for noxious weeds
  - Amended in 2005 (came into force March 2006)

Role of Local Government
Councils can undertake their responsibilities as Local Control Authorities in 2 possible ways:

1. Individual Council LCA
2. Group of Councils LCA (County Council)

Responsible for -

- Inspection of Private Property & Businesses
- Enforcement of the NW Act – Extensive powers
- Maintaining records of noxious weeds
- Control of noxious weeds on council land
- Cooperating with neighboring LCAs
- Developing 'Control Requirements' for Class 4 Weeds (are law upon publication)
- Preventing establishment and spread of new and emerging weeds (now the main priority for all noxious weed programs).

Decision Making Frameworks within Local Government

Strategic Planning

- What is the role of NWAC in local decision making?
- What is the role of Regional Weeds Committees in local decision making?
- How is the legislative process managed within local councils?
- What is the role of the (elected) council and how does it make decisions?
- Are there any guidelines local councils have in place to address potential problems?
- The mechanics of the progress through the various stages from emergence of a problem to the development of laws to cope with the problem
    - Submissions for declaration are generally made through LCAs.
    - Orders are applicable for periods not exceeding five years.
    - Control Requirements for Class 4 Weeds are developed locally

Statutory Planning

- Can weed management be incorporated into Council's land use planning powers?
- Can weed management be incorporated into the Local Environment Plan (LEP)?
- Should weed infestations be listed on Section 149 Planning Certificates?
- Do land zonings impact on weed declarations and/or weed control requirements?

Operations

- How is weed management incorporated into Council's day-to-day operations (across all areas of council)?
- How is it incorporated into the Management Plan?
- LCAs must control noxious weeds on their land as per the declaration.
- What are the inspection procedures of each LCA?

Funding Issues

- Is Australian Government funding allocations to weed management adequate?
- Is NSW Government funding allocations to weed management adequate?
- Is grant funding flexible enough to tackle (always changing) priority weeds?
- Should external funding (timing and amount) impact of a LCAs responsibilities and operations?
- Do financial constraints limit the effectiveness of LCAs to tackle weeds?

Other Land Managers

- Public authorities must control as necessary to prevent spread to adjoining land.
- What is Councils relationship with other agencies (RLPB, NPWS, Crown Lands, SRA, etc) regarding weed control on public land?

Adv. Hort. Sci., 2002 16(3-4): 175-183

Feral olives (*Olea europaea* L.) in southern Australia: an issue of conservation concern

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Key words: biodiversity, dispersal, environmental weeds, proclaimed pest plants, weed risk assessment.

Abstract: The olive (*Olea europaea* L.), imported into Australia and subsequently cultivated for economic purposes, has spread into native vegetation in several regions of southern temperate Australia. The impacts of olives going 'feral' have only recently been quantified. It is reported that native plant species diversity and canopy cover was 50% and 80% lower, respectively, in a native eucalypt woodland heavily invaded with feral olives. Consequently, feral olives are considered an environmental weed as well as being proclaimed a Pest Plant in South Australia. The 1990s has seen a resurgence in the olive industry. In response to the risk that new olive orchards will be foci for invasion into natural ecosystems currently free from feral olives, risk assessment and management guidelines were developed by the Animal and Plant Control Commission in conjunction with an Olives Advisory Group. Local governments and prospective growers can use the guidelines when assessing the suitability of a proposed olive orchard. However, if olives have escaped from orchards into native vegetation, then their removal is paramount. Unfortunately, feral olive control is a very costly and time consuming exercise, and requires careful planning before doing so. In severe cases of olive infestations, the removal of olives may lead to other problems in fragile ecosystems. It can cost up to A$15,000 per hectare to remove a dense infestation of feral olives, such as the one described in this paper.

1. Introduction

Introduced plants that invade native vegetation outside their normal ecological range can alter ecosystem-level functions, thereby adversely affecting habitat conditions or resource availability (Adair and Groves, 1998). These plants, termed environmental weeds, threaten nearly all biological communities in Australia (Adair and Groves, 1998) and have been described by Carr *et al.* (1986) as 'the greatest conservation problem in Australia'.

Quantitative studies have shown that environmental weeds impact on the biological diversity of the indigenous vegetation communities they invade by reducing species richness, abundance, and/or canopy cover of native species (Gleadow and Ashton, 1981; Waterhouse, 1988; Braithwaite *et al.*, 1989; Fensham *et al.*, 1994; Mullett and Simmons, 1995; Rose and Fairweather, 1997; Csurhes and Edwards, 1998). Mullett and Simmons (1995) report that increased cover and abundance of the native environmental weed sweet pittosporum (*Pittosporum undulatum* Vent.) was associated with a reduction in local native species cover and diversity of 90% and 50%, respectively, in southern Victoria. In severe cases of *P. undulatum* invasion, native species may become extinct (Cronk and Fuller, 1995). Comparable results were obtained in Waterhouse's (1988) study of the impact of broom (*Cytisus scoparius* (L.) Link ssp. *scoparius*) invasion on native species in central eastern New South Wales.

Recent estimates suggest that approximately 2,700 introduced plant species have become naturalised, sustaining wild populations free from cultivation

Received for publication 30 October 2002.

(Muyt, 2001). This represents about 10% of Australia's total vascular flora. Of these naturalised species, approximately 50% have been recorded in natural ecosystems, with several hundred posing a serious threat to native vegetation (Muyt, 2001). The majority of taxa that have become environmental weeds were introduced into Australia as garden plants either for ornamental or utilitarian purposes (Vranjic *et al.*, 2000). Three quarters of the naturalised flora of South Australia, a region that receives dominant winter rainfall and a summer drought of variable length, originates from the Mediterranean region, other parts of Europe, and South Africa. The comparable climates of these regions partly account for this phenomenon. In addition to similar climates, introduced plants may also become weeds because they reproduce early in their life cycle; are highly fecund; possess fruits highly attractive to potential dispersal agents; are resistant to most causes of mortality; and exhibit a competitive advantage over indigenous plants with a higher canopy or deeper root system (Groves, 1986; Newsome and Noble, 1986).

Feral European olives (*Olea europaea* L.) are a major weed problem in parts of southern South Australia and in some cases are, or have the potential to become so in other parts of southern temperate Australia. These feral olives (i.e. naturalised trees that have dispersed from formally cultivated orchards) reduce native plant diversity by crowding out and preventing indigenous species from regenerating. They are highly fecund, produce fruit highly attractive to avian and mammalian dispersal agents, have few predators, and evolved in a similar climate. This paper discusses the ecology and impacts of feral olives in southern Australia, the development of policy aimed at minimising risk of escape and spread from orchards, on-ground control considerations and techniques, as well as the implications of the current growth in the olive industry.

2. Introduction, dispersal and impacts of feral olives

History of cultivated olive introduction

The cultivated European olive is recorded as one of the earliest plant introductions into Australia. Olives were first introduced into Sydney in 1800. Since then olives have been introduced to Australia on several occasions, and are now cultivated in most states (Spennemann and Allen, 2000). The early attempts to establish olive industries in Victoria, New South Wales and South Australia were greeted with mixed success. Only in South Australia was early olive production profitable.

In the 1870s olive production in South Australia was considered to be a more viable enterprise than wine production. This led to the establishment of a three-acre (1.2 ha) orchard in 1874, which was expanded to over 100 acres (40 ha) by 1882 (Reichelt and Burr, 1997). By the early 1900s, however, the olive industry in South Australia was in decline. Interest in olives increased during the late-1940s and 1950s, coinciding with increased immigration from the Mediterranean region. By 1959, 7,233 acres (2,929 ha) were under cultivation in Australia (Hartmann, 1962). The 1990s has seen a revival in the olive industry. By 1998 plantings of olives had increased to more than 5,000 ha, with plants equivalent to another 7,000 ha of trees on order (Spennemann and Allen, 2000). Olive orchards are now found in all six Australian states and two territories.

Distribution of feral olives

Olives have naturalised across a wide range of habitats in South Australia (Fig. 1). Occurrences are predominantly within the 400 mm to 600 mm median annual rainfall range (Fig. 1) (Crossman, 2002). The highest concentrations occur on the western foothills of the southern and central Mount Lofty Ranges, directly to the east and south of Adelaide (Fig. 1). These populations are likely to be the direct descendants of the orchards planted in the late-1800s/early-1900s. The naturalisation of olives in the southern and central

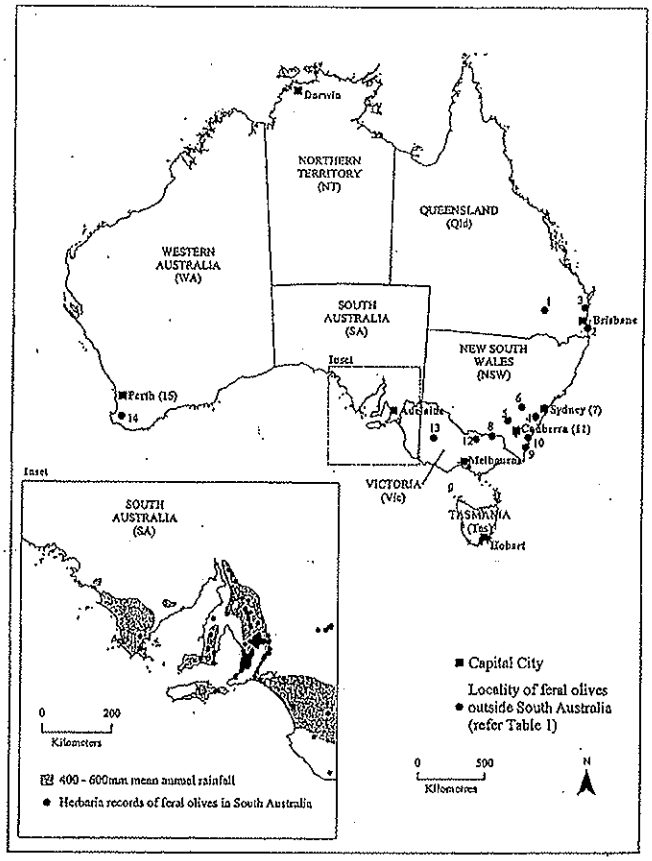

Fig. 1 - Distribution of feral olives outside South Australia, and inset, within South Australia.

Mount Lofty Ranges is not a recent event. As early as the 1920s Adamson and Osborn (1924) noticed the abundance of feral olives on the dry and rockier slopes of the western foothills. Specht and Perry (1948) and Specht and Cleland (1961) made similar observations. Other large concentrations can be found in the Barossa and Clare valleys, 60 km and 120 km north of Adelaide, respectively. The occurrence of a small number of feral olives on Yorke Peninsula and in the far east of the State suggests that the species can survive in regions that receive less than 400 mm median annual rainfall.

Populations of feral olives are also found in Western Australia, particularly in bushland near Perth, Victoria, New South Wales and south-east Queensland (Table 1, Fig. 1). There are no known populations of feral olives in Northern Territory and Tasmania.

Feral olive dispersal

Dispersal of olive seed is almost wholly dependent on birds. Mladovan (1998) found that density of feral olive plants declined exponentially with distance from the trunks of tall trees, supporting the belief that birds are a key means of seed dispersal. Mladovan (1998) observed seventeen species of birds including olives in their diet, although only seven dispersed olive seed. In South Australia, Common Starling (*Sturnus vulgaris*) is the most prevalent disperser: a common sized flock of 100 could disperse thousands of seeds in a day (Mladovan, 1998). They usually swallowed olives whole, regurgitating the stones 20-50 minutes later. Most seeds were likely to be dispersed within 100 m of the parent trees, as starlings moved to nearby perch sites to consume the fruit. The exception was at dusk when starlings returned to nocturnal roosts, so that some seeds could be dispersed kilometres [up to 40 km by some estimates (Spennemann and Allen, 2000)] away from parent trees. Starlings had difficulty in handling and swallowing large fruits, and showed a strong preference for intermediate sized fruits. Many other birds have also been noted ingesting fruit and dispersing seeds of olives (Loyn and French, 1991)

Table 1 - Recent observation of feral olives outside South Australia

Location	State	Map Ref.	Severity of feral olives	Source
Darling Downs	QLD	1	1	Luise Hucks, Australian Quarantine Inspection Service
Moreton	QLD	2	1	Luise Hucks, Australian Quarantine Inspection Service
Wide Bay	QLD	3	1	Luise Hucks, Australian Quarantine Inspection Service
Cumberland Plain, Camden	NSW	4	4	Peter Dixon, Australian Association of Bush Regenerators; Richard Groves, Commonwealth Scientific and Industrial Research Organisation; Lynton Auld, Blue Mountains City Council; Tanya Mason, University of Wollongong; Hugh Paterson;
Jugiong	NSW	5	1	Michael Mulvaney, NSW National Parks and Wildlife Service
Cowra	NSW	6	2	John Virtue, Animal and Plant Control Commission
Parsley Bay Res., Sydney	NSW	7	1	Lynton Auld, Blue Montains City Council
Cooper Park, Sydney	NSW	7	3	Lynton Auld, Blue Montains City Council
Albury	NSW	8	2	Sue Brunskill, Riverina Institute of TAFE
Bega	NSW	9	1	Jackie Miles
Moruya	NSW	10	1	Jackie Miles
Red Hill Nature Park, Canberra	ACT	11	1	Michael Mulvaney, NSW National Parks and Widlife Service
Dookie	VIC	12	1	Ken Young, University of Melbourne; Sue Brunskill, Riverina Institute of TAFE
Rutherglen	VIC	8	2	Sue Brunskill, Riverina Institute of TAFE
Yackandanah	VIC	8	2	Sue Brunskill, Riverina Institute of TAFE
Horsham	VIC	13	1	Wendy Bedggood, Department of Natural Resources and Environment
Nannup	WA	14	1	Julia Boniface, Shire of Nannup
Bridgetown	WA	14	1	Julia Boniface, Shire of Nannup
Greenbushes	WA	14	1	Julia Boniface, Shire of Nannup
Augusta	WA	14	1	Julia Boniface, Shire of Nannup
Margaret River	WA	14	1	Julia Boniface, Shire of Nannup
Kings Park, Perth	WA	15	1	Peter Moonie, Kings Park Botanical Garden
Yellonga Regional Pk, Perth	WA	15	2	Jayson Puls, Department of Conservation and Land Management WA
Darling Range Reg. Pk, Perth	WA	15	1	Peter Batt, Department of Conservation and Land Management WA

Refer to figure 1 for map reference location. Severity of feral olives follows four classes: 1= few individuals; 2= many individuals including seedlings; 3= large population; 4= serious infestation.

(Table 2). Of these, Red Wattlebird (*Anthochaera carunculata*), Crested Pigeon (*Ocyphaps lophotes*), Black-faced Cuckoo Shrike (*Coracina novaehollandiae*), Golden Whistler (*Pachycephala pectoralis*) and Silvereye (*Zosterops lateralis*) are common in Western Australia, South Australia, Victoria, New South Wales and Queensland and likely to be important dispersers of olives seeds in these regions. Common Blackbird (*Turdus merula*), House Sparrow (*Passer domesticus*) and Common Starling are introduced species important in olive dispersal in south-eastern Australia. Parsons and Cuthbertson (2001) suggest that avian frugivores defecate, as opposed to regurgitate, olive seeds at locations away from the source. There is evidence to suggest that Emus (*Dromaius novaehollandiae*) disperse seeds in this manner (Jupp *et al.*, 1999). The European Fox (*Vulpus vulpus*) consumes olives and disperses seed in the southern Mount Lofty Ranges with seeds frequently found in fox scats during the winter months (Paton *et al.*, 1988). Spennemann and Allen (2000) suggest that foxes may disperse olive seed up to 5 km away from the parent tree. The nursery trade and expanding olive industry are responsible for long distance dispersal of 100 s of km.

Impacts

Until recently there was a dearth of research quantifying the impacts of feral olives on native vegetation. This gap in evidence has been reduced, with the publication of the results of a study into the impacts of feral olives on remnant patches of the conservationally significant Grey Box (*Eucalyptus microcarpa* Maiden)

Table 2 - Occurrence of common avian feral olive dispersers in southern Australia

Disperser	WA	SA	Vic	NSW	Qld	Tas
Pied Currawong			✓	✓	✓	
Red Wattlebird	✓	✓	✓	✓	✓	
Crested Pigeon	✓	✓	✓	✓	✓	
Black-faced Cuckoo Shrike	✓	✓	✓	✓	✓	✓
Golden Whistler	✓	✓	✓	✓	✓	
Silvereye	✓	✓	✓	✓	✓	
Common Starling		✓	✓	✓	✓	✓
Common Blackbird		✓	✓	✓		
House Sparrow		✓	✓	✓	✓	

Derived from Blakers *et al.*, 1984; Loyn and French, 1991.

a clear indication of the reduced native plant canopy cover in the lower-, mid- and upper-strata. Figure 2a shows extensive canopy of the dominant native grey box eucalypt in the upper-stratum (greater than 8 m in height), with good stands of golden wattle (*Acacia pycnantha* Benth.) in the mid- and lower-strata (less than 2 m in height). In comparison, feral olive canopy dominates in the mid- and lower-strata at the heavily invaded site (Fig. 2b), with a significantly reduced presence of grey box and golden wattle. Grey box

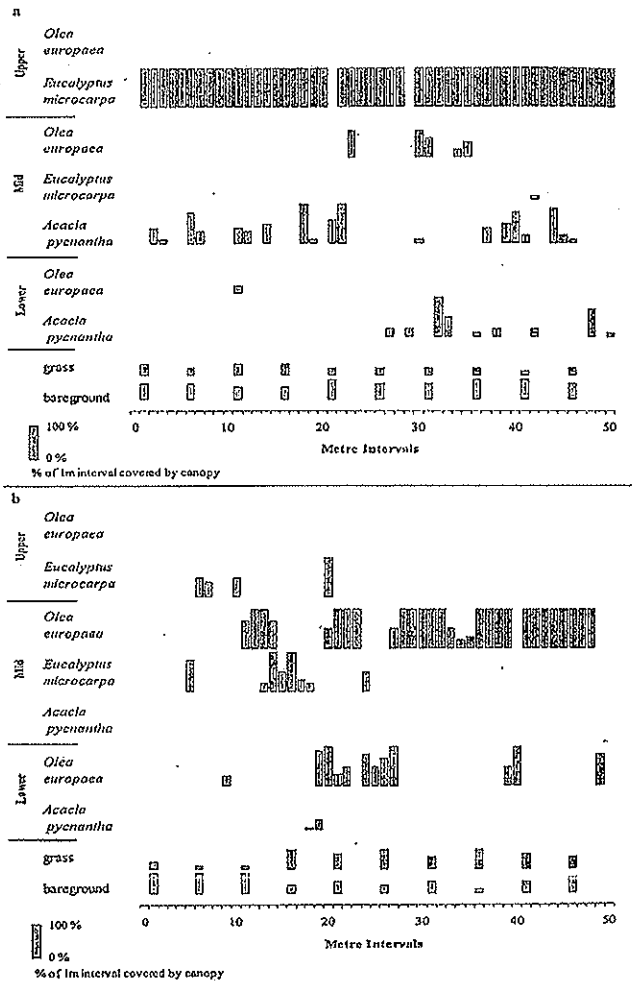

Fig. 2 - Schematic diagram of canopy structure along 50 m length transects. (a) at a control site; (b) at an invaded site.

woodland in South Australia (Crossman, 2002). This study compared patches of Grey Box woodland that were heavily invaded by feral olives with patches of the same woodland that were relatively free of feral olives. Canopy cover, abundance and diversity of native species and feral olives were measured at each site.

Reduced native canopy cover. The dense cover of feral olive canopy coincides with reduced cover of native plants at heavily invaded sites (Crossman, 2002). Schematic diagrams (a) and (b) in figure 2 give

eucalypt upper-stratum cover and golden wattle mid-stratum cover was 80% and 75% lower, respectively, at this heavily invaded site (Crossman, 2002). Given that feral olives are generally less than 10 m in height, it is no surprise that the greatest impact of olive invasion on native vegetation is in the lower- and mid-strata.

Reduced native biodiversity. Native species richness, i.e. the variety of different species, and native species abundance, i.e. the number of individuals within each species, were found by Crossman (2002)

to be significantly lower at the sites heavily invaded by feral olives. Species most at risk were herbaceous and shrub forms found in the lower- and mid-strata. These include golden wattle, kangaroo thorn (*Acacia paradoxa* DC.), drooping sheoak (*Allocasuarina verticillata* (Lam.) L. Johnson), brush heath (*Brachyloma ericoides* (Schldl.) Sonder), sticky hop-bush (*Dodonaea viscosa* Jacq.), native lilac (*Hardenbergia violacea* (Schneev.) Stearn), *Hibbertia* spp., twiggy daisy-bush (*Olearia ramulosa* (Labill.) Benth.), and dwarf green-hood orchid (*Pterostylis nana* R. Br.). Crossman (2002) reported that native plant species richness and abundance was more than 50% lower at one heavily invaded site.

3. Policy and Management

Proclaimed pest plants

The Animal and plant control (Agricultural Protection and Other Purposes) Act, 1986 incorporates the noxious weed legislation of the government of South Australia. The Act aims to protect agriculture, the environment and public safety via legal obligations for animal and plant control. Under this Act, certain plant species may be proclaimed as pest plants, with requirements for their control by landholders, and/or restrictions on sale and movement of the plants to limit their geographic spread. Feral olives were first proclaimed for control by landholders in three local government regions of SA in 1980. Proclamation was extended to 15 regions by 1996. Feral olives were proclaimed state-wide in 1999 in recognition of their significant potential impacts on eucalypt forests and woodlands in southern South Australia.

Development of the olive risk management strategy

In 1999 concern was raised by the Animal and Plant Control Commission (APCC) that a resurgence in plantings of olives in South Australia was likely to lead to many new feral olive infestations, particularly in areas that were currently free of the noxious weed. There was an inherent conflict of interest between an expanding olive industry and the future potential cost of feral olive control. In order to reduce this future weed threat, the APCC convened the Olives Advisory Group (OAG) in 1998 to discuss various risk management options. The group comprised of representatives of the Department of Environment, Heritage and Aboriginal Affairs (DEHAA), South Australian olive industry, Primary Industry and Resources South Australia (PIRSA) industry development, Local Government Association, University of Adelaide olive research group, Conservation Council of South Australia and the APCC. Concurrently the APCC also supported university research examining bird dispersal of olives (Mladovan, 1998).

The outcome, after a series of OAG meetings, was a draft discussion paper outlining (i) a code of practice for orchards, (ii) the formation of an olive grove register, (iii) a risk assessment system for local government planners examining new orchard proposals, and (iv) guidelines on how to manage the levels of risk through planning and noxious weed laws (Jupp *et al.*, 1999). This paper was finalised as APCC policy after canvassing public comment (APCC, 1999). The APCC proclaimed feral olives for landholder control in all regions of South Australia in 1999, including on roadsides adjacent to properties.

Code of practice for orchards. This includes the harvest of all fruit each year, and fox and bird control to limit seed dispersal. Despite seed dispersal by birds and mammals over many tens of kilometres, most dispersed seeds travel less than 1 km from parent plants (Van der Pijl, 1969). Birds usually fly to a nearby perching site to process seeds, therefore a buffer zone between orchards and native vegetation (preferably at least 200 m) was needed, 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. Orchards that were not harvested for two successive years could be declared "feral" at the local Animal and Plant Control Board's discretion, requiring the trees' removal by the landholder. The term "feral" in this instance refers to "abandoned" as opposed to "escaped".

Olive grove register. This was to record the location of new and existing orchards, so that local Animal and Plant Control Boards and local governments could monitor the locations and risk management practices of these orchards. Unfortunately there has been a poor level of cooperation with the Register to date.

Risk assessment for new orchards. The risk assessment system for olives (APCC, 1999) was designed as a decision tool for local government planners to rate the risk that a proposed olive orchard poses to native vegetation, based on a national standard for risk management (Standards Australia and Standards New Zealand, 1995). The scoring system had two criteria; the likelihood of olive spread from the orchard, and the consequences of this spread.

The *likelihood* criterion was split into two sub-criteria: non-management factors and 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. These environmental factors are beyond the control of the orchardist. Management factors considered steps that the orchardist planned to follow to minimise dispersal of fruit. These related to bird control, fruit maturity and size at harvest, visibility of fallen fruit, a control zone around the orchard, and fox control.

The *consequences* criterion had factors considering the distance to significant native vegetation, the presence and control of feral olives, and the presence of existing

orchards. A new orchard would not greatly increase the weed risk if there were already many feral olives which were not being controlled and/or if existing orchards were in the area. Areas of "significant" native vegetation were determined by DEHAA.

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.

Risk management of orchards. Local government planners were recommended to reject planning approval for orchards posing very high risk (APCC, 1999). For high risk orchards, compulsory management conditions to limit seed dispersal were recommended as a condition of approval, or the approval could be denied. For medium risk orchards, a voluntary land management agreement or a memorandum of understanding between local government and the orchardist was advised, to encourage compliance with an industry code of practice (APCC, 1999) on minimising seed dispersal.

The development of risk assessment and risk management guidelines for olive production in South Australia was an important step towards reducing the conflicts between the commercial use and conservation threats of olives. Unfortunately, local governments are not currently legally obliged to use the olive risk assessment system, nor follow the associated management recommendations. However, the system's use has increased since 1999 as many local governments have become increasingly aware of the weed risks of olives and the need to balance industry development and environmental responsibility.

Improvements sought to improve olive weed risk management

In March 2001 the Weed Management Society of South Australia Inc. (WMSSA) convened a public meeting on the issue of feral olives and the expansion of the olive industry. Concerns were raised by the public about a lack of uniform adoption by local governments of the APCC risk assessment and management guidelines, and industry awareness of and commitment to managing weed risks. A WMSSA Position Statement on management of feral olives in South Australia was prepared with member input (WMSSA, 2001) and ratified by the Council of Australian Weed Science Societies. This statement is now being circulated to relevant state government departments, local governments and the olive industry. A key action sought is the consistent adoption of the risk management guidelines by local governments, including a strengthened legal framework for approval and landholder land management agreements under South Australia's planning laws. Also sought is the availability of objective economic information on olive economic returns for growers, in the face of strong price competition and a large increase in olive oil supply within Australia. Investors need to be fully informed of the economic viability of small and/or isolated orchards.

4. Control and management options

Habitat considerations

The consequences of olive invasion extend beyond altered vegetation structure and species assemblages. Areas of significant olive invasion coincide with agricultural landscapes that have been substantially cleared of native woodlands. Clearance has lead to simplification of habitat structure. Habitat change has been implicated in the widespread decline in native bird diversity through loss of sites for nesting, feeding and social interaction. Over the years invasion by olives has increased habitat diversity, by establishment of a shrub and small tree understory composed of olives. Olives may now paradoxically provide pivotal habitat resources for small birds, especially feeding substrates, perches, vegetation corridors and protection from predators. While this new habitat is demonstrably poorer in terms of species diversity and habitat diversity when compared to intact native vegetation, it represents important habitat in a severely altered landscape.

Evidence of the ecological role of olives is demonstrated by the local increase of the relatively uncommon meemeei (*Pittosporum phylliraeoides* DC.). Seeds of meemeei are dispersed by birds including native honeyeaters. Seedlings of meemeei occur commonly under the canopy of mature feral olives. This suggests that olives are a perching site for birds where they void meemeei seeds. Without olives there are fewer suitable perching sites for small birds. Olives facilitate the recolonisation of meemeei. Traditional weed control that involves the complete removal of olives is likely to remove an important habitat resource and may affect local vegetation succession. Alternative weed management strategies should be developed with improved knowledge of new ecologies established in weed invaded landscapes. Lawrie (2000) developed an audit system to identify new animal-weed interactions. Armed with this knowledge she has outlined alternative management actions including the killing of olives by 'drill and fill' (stem injection of herbicides) and allowing plants to die *in situ*, leaving the tree to remain standing. This would provide maintenance of vegetation structure while native plant recruitment occurs to a stage where habitat resources are re-established.

Weed control options

Olives have a tremendous capacity for regrowth following physical damage. As a result herbicide control is the most widely used technique. The recommended herbicide is Triclopyr (Robertson, 1997) which is usually mixed with diesel and applied to cuts made in

the trunk of trees near the ground. There are problems with off target damage and effects on aquatic fauna. As a result Glyphosate is preferred for treatment of feral olives in and near watercourses. Irrespective of the herbicide or application method, follow up treatment within two years is usually necessary to retreat trees and monitor regrowth. Trees partially killed may lay apparently dormant after initial treatment and then densely resprout. If left to grow, this regrowth is often more difficult to treat than the initial tree. Seedlings are best grubbed from the soil when soil moisture levels are high. A soil seed bank and continual seed dispersal ensures that seedlings will continue to germinate at a treated site. Regular follow up treatment is integral to successful control. Alternative application techniques involve either 1) felling trees and then frilling the stump with an axe with herbicide applied to the fresh vertical cuts or 2) drilling holes into trunk near the ground and filling the holes with herbicide.

Costs of control. The principal expense associated with feral olive control is labour which accounts for 80-90% of total costs. The City of Mitcham, in Adelaide, estimated costs of olive control at A$ 10-15,000 per hectare. The range accounts for variation in access to sites. Olives often invade steep and rocky terrain to which access by people and machinery is either very difficult or more importantly dangerous. In the main Councils rely on contract labour. Community groups rely on volunteer labour. Under national funding guidelines labour costs are calculated at A$ 15/hour. Control of feral olives can be broken down into two stages. The first is integral to the management guidelines developed by the Animal and Plant Control Commission. The establishment of buffer vegetation around olive orchards can facilitate short distance seed dispersal by birds to sentinel trees.

The future – impacts of an expanding industry

The risks of feral olives associated with an expanding olive industry are great but ultimately can be controlled. Much of the expansion of the industry is focussed on large commercial plantings. However there are significant small and potentially non-commercial plantings also established in recent years. Each new planting represents a potential invasion focus. If for any reason the fruit crop is not harvested then that fruit may be ingested by birds and seeds subsequently dispersed. The olive industry has seen periods of expansion and contraction with some orchards abandoned. It is clear that poor management and abandonment of groves can ultimately result in significant feral olive invasion into surrounding native vegetation.

The expansion of the olive industry also coincides with the distribution of grassy woodlands of southern central Queensland; north western, central western and south western slopes and plains of New South Wales; central and western Victoria and the southern agricultural regions of South Australia. This area also contains grassy White Box (*Eucalyptus albens* Benth.) woodlands which have been listed as an endangered ecological community under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. There are a variety of birds that are potentially important seed dispersers of olives throughout these areas (Table 2). Of most importance is the Pied Currawong (*Strepera graculina*). Pied Currawongs are responsible for the dispersal and widespread establishment of other autumn fruiting environmental weeds including privet (*Ligustrum* spp.), firethorns (*Pyracantha* spp.), hawthorns (*Crataegus* spp.) and Camphor laurel (*Cinnamomum camphora* (L.) J. Presl) (Buchanan, 1989; Bass, 1990, 1995, 1996; Ekert and Bucher, 1999; Low, 2002).

Based on the South Australian experience, environmental managers in temperate Australia should be aware of the potential impact of feral olives in grassy woodlands. Olive invasion not only reduces biodiversity and alters ecological relationships, it has the potential to substantially alter plant and animal succession. Successional change at a landscape scale may take hundreds of years to manifest itself. By the time successional outcomes are recognised, the impacts of olives on native vegetation communities may be irrevocable.

5. Conclusions

The expansion of the Australian olive industry over the last decade poses a major threat to the integrity of remnant native vegetation in southern temperate climatic zones of Australia. The consequences of cultivated European olives 'going feral' are severe in many cases, as evidenced in South Australia. The impacts extend beyond reduced biodiversity, leading to complete alteration in habitat structure and function. Ironically, some native fauna and flora species have benefited from this change. There must be careful planning before embarking on a feral olive control program. The heavy financial costs of olive control programs will need to be spread across the three tiers of government in Australia (local, state and national).

However, prevention is the best cure. Planning authorities in South Australia have the option to apply the APCC risk assessment of the likelihood that a proposed olive orchard will be a focus for feral olive spread into native vegetation, rejecting those proposals that pose a significant threat. Although it is not compulsory to do so, recent applications for olive orchards have been refused by local planners, based on the APCC risk assessment criteria (John Wills, APCC, personal communication; John Bracken, National Parks and Wildlife, personal communication). In some instances the applicants have threatened to appeal the decision in court. To date, the courts have not been

nvolved due to the withdrawal of appeals based on mounting evidence in support of the defendants (planers). There is no legal precedent as yet.

Of course there are many approvals for every application that is refused. As long as those growers manage their orchards with the goal of preventing the non-human movement of olives from the property, then the risk will be minimal. Currently there is no legal obligation for them to do so, thus they have a moral obligation to ensure their olive orchards do not become the foci for feral olives in the future. Education of growers is the key.

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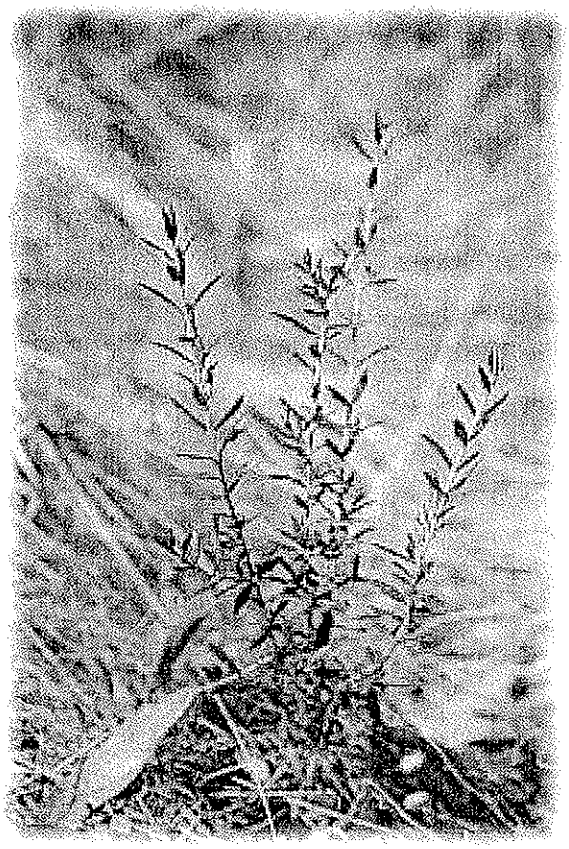
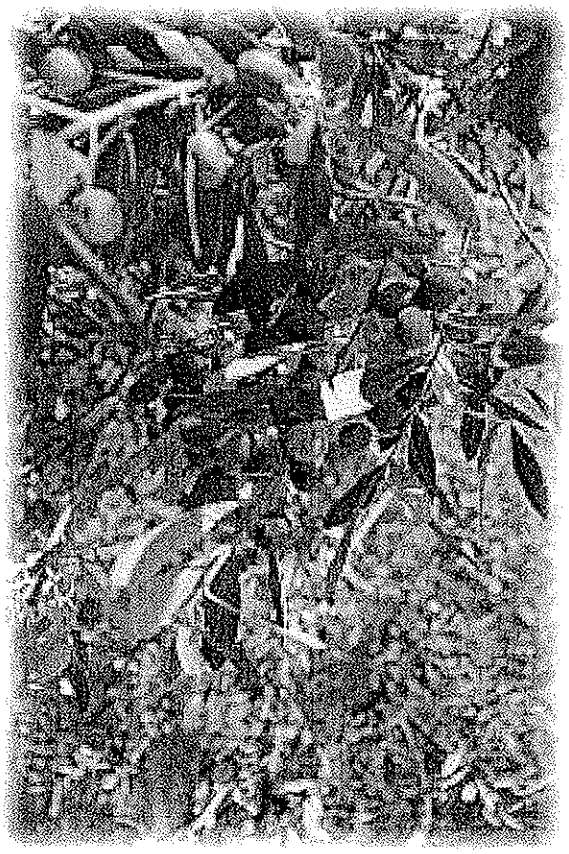
OLIVES



Olive seedling

Olive flowers

Cleared hillside invaded by olive trees



Olive fruits

OLIVES

Government of South Australia

The olive tree, *Olea europaea,* was introduced from the Mediterranean area as a tree crop. It is now established in many parts of South Australia, causing a major problem in native vegetation.

Distribution

Eyre Peninsula	- isolated infestations but high risk of spread to native vegetation
Northern pastoral	- common in southern Flinders Ranges, isolated plants elsewhere
Northern ag districts / Yorke Peninsula	- common on roadsides and native vegetation in the higher rain fall areas
Murray Mallee	- isolated outbreaks along the Murray River and in irrigated areas
South East	- isolated plants on roadsides and some reserves
Central region	- common in the Mt Lofty Ranges

Impacts

Olive is an invader of native vegetation, especially dry sclerophyll forest or woodland, and adjoining cleared, ungrazed land. If uncontrolled it can alter the composition, decrease biodiversity and increase the fire hazard of native vegetation. As it is very long-lived, such changes are permanent unless controlled.

The fruit and oil of the olive tree have a high commercial value and the industry is currently undergoing a boom, resulting in larger areas of plantations throughout South Australia.

Recognition

Olive is an erect, bushy evergreen tree growing to about 12 m tall with a deep, widely-branched, woody root system. The trunk branches from the base and has rough black bark. Leaves are undivided, narrowly elliptic and tapered to a point, glossy dark green on top, silvery below, 3 to 8cm long and 1 to 4cm wide. The tiny cream flowers appear in large clusters in late spring; each has four petals and four protruding stamens. The fruit reaches1.5 to 3cm long, ellipsoid in shape and purple-black when fully ripe; each contains one brown oblong seed about 1.5cm long.

Olive seedlings have smaller oblong leaves arranged rigidly in opposite pairs. They are densely branched and can produce many new stems from the base if cut or grazed.

Biology

Olive grows well in most environments, particularly where winter rainfall is high and summers dry. It will grow on a wide range of soil types but will not survive in waterlogged soil. Like eucalypts, olives are highly inflammable due to their oil content and can regenerate from stumps after fire.

Seeds germinate mainly in autumn and seedlings grow during winter. Flowering does not begin for several years. Flowers appear in October/November and fruit develops slowly over summer. The ripe fruits hang on the tree for a long period during the following winter.

The spread of olives is mainly due to birds and foxes eating the fruit and dropping the seeds elsewhere. The development of olive orchards has lead to spread throughout the State. Some seed may be moved locally in soil during earthworks.

Further Information :

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For more advice on recognising and controlling olive, contact your local Animal and Plant Control Board :

factsheet

Weed risk minimisation:

European olive in Tasmania

The Problem and History

The European olive (*Olea europaea* spp. *europaea*) is a serious environmental weed in many areas of south eastern Australia. It was introduced to Australia around 1800 and it is now widely cultivated in most States and Territories. Prior to the 1990s many groves were abandoned due to poor economics resulting from low global demand and high costs of picking. The olives from these groves have been spread by birds (at least 16 bird species in South Australia feed on olives), foxes and other mammals that eat the fruit. Feral olives have invaded a range of native vegetation types and become established along roadsides and in degraded pasture.

Project: Weed awareness initiative to assist the management of the potential weed risk posed by the European olive to Tasmania's natural environment.

Participants: The Feral Olive Working Group and Department of Primary Industries, Water and Environment, Tasmania.

Location: North, North West and Southern regions of Tasmania.

VET sector resource: RTD5401A *Define a pest problem in a regional or broader context.*

The European olive has not yet naturalised in Tasmania. However the recent increase in plantings, the presence of suitable vectors, broad climatic suitability and the presence of natural vegetation types similar to those invaded in other parts of Australia indicate potential for the olive to become a weed in Tasmania.

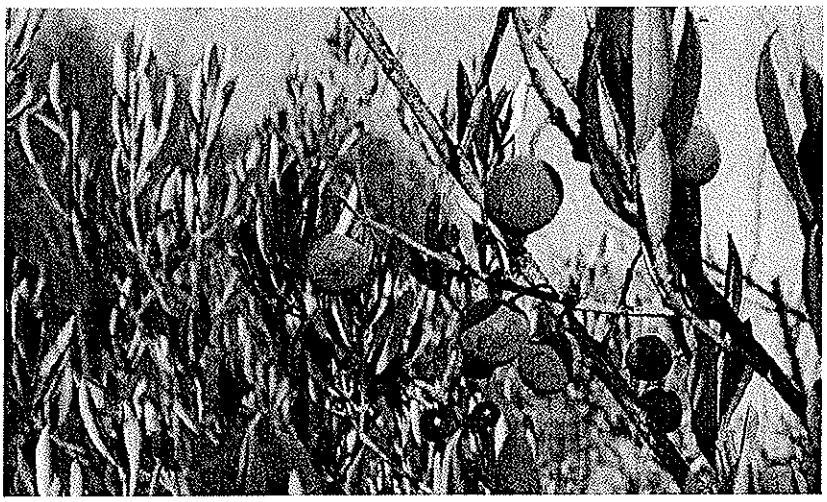
European olives are spread by many species of birds which eat the fruit and drop seeds large distances from the original tree. Here a currawong feasts on some ripe olives.

Olives in Tasmania

Olives are grown in all three regions of Tasmania, with many areas suitable for cultivation, except for the Central Highlands and the West Coast. Olives have been grown in Tasmania for over 150 years but were generally confined to backyard trees and small groves. However since the 1990s, plantings have rapidly increased and numbers are likely to continue to grow for some years to come.

Risk management strategy

In order to minimise the chances of olives becoming a weed in Tasmania, especially in sensitive vegetation, a risk management strategy was developed. An industry based Feral Olive Working Group developed a number of practical actions to address aspects of olive weed risk, considering the roles of government, industry and individual growers.



Olive register

A voluntary olive register was considered important to help track the size, growth and distribution of the industry. A database to store information including the location, numbers, age and varieties of olives was essential in determining the proximity of groves to susceptible vegetation.

Code of practice

A code of practice for the professional operation of olive groves was developed to help managers reduce the risk of olives escaping cultivation. The code includes wildlife monitoring and management, bush and roadside surveillance for seedlings, thorough harvest, participation in the olive register and planning for abandoned groves.

Risk assessment

The potential weed risk was assessed for each grove. This provided growers with a tool to help gauge the environmental weed threat their grove poses. It is hoped that this will improve the management and surveillance with regard to olive escapes.

Education and awareness

Education and awareness efforts have been targeted at both commercial olive growers and home gardeners, informing them of the weed status of olives in many regions of Australia. The education program addressed the environmental weed problem generally, and as it relates to olives specifically, the concept of weed risk, and measures that may be taken by growers to reduce the likelihood of escapes.

Strategy adoption

Strategy adoption incentives for growers were put in place by the Feral Olive Working Group to encourage participation in the initiative. Incentives included a positive media campaign highlighting industry efforts, nomination for environmental awards, a research program targeting wildlife management in groves, and eco-labelling of products from groves implementing weed risk minimisation measures.

The future

The initiative is in its early stage but feedback to the Feral Olive Working Group has been positive. An estimated 10% of commercial growers provided data for the olive register in the first 18 months. Other components of the initiative are in very early stages.

Future outcomes of the initiative are dependent on continued support from industry and government. It is important for grower associations to keep the issue of the weed risk alive. This is particularly challenging for a new plant enterprise with commercial promise. Weed risk management can appear to be in direct conflict with the developing industry. Program components such as the weed risk assessment and the code of practice aim to bring the two together, so weed risk is managed while the industry grows and succeeds.

For further information visit the Weeds CRC's website: www.weeds.crc.org.au

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Established and supported under the Australian Government's Cooperative Research Centres Program

Ref: 17/2004/fs

A weed risk minimisation strategy for the European olive, *Olea europaea* ssp. *europaea*, in Tasmania

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Summary The European olive (*Olea europaea* ssp. *europaea*) is the focus of an emerging industry in Tasmania. It is also a serious environmental weed in several areas of mainland southern Australia.

This paper describes a weed awareness initiative, the aim of which is to assist the management of the potential weed risk posed by the European olive to Tasmania's natural environment. A range of factors indicates a precautionary approach is justified, even in the absence of feral olive plants in Tasmania at present.

The Feral Olive Working Group considered what Tasmanian growers could do to reduce potential olive weed risk. The output of the group's discussions over 18 months is a five-part strategy. This addresses the need for better tracking of the industry's size, distribution and growth, a code of practice which reduces the spread of seed from groves, a weed risk assessment for individual groves, an education and awareness program and strategy adoption incentives. Each component requires sustained activity into the long term, continued agency/industry cooperation and periodic review. Education and awareness initiatives underpin the strategy throughout and the need to inform these with research that assesses the weed risk of this plant in different Tasmanian environments is highlighted. The ongoing role of growers in data collection is critical. The initiative demonstrates an initial willingness by the local industry to acknowledge environmental responsibilities.

This is a novel approach to preventative weed management in Tasmania because its subject is a problem yet to develop, for a plant with apparent commercial promise. Typically, the weed risk of a new plant enterprise is given little attention relative to its commercial outlook. The strategy seeks to demonstrate one approach to reconciling these two attributes.

Keywords European olive, preventative weed management, grower awareness.

INTRODUCTION

The European olive in Australia *Olea europaea* includes more than 2500 cultivars evolved from a handful of wild forms that originated in the Mediterranean (Zohary 1994). The European olive, *O. europaea* ssp. *europaea*, was first introduced to Australia in 1800 (Spennemann and Allen 2000). It is now found in cultivation in most states and territories. Despite repeated attempts, the fortunes of the Australian olive industry have been mostly unspectacular due to the high drupe picking costs and low domestic demand that existed for most of the 20th century. However, since the early 1990s, new olive plantings have proliferated in response to increased domestic and global demand. Industry estimates for the late 1990s gave the area planted to olives in Australia at around 5000 ha with another 7000 ha planned for the near future, compared with 200 ha in 1975 (Rural Industries, Research and Development Corporation [RIRDC] 1998). No hard data are available, but press estimates put the number of trees at this time between 3 million and 7 million (The Weekend Australian March 23–24 2002). This recent upturn in the olive industry, whilst promising economic benefit, is also cause for concern because the environmental weed legacy of previous plantings is significant but relatively poorly understood.

Unprofitable plantings of olives in the past saw many groves abandoned to appreciative frugivores, in particular, birds. The dispersal of olive seeds is accomplished by a variety of birds, but foxes and other mammals may also be instrumental. The European olive, spread thus, has proven a successful invader of roadsides and disturbed areas. However, it also establishes in a range of native vegetation types including open forest, woodland, rock outcrop vegetation and riparian strips (Muyt 2001). The dense crown that forms over mixed aged thickets virtually precludes native plant recruitment (Carr *et al.* 1992). The plant is therefore considered an environmental weed in Australia. It is has naturalised around Perth in Western Australia, in several regions of New South Wales and in the Grampians National Park and the Warby Ranges in Victoria. The most well-known populations occur in the Adelaide foothills in South Australia. Here, one study indicated native species richness and abundance in *Eucalyptus microcarpa* woodland was reduced by more than 50% by European olive invasion (Crossman 1999).

Interestingly, a Rural Industries, Research and Development Corporation (RIRDC) analysis identified the feral populations of South Australia as a strength in view of the genetic resource they represent, whilst

the environmental restrictions proposed as a result of the plant's invasiveness were deemed a threat (RIRDC 1998). In addition, feral populations are harvested frequently for private and commercial use (Animal and Plant Control Commission 1999). Clearly, the feral olive issue is a dramatic example of colliding economic, social and environmental priorities.

The European olive in Tasmania The European olive has not yet naturalised in Tasmania. However, given the growing significance of the plant as an environmental weed in other regions of southern Australia and the current steady and enthusiastic level of anthropogenic introduction to Tasmania, it seems timely to consider the potential for this situation to arise.

Distribution European olives are grown in many localities in Tasmania, with clusters in the Southern Midlands, the South East, the East Coast, the Tamar Valley and the North West. Apart from the South West, Central Highlands and West Coast, most regions in Tasmania are proving suitable for olive cultivation.

Numbers and grove size Whilst European olives have been grown in Tasmania for at least one hundred and fifty years, plantings were confined to scattered backyard trees and small, domestic groves. This situation changed rapidly over the 1990s as a Tasmanian olive industry emerged. Estimates of the number of European olives in Tasmania at present vary tremendously. Industry records suggest 82,000 trees, most under five years old (RIRDC 1998). A recently established Tasmanian company aims to plant nearly a quarter of a million trees over the next five years (Tasmanian Country April 5 2002). Numbers aside, it is clear that the rate at which the European olive is being planted in Tasmania today is significant, exceeds any previous introductions and is likely to be sustained for a number of years.

Stock sources Tasmania has several independent olive propagation nurseries that supply many of the nearly 40 named varieties thought to be grown in the state. At least one nursery is developing cool climate varieties. Most trees are sourced from the Australian mainland. The majority of olive juveniles have been raised from cuttings. However, some mainland sourced stock are grafted, with certain rootstock reportedly from feral South Australian plants. Other trees have been raised from seed, but the sources are largely unknown.

Environmental limits Whilst most olives in Tasmania are cultivated under regimes involving some or all of irrigation, fertilisers and protection from browsing, older plantings have survived and produced fruit without any special assistance.

The major environmental limits in terms of rainfall, temperature, light and soil conditions for European olive survival and fruiting in Australia, outside cultivation have been identified loosely (Animal and Plant Control Commission [APPC] 1999, Spennemann and Allen 2000). Hot, dry summers, cold, wet winters, an annual rainfall of at least 500 mm, night chilling in winter, the absence of frost during bloom formation and seed set and well drained soils are each considered important. It is suggested that conditions within or nearly within the ranges of these parameters may be satisfied in certain natural environments in Tasmania.

Vector pools Olives are an excellent source of high-energy oil and birds in particular appreciate this. In South Australia, at least sixteen bird species feed on olive fruits (Paton *et al.* 1988). Of these, the introduced European Starling (*Sturnus vulgaris*) is one species known to disperse the seed appreciable distances.

Tasmania has a widely distributed population of starlings. In addition, growers have reported losses to currawongs, magpies, ravens, blackbirds and a variety of parrots. The distances over which these birds may disperse the fruit, if at all, is not known.

Invasive history elsewhere One of the most consistent indicators of whether or not a plant will become a weed is its invasive history in similar environments elsewhere. Tasmania has vegetation formations similar to those being invaded in mainland southern Australia. These include lowland grasslands and woodland, dry eucalypt forest, riparian vegetation and rock outcrop vegetation. Some of these, and in particular grassy woodlands, already require urgent protection. Carr *et al.* (1992) give the European olive a risk rating of 'serious' with respect to similar Victorian vegetation formations. Mulvaney (1997) assessed the European olive as having a low risk rating for Tasmanian World Heritage Area (WHA). However, much of this area is quite removed from current olive plantings, and represents mostly upland, montane or alpine environs and vegetation. Thus, the low risk identified for Tasmanian WHA cannot be readily translated to warmer, lowland vegetation nearer to olive plantings in the state.

Environmental weed potential of the European olive in Tasmania Will *O. europaea* become an environmental weed in Tasmania? A number of factors indicate the necessity of taking a precautionary approach. In summary, these include:

- An increase in introduction pressure, resulting from more European olives being planted, and plantings increasing in size and distribution in Tasmania.
- The likely presence of stock raised on mainland feral rootstock or from mainland feral seed.
- The development of cool climate varieties.
- Tasmania falls within the bioclimatic range of the European olive so far as that has been defined.
- The widespread distribution of at least one known major vector, the European starling.

STRATEGY PLANNING AND DEVELOPMENT

An industry-based group was convened in mid-2000 by the Department of Primary Industries, Water and Environment (DPIWE). The eight-member Feral Olive Working Group (FOWG) met first to identify and discuss the main issues. Subsequent sessions involved information input from other DPIWE personnel (e.g. wildlife managers), the design of practicable actions to address aspects of olive weed risk, consideration of roles of government, industry and individual growers in the initiative and the development of the strategy.

STRATEGY COMPONENTS

The strategy has five principal components:

An olive register The olive register is a database of numbers, varieties, ages and the locations of olives in Tasmania. Its function is to facilitate better tracking of the size, growth and distribution of the industry. Since weed risk often relates both to introduction pressure and the proximity of introductions to susceptible vegetation, this information is critical.

Code of practice A code of practice gives guidance to industry proponents seeking to conduct their activities in a way that is professional and recognisable as such. The code lists simple, readily adopted actions. These include wildlife monitoring and management, grove, bush and roadside surveillance for wildings, planning for thorough harvest, participation in the olive register and planning for abandoned groves. The code emphasises the importance of grower involvement and cooperation in the collection of data that relates to the feral olive issue.

Weed risk assessment for groves The function of a weed risk assessment protocol for groves is to provide growers with a tool to help gauge the environmental weed threat posed by their olive plantings, thus informing and improving grove management as it relates to olive escapes. The criteria for the assessment have been agreed upon but the weighting of scores is unresolved.

Education and awareness Many olive growers in Tasmania are relatively uninformed about the plant's weed status. Until this is addressed, the overall success of the strategy will be limited. The FOWG identified target audiences, key messages and appropriate means of delivery. Audiences include both commercial olive growers and home gardeners. Key messages address the environmental weed problem generally and as it relates specifically to olives, the concept of weed risk and the actions that may reasonably be taken by growers in order to reduce the likelihood of escapes.

Strategy adoption incentives for growers Participation in the initiative is completely voluntary. In order to encourage participation, a number of incentives were devised by the FOWG. These include a positive media campaign which highlights industry efforts to manage the issue, nomination for environmental awards, a research program targeting wildlife management in groves and eco-labelling of products from groves undertaking weed risk minimisation measures.

RESULTS AND DISCUSSION

Thus far, the accomplishments of the initiative relate mostly to awareness raising. The feral olive issue has been highlighted by FOWG members through a number of avenues including radio interviews, presentations at field days, newspaper and newsletter articles and the production of an information pamphlet. The strategy document is also available at all state libraries, from grower associations and from DPIWE. Positive feedback from a variety of sources including individual commercial olive growers, the Australian Olive Association, environmental consultants, gardeners, weed strategy groups and nature conservation supporters, indicates the issue is now receiving better consideration amongst olive growers and in the wider Tasmanian community.

The olive register form is distributed in an ongoing fashion by both Tasmanian olive associations, a number of olive nurseries and DPIWE. Approximately 30 growers have registered their details with the FOWG over the past 18 months. This is crudely estimated to represent a response in the order of 10% from commercial growers. The number of olive trees planted by each respondent ranges from 50 to 2500 whilst the average number of trees planted is around 550. The varieties most frequently planted by respondents are Manzanillo, Barnea, Parragon and Corregiola. Grafted varieties have been planted by 30% of respondents. Respondents are relatively evenly distributed between the north and south of the state and there is clustering of responses from the east coast, the south-east, the Southern Midlands, the Tamar Valley and the

north-west. Recent developments suggest the maintenance of the olive register may shift. The Department of State Development is pursuing similar information for its industry support efforts and the potential for centralising the collection of such data is being considered.

Implementation of the code of practice has yet to be assessed due to its recent introduction. However the submission of avian scat samples containing olive seeds and inquiries regarding grove wildlife log sheets, indicate some growers are seeking to incorporate at least some aspects of the code into their management practices.

The weed risk assessment for groves has not progressed beyond the identification of appropriate criteria at this point. The general weed risk assessment procedure includes complexities that will be better understood and accepted by growers once they are better informed about the issue. The FOWG decided that completion and delivery of the weed risk assessment for groves would be more strategically undertaken once grower awareness and acceptance had been given some time to mature. Research investigating the environmental weed potential of the European olive has commenced in the form of a PhD undertaken through the University of Tasmania. The results of this are expected to inform the initiative into the future and in particular, the weed risk assessment component.

Encouraging growers to support the strategy by providing participation incentives is limited by the funding and time available to generate tangible benefits for individuals and the industry overall. So far, several positive media efforts, praising the industry for its involvement in the initiative have been undertaken. In addition, three research proposals aimed at finding better ways of managing wildlife in groves have been drafted. Whilst there was student interest in at least two of these proposals and although each grower association agreed to donate a small amount of funding, the proposals were not promoted sufficiently and consequently research has yet to commence.

Future outcomes depend absolutely upon the continued support and maintenance of the strategy by both grower associations and the DPIWE. Grower association support is required mostly in the form of keeping the issue alive through networking fora such as newsletters, information packs for new growers, field days and industry seminars. DPIWE responsibilities lie in promoting and supporting formal research and grower data collection efforts, coordinating activities in relation to each of the five components and supporting growers and grower associations in any attempts they make towards reducing the chance of olive escapes.

ACKNOWLEDGMENTS

The author acknowledges gratefully each member of the Feral Olive Working Group – Fred Duncan, Justin Galati, Russell Hatton, Leon Hennessey, Brian Hinson, Bill Lawson, Lesley Maher and Bryn Williams. Thanks also to the Natural Heritage Trust and the DPIWE, Tasmania for funding and supporting this initiative thus far. The South Australian publication, APCC (1999) was a principal source of guidance. Its authors are thanked.

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Declared Plant Policy

Olive (*Olea europaea*)

Background

The domestic olive is a group of cultivars and semi-wild forms of *Olea europaea* subsp. *europaea*, a long-lived evergreen tree. Olive cultivation began around 6,000 years ago in the near east and at approximately the same time in Spain (Terral & Arnold-Simard, 1996), and the domestic olive has been developed from various local populations of *Olea europaea* around the Mediterranean basin (Contento et al., 2002).

Oleasters or wild olives are a prominent element in the vegetation of Mediterranean Europe. The maquis scrub communities in which they are often co-dominants are anthropogenic vegetation types growing on land that has been cleared and grazed at various times since antiquity. Oleaster populations in the eastern Mediterranean are now largely derived from feral olives, but some original wild *O. europaea* remain, particularly in the western Mediterranean (Lumaret & Ouazzani, 2001).

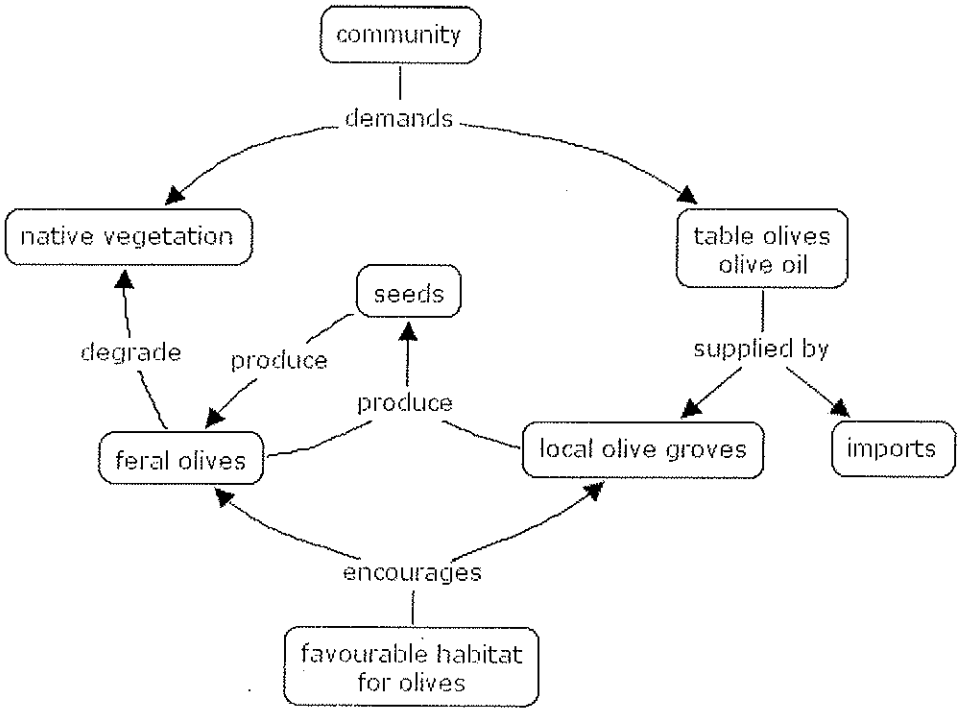
Compared to other tree crops, olives have been little modified by selective breeding. Up to 2600 named cultivars are recorded but these are either heterozygous clones selected from spontaneous, uncontrolled crosses or at most a few generations removed from 'wild' land races. Scientific breeding programs only began in the late 20th century, and there is great potential to improve fruit yield and disease resistance (Zohary, 1994).

Olives are wind-pollinated (Cuevas & Polito, 2004) and predominantly outbreeding (Belaj et al., 2004); those naturalised in SA appear to be all self-compatible. Seeds are spread from planted trees by foxes and emus, which swallow the whole fruit and defaecate the seed hours later. Many other birds also remove olives from the trees (Paton et al, 1988). Those that do not swallow the pit will disperse it no more than 100 metres, but starlings swallow whole fruit and may regurgitate or defaecate seeds at their roosts up to 40 km away (Mladovan, 1988).

Olives were first introduced to South Australia in 1836. Five selected cultivars from Marseilles were imported by the South Australian Company in 1844, and accessions later arrived from Portugal, Spain, Provence and northern Italy. Because parts of our State have similar climate and soils to these areas, olives readily became naturalised. Feral olives can be shown genetically to be the offspring of nearby cultivated olive trees (Mekuria et al, 2002). Feral olive trees generally produce smaller fruits than trees in cultivated orchards, both because the trees are unpruned and because they are no longer under selection for maximum fruit size. The pits of the smaller fruit are more easily dispersed by birds (Spennemann and Allen, 2000), facilitating their further spread.

Invasion by feral olives takes place on a much slower time scale than most other weeds. Their seeds are long-lived in the soil and slow to germinate, due to both the resistant endocarp and an endogenous dormancy of the embryo even when the endocarp is removed. This endogenous dormancy varies widely between cultivars (Rinaldi, 2000). Self-sown seedlings establish on roadsides, in bush and abandoned pasture and may be slow-growing at first, with a juvenile period of 5-10 years before they begin to bear fruit. But established olive trees form a dense and permanent canopy that prevents other vegetation from re-establishing. Individual trees live for many centuries and retain the ability to regenerate from stumps after felling or burning, as well as forming a large seedbank in the soil. They have now formed a new, stable climax vegetation on some sites and will continue to dominate these sites unless

land managers intervene, either by planting and maintaining native vegetation or by adopting some other sustainable land use.



Concept map of the olive problem.

Olives can survive in an annual rainfall of less than 250 mm (Price et al., 2003). However, they are vulnerable to root rot, and will not persist in waterlogged sites.

The great majority of feral olive infestations occur in former areas of woodland vegetation. These areas were the first to be cleared and settled, and also provide an optimum environment for olives with 400-600 mm annual rainfall on generally well-drained soils. They are commonest on fertile and slightly acidic soils but will also tolerate alkaline and mildly saline soils. However, olives are not completely absent from uncleared forest or uncleared woodland. Areas with an annual rainfall over 700 mm are less susceptible to invasion, partly because they typically have higher watertables and may suffer transient waterlogging within the root zone.

Major olive infestations occupy the drier foothill slopes of the Adelaide Hills, forming a distinct olive zone in former woodlands of *Eucalyptus leucoxylon* and *E. microcarpa* (Specht, 1972). Cessation of sheep grazing in the Hills Face Zone in the 1970s led to a sudden appearance of olives over paddocks where they had formerly been controlled by continual grazing of seedlings. Serious roadside infestations have now also developed in the northern Lofty and southern Flinders Ranges areas inside the 500 mm annual isohyet, although olives are also grown and may volunteer in lower rainfall areas. Feral olives infestations reduce the abundance and diversity of native plant species, altering the canopy structure of the woodland and preventing native regeneration. Native canopy cover may be reduced by 80% and native species diversity by 50% (Crossman, 2002).

Clearing mature olive infestations has an initial cost of about $15,000 per hectare (Crossman et al, 2003; Interdepartmental Taskforce on Feral Olives, 2005) with an annual maintenance cost of about $500 hectare if native vegetation is planted to replace the olives.

Risk Assessment

Assessment using the Commission WRA protocol gave the following scores for some declared weeds in native vegetation:

Species	Invasiveness	Impact	Weed ranking
olive	**10**	**13**	**46**
blackberry	11	12	46
Cape broom	11	12	46
English broom	11	11	42
boneseed	11	9	35
Aleppo pine	9	10	32

Olive is one of the highest ranking woody weeds in native vegetation, comparable to Cape broom and blackberry.

Aims

- To protect native vegetation from invasion by feral olives
- To protect the olive industry from pests and pathogens harboured by feral olive trees.

Objectives

- Spread of feral olives is controlled.
- Existing feral olives are removed from sites of high conservation value.

Considerations

- olives will continue to be cultivated in South Australia because local climates are ideal for olive growing and there is a large demand for the product
- feral olives are the consequence of an olive industry and other cultivated olive trees
- the existing feral populations are self-sustaining and are the major source of seed for further spread, even in the absence of olive orchards
- an ongoing program will be necessary to minimise the dispersal of seed from cultivated olives and promptly destroy feral olive seedlings
- established infestations of feral olive trees on public and private land should be removed as resources permit
- a voluntary code of practice should be adopted by olive growers to minimise seed spread from orchards; this code could also be used by NRM authorities as a basis for action plans on properties with a feral olive problem, and by Councils in considering planning applications for new olive orchards.

Implementation

Actions at State level:

- Extension to increase awareness of the environmental damage caused by feral olives.

Actions at regional level:

Region	Implementation
Alinytjara Wilurara	none
South Australian Arid Lands	none
Eyre Peninsula	inspection and enforcement of control
Northern and Yorke	inspection and enforcement of control
South Australian Murray Darling Basin	inspection and enforcement of control
Adelaide and Mount Lofty Ranges	inspection and enforcement of control
Kangaroo Island	inspection and enforcement of control
South East	inspection and enforcement of control

Declaration

Sections of the Natural Resource Management Act that apply to feral olives throughout the State:

182(2)(3) Requiring land owners to control plants on their properties
185(1) Allowing recovery of costs of control on road reserves

It is legislated that:

- land owners have a responsibility to control olives (other than trees planted and maintained for domestic or commercial use) on their land
- land owners must take any measures prescribed by the regulations or specified by a relevant authority for the control of olives on their land
- Natural Resource Management Groups have a responsibility to control feral olives on road reserves, and may recover costs of this work from the adjoining land owners

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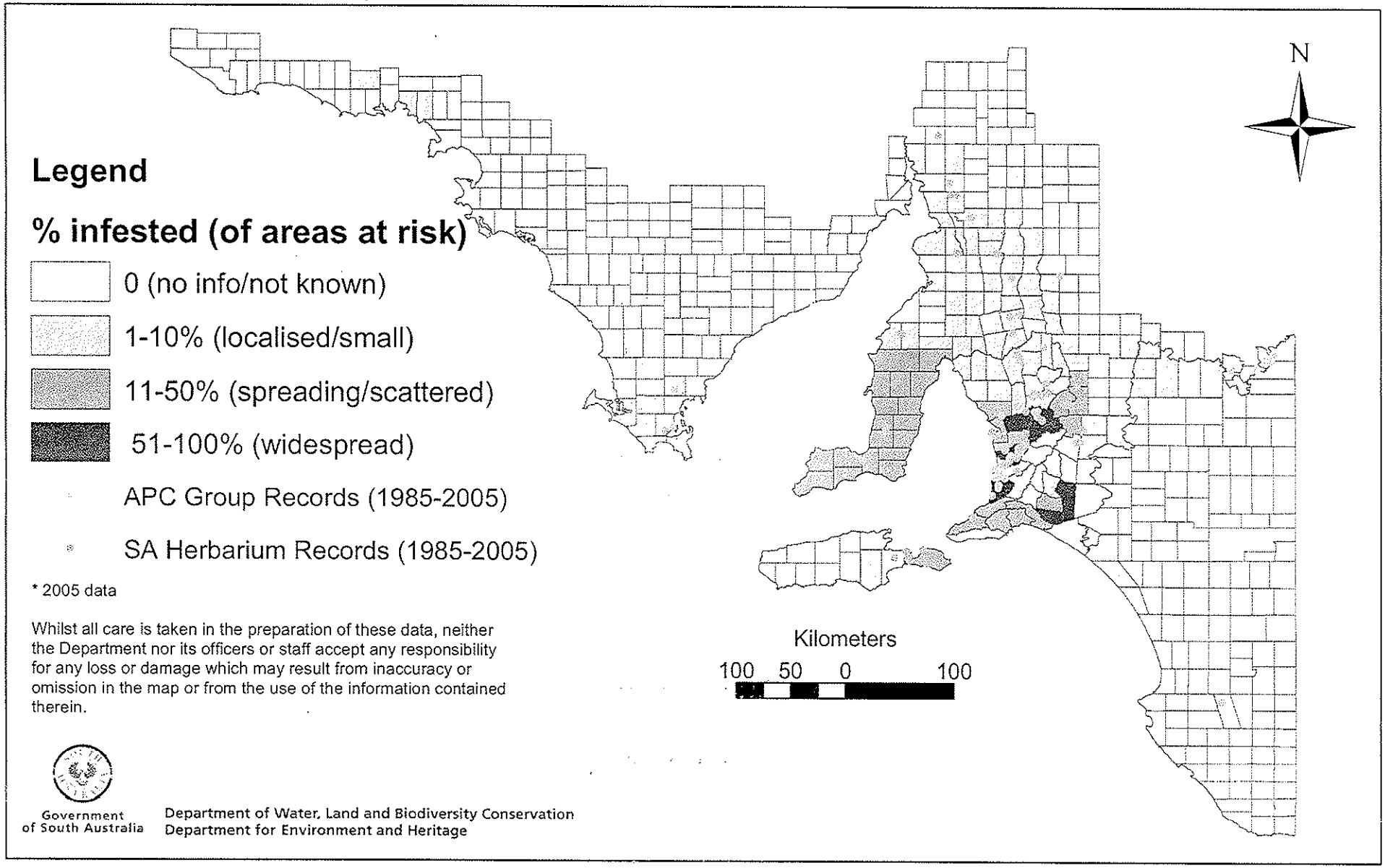
Infestation Level of *Olea europaea* (OLIVE) by Hundreds in the State of South Australia. *



Risk assessment for new olive orchards

Please answer each question by typing a '1' opposite one of the alternative answers

LIKELIHOOD OF OLIVE SPREAD FROM NEW ORCHARD: SCORE

Non-Management factors:

1	**Is the annual rainfall suitable for olive seedlings to establish (based on Bureau of Meteorology long term records)?**			
a	Median rainfall greater than 500 mm per year.		50	Go to question 2
b	Median rainfall between 350 and 500 mm per year.		35	Go to question 2
c	Median rainfall less than 350 mm per year, but annually flowing watercourses within 1km of the proposed orchard.		15	Go to next section
d	Median rainfall less than 350 mm per year with no annually flowing watercourses within 1km of the proposed orchard.		0	Go to next section
2	**Are the surrounding landuses within 1 km of the proposed orchard (eg. grazing, cropping, native vegetation, horticulture) suitable for olive seedlings to establish?**			
a	Less than 50% of the surrounding area has grazing, cropping or perennial horticulture.		25	Go to question 3
b	Between 50 and 90% of the surrounding area has grazing, cropping or perennial horticulture.		15	Go to question 3
c	More than 90% of the surrounding area has grazing, cropping or perennial horticulture.		5	Go to question 3
3	**Are the soils within 1 km of the proposed orchard waterlogged for at least one month per year?**			
a	Less than 50% of the surrounding soils have waterlogging.		25	Go to next section
b	Between 50 and 90% of the surrounding soils have waterlogging.		15	Go to next section
c	More than 90% of the surrounding soils have waterlogging.		5	Go to next section

SUB-TOTAL = 0 Max = 100 Min = 0

Orchard management factors:

1	**How is bird predation of olive fruit to be managed in the proposed orchard?**			
a	No bird control plan described.		0	Go to question 2
b	Integrated bird control will be done, following the guidelines provided.		-10	Go to question 2
c	Permanent bird-proof netting over entire orchard.		-65	Go to Question 6
2	**At what stage of maturity will olives be harvested?**			
a	Ripe only.		0	Go to question 3
b	Green and ripe.		-5	Go to question 3
c	Green only.		-10	Go to question 3
3	**How large will the fruit be when harvested? (Consider variety and use of irrigation)**			
a	Small fruit (length <15 mm).		0	Go to question 4
b	Medium fruit (length 15-25 mm).		-5	Go to question 4
c	Large fruit (length >25 mm).		-10	Go to question 4
4	**Will fallen fruit be visible on the ground?**			
a	At fruit fall there will be minimal ground cover, as weeds will be controlled by cultivation and/or herbicides.		0	Go to question 5
b	At fruit fall there will be ground cover of at least 10 cm height, as weeds will be controlled by mowing or grazing.		-5	Go to question 5
5	**Will a control zone be established around the orchard? Olive seedlings must be controlled in this zone. Perch trees for birds in this zone should be over 7 m high and spaced at 50 m intervals (or less) around the orchard.**			
a	Buffer around 50 m wide or less, with no perches for birds.		0	Go to question 6
b	Buffer around 100 m wide, with no perches for birds.		-5	Go to question 6
c	Buffer around 200 m wide, with no perches for birds.		-10	Go to question 6
d	Buffer around 20 m wide, with perches for birds.		-5	Go to question 6
e	Buffer around 50 m wide, with perches for birds.		-10	Go to question 6
f	Buffer around 100 m wide, with perches for birds.		-15	Go to question 6
g	Buffer around 200 m wide, with perches for birds.		-20	Go to question 6
6	**How is fox predation of olive fruit to be managed in the proposed orchard?**			
a	No fox control plan or fox baiting is not possible due to legal restrictions.		0	Go to next section
b	Fox control program by olive grower only.		-10	Go to next section
c	Coordinated fox control program amongst properties in the local area.		-20	Go to next section
d	Fox proof netting around orchard, or no foxes present (Kangaroo Island only).		-35	Go to next section

SUB-TOTAL = 0 Max = 0 Min = -100 Min without bird netting = -75

ADDING SUB-TOTALS = 0

LIKELIHOOD SCORE = 0 Max = 100 Min = 0

CONSEQUENCE OF OLIVE SPREAD FROM NEW ORCHARD:

1 How close is the proposed orchard to the nearest area of significant native vegetation?

a	Less than 500 m.		50	Go to question 2
b	Between 500 m and 1 km.		40	Go to question 2
c	Between 1 and 2 km.		30	Go to question 2
d	Between 2 and 5 km.		15	Go to question 2
e	Greater than 5 km.		0	Go to question 2

2 Does this area of significant native vegetation already have feral olives (within the reserve or within 1 km of its boundaries)? Is there a formal, ongoing control program (eg. coordinated by the local Animal and Plant Control Board)?

a	No mature trees are present in the reserve, or within 1 km of its boundaries.		25	Go to question 3
b	Fewer than 10 mature trees are present, and there is a control program.		20	Go to question 3
c	Between 10 and 100 mature trees are present, and there is a control program.		15	Go to question 3
d	More than 100 mature trees are present, and there is a control program.		10	Go to question 3
e	Fewer than 10 mature trees are present, and there is no control program.		10	Go to question 3
f	Between 10 and 100 mature trees are present, and there is no control program.		5	Go to question 3
g	More than 100 mature trees are present, and there is no control program.		0	Go to question 3

3 Does this area of significant native vegetation already have legal (council approved) olive orchards within a 5 km radius of its boundaries?

a	There are no existing, legal olive orchards.		25
b	There are 1 to 3 existing, legal olive orchards.		10
c	There are more than 3 existing, legal olive orchards.		0

CONSEQUENCE SCORE = 0 Max = 100 Min = 0

RISK SCORE = 0 Max = 200 Min = 0

OVERALL RISK: LOW

Low risk = 50 or less
Medium risk = 51 to 100
High risk = 101 to 150
Very High risk = over 150

Government
of South Australia

WEED CONTROL NOTES

ANIMAL AND PLANT CONTROL COMMISSION

OLIVE

Introduction
Olive is an introduced tree that is now established in many parts of South Australia. Olive trees can grow to 12m tall and has a deep, widely branched root system. It grows well in most environments and on most soil types but is sensitive to waterlogging.
Although the olive tree has a high commercial value for its fruit and oil, it is also an invader of native vegetation. If uncontrolled, olive can alter the composition, decrease biodiversity and increase the fire hazard of native vegetation. The planting of olive orchards, particularly if they are later abandoned, has spread olives to many parts of the State.
Olive is spread from orchards by birds that eat the fruit and deposit the seed under other trees. Those that do not swallow the pit carry it less than 100 metres, but starlings swallow whole fruit and later regurgitate seeds at nearby trees or at their roosts many kilometres away. Foxes and emus also swallow whole olives and defaecate the seeds hours later.

General control advice

Prevention
Olive trees that are not maintained for harvesting must be destroyed and any seedlings removed when found.

Do not plant olives close to native vegetation that has a high conservation value. Minimising losses of fruit to birds and foxes will also minimise the spread of olives by seed. This can be done by

Prompt harvesting of olives
Netting of orchards with bird-proof mesh on permanent posts
An integrated program using a variety of bird-scaring techniques
A buffer zone around the olives with perching sites where birds can drop seeds.
Fox baiting programs in co-operation with adjoining landholders
Electric fences or fences of extra height to exclude emus if these are present

Eradication of feral olives from a site will take at least 3 years; target mature trees in the first year, regrowth and seedlings in subsequent years.

Mechanical
- Cut trees down at base of trunk and treat fresh stump or regrowth as described below.
- Seedlings can be hand pulled if the correct method is used to remove the lignotuber completely and prevent regrowth.

Biological
No insects or pathogens are available as biocontrol agents for olive.
Olive seedlings are palatable and can be controlled by stock grazing. They are also controlled by competition from dense vegetation. After removal of olive trees and seedlings, replant the area with competitive species such as kangaroo grass (*Themeda triandra*).

Chemical

Cut mature trees and immediately swab the stump with a 600g/L triclopyr product, mixed 1L herbicide in 30L of diesel.

Spray basal bark and foliage of smaller olive plants with :

Triclopyr
use a 600g/L triclopyr product, mixed 1L herbicide in 30L of diesel.

WARNINGS - soil active herbicide: may damage vegetation
- hormone herbicide: use with caution near sensitive crops

READ THE LABEL BEFORE USING ANY HERBICIDE
ENSURE SPRAY EQUIPMENT IS CORRECTLY CALIBRATED AND MAINTAINED

As olive seeds are long-lived in the soil, follow-up inspections will be needed for many years.

Further information:
Animal and Plant Control Commision (1999) *Risk Assessment and Management of Olives.*
InFINDer, PIRSA agrivet chemical information system.
Parsons, W.T., Cuthbertson, E.G. (2000) *Noxious Weeds of Australia* . 2nd edn. Inkata Press.

The assistance of officers of local Animal and Plant Control Boards and Rural Solutions SA in compiling this information is acknowledged.

For more advice on recognising and controlling feral olives, contact your local Animal and Plant Control Board:

The Department of
Water, Land and
Biodiversity
Conservation

Report DWLBC 2004/12

Government
of South Australia

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Department of Water, Land and Biodiversity Conservation
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Disclaimer

Interdepartmental Taskforce on Feral Olives. South Australia 2003. *Department of Water, Land and Biodiversity Conservation. Report,* DWLBC 2004/12.

PREFACE

The Meeting of the Natural Resources Environment and Energy Cabinet Committee meeting held on 1 May 2003 resolved (Item 3.1, Olive Growing in the Mount Lofty Ranges):

> **"The Department of Water Land and Biodiversity Conservation to establish an executive level taskforce, with representation from DWLBC, PIRSA and Planning SA, to review existing legislation and develop new measures, and possibly drafting instructions for a Bill, to address the spread of olives in the Mount Lofty Ranges."**

An Interdepartmental Executive Steering Committee was established involving Roger Wickes (DWLBC), Barry Windle (PIRSA) and Phil Smith (Planning SA). The Committee met on 26 June, 2003 to approve terms of reference and membership of the olives taskforce.

Terms of reference

The taskforce was asked to develop a plan to address the spread of feral olives in the Mount Lofty Ranges, including strategies to:

1. evaluate any gaps in the current legislation relating to olives.
2. resolve planning issues arising from commercial and domestic olive plantings.
3. address the control of feral olives in the region.
4. manage existing commercial olive groves to minimise spread of ferals.

Provide advice to government on legislative changes, which may be needed to implement these strategies.

Taskforce membership

The taskforce included Mark Ramsey and David Cooke (APCC), Colin Harris and Simon Lewis (DWLBC), John Fennell and Peter Willmott (PIRSA), Laurie Haegi (DEH), John Wills (Mount Lofty Ranges Animal and Plant Control Board), Lara Daddow and Phil Smith (Planning SA).

Expert advice was obtained from Chad Jacobi and Roz Daniel, Crown Solicitors, and from Neville Crossman, Flinders University

CONTENTS

BACKGROUND

Olives are recognised as a valuable tree crop and an increasingly important industry in South Australia. However, once naturalised as feral olives, they become a woody weed with negative impacts:

- on biodiversity by invading and displacing native vegetation,
- as a harbour for diseases and pests such as olive fly that may cause losses to the industry, and
- as a fire hazard due to their dense growth and high oil content.

Major olive infestations occupy the drier foothill slopes of the Adelaide Hills, forming a distinct olive zone in former woodlands. Cessation of sheep grazing in the Hills led to appearance of olives over land where they had formerly been controlled by continual grazing of seedlings. Serious roadside infestations also occur around Clare and in the northern Mt Lofty and southern Flinders Ranges areas.

Feral olives are especially conspicuous in the Hills Face Zone because this area includes much idle land where neither development nor native revegetation is now occurring. Woody weeds are a symptom rather than the cause of land degradation on these idle blocks. Clearing of feral olive infestations on idle land will lead to reinvasion by other weeds such as blackberry, boneseed or bridal creeper unless the management of these lands is changed.

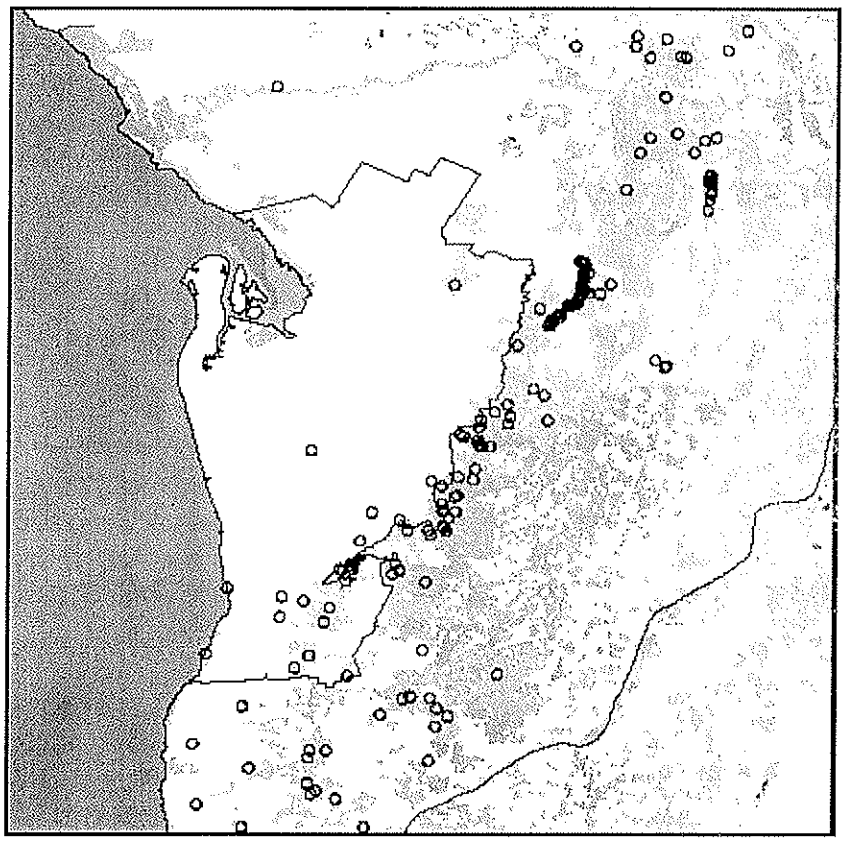
Olives were introduced to South Australia in colonial times from Portugal, Spain, southern France and northern Italy. They have readily become naturalised in regions of our State with climate and soils similar to these areas. Seeds are spread from olive trees by foxes and emus, which swallow the whole fruit and defaecate the seed some hours later. Many other birds also remove olives from the trees; starlings swallow whole fruit and regurgitate most seeds nearby, but may drop some at their roosts as far as 40 km away.

The dispersal of seed from cultivated olives can be minimised by careful management, but not totally eliminated. However, commercial olives groves are only a subsidiary source of the olive seeds now entering native vegetation because the majority of their fruit is harvested and losses to birds are minimised. The main seed source is the existing populations of feral olives, as their fruit production is abundant and rarely harvested.

Feral olives can establish on a wide range of soil types. They are commonest on fertile and slightly acidic soils but will also tolerate alkaline and mildly saline soils. They are vulnerable to root rot, and will not persist in waterlogged sites.

The great majority of feral olive infestations occur in former areas of woodland vegetation. These areas were the first to be cleared and settled, and also provide an optimum environment for olives with 400-600 mm annual rainfall on generally well-drained soils. However, olives are not completely absent from uncleared forest or uncleared woodland. Areas with an annual rainfall over 700 mm are less susceptible to invasion by olives, partly because these sites often have a higher watertable and suffer transient waterlogging.

Invasion by feral olives takes place on a much slower time scale than most other weeds. Their seeds lie dormant for several years before they can germinate; seedlings have a juvenile period of 5-10 years before they begin to bear fruit. However, olives form a dense and permanent canopy that prevents other vegetation from re-establishing. Individual trees live for many centuries and retain the ability to regenerate from stumps after felling or burning, as well as forming a large 'bank' of seeds in the soil. Olives have formed a new, stable climax vegetation on some sites and will continue to dominate these sites in perpetuity unless land managers intervene, either by planting and maintaining native vegetation, or by changing to another sustainable land use.



Current distribution of feral olives mapped against native vegetation along the Hills Face Zone (**o** indicates existing infestations).

Map by Neville Crossman

DISCUSSION

Current management

Feral olives are proclaimed for enforced control in all parts of South Australia under the Animal and Plant Control Act. Control is implemented by local animal and plant control boards (APCBs), which receive 50% of their funding from the State Government via the Animal and Plant Control Commission. The Boards have powers to enforce control of proclaimed weeds under the Animal and Plant Control Act, and are empowered to recover the costs of control from landholders. In urban areas, local councils have the powers of an animal and plant control board. Implementation of these powers is limited by the resources available for investigating, advising and enforcing olive control by landholders.

Research at Flinders University has estimated that 13% of the Mount Lofty Ranges APCB area (co-extensive with the Adelaide Hills Council area) is at high risk of feral olive invasion, 46% is medium risk and 41% is low risk. There are approximately 2000 infested properties in the Mount Lofty Ranges APCB board area, a similar number in the Fleurieu APCB and 500 in Barossa Ranges APCB.

Weed control, including feral olives, is a responsibility of the landholder. But removal of olives without changing the underlying management of the land does not address the cause and will not resolve the problem. Feral olives can be controlled by treating the base of trees with systemic herbicides and leaving the dead tree standing. However, this practice does not eliminate the fire hazard and creates problems with access for follow up treatment. As the dead trees take several years to breakdown complete removal of the vegetation is preferred, particularly in prominent areas. The removal of mature olive trees is very expensive and in many cases the cost of clearance may exceed the market value of the land.

The definition of feral olives includes all olive trees not planted and maintained for commercial or domestic use. Under Commission policy, a grove that has been left unharvested for two successive years is deemed to be abandoned and subject to enforced control. However, this policy is not written into legislation and has not been tested in court.

Commercial Olive Industry

The feral problem has arisen from historical olive introductions since the 1850's. Many of these trees were planted in the vicinity of Adelaide and old trees still exist on domestic and rural blocks and in the City parklands. Many of these old trees are heritage listed.

A renascent industry has developed rapidly over the past decade. It is estimated that between 1.5 and 2.0 million trees have been planted, mostly under irrigation. There are in excess of 600 growers with plantings ranging from 100 trees to 150,000 trees. The largest plantings are in the South East where it is estimated that 30% of the trees are now established. Other substantial plantings are located in the Riverland and in the Mallee.

It is estimated that South Australia has approximately 20% of the national total and most have been planted longer than elsewhere in the country. SA is now producing commercial quantities of extra virgin olive oil and full production of at least 6000 tonnes will come on stream within the next 5 years.

The national industry is coordinated through a peak body, Australian Olive Association and the local industry is represented by Olives South Australia. Olives SA is very concerned about the feral olive issue and wishes to be represented at decision-making stages.

The industry is in the process of establishing a levy to support future development. Many priorities exist including establishing quality standards, harvesting and processing efficiency, waste disposal or utilisation, marketing and promotion. At this time the industry has more issues needing attention than it can fund from levied sources.

The industry has a strong concern about feral olives as a potential biosecurity risk by harbouring pests. The industry believes that the current approval processes are adequate and has no evidence to indicate that currently managed groves are contributing to a feral problem.

Existing feral olive populations and unharvested olive trees in backyards, amenity plantings, hobby farms and abandoned groves, contribute by far the greatest risk to the continued invasion by feral olives. In comparison, managed olive groves are a low risk, as their fruit is efficiently harvested and losses to birds are minimised. The risk from commercial olives arises principally from new plantings in areas where feral olives are not yet established. This latter risk is addressed during consideration of developments applications by local government using the Commission's risk assessment process.

The industry will more readily accept restrictions on the planting of olive groves if the Government demonstrates an intent to effectively control existing feral olive populations and to remove abandoned olive groves. Also there is a perceived anomaly where some inefficiently harvested trees, such as those in the Adelaide Parklands, have the protection of heritage listing.

Local Government

Olives and other woody weeds are a problem for all of the metropolitan councils abutting and extending into the Hills Face Zone, including Mitcham, Onkaparinga, Marion, Adelaide Hills, Campbelltown, Tea Tree Gully, Salisbury and Playford.

Mitcham City Council has commenced a program of educating landholders about woody weed issues in the Hills Face Zone. The Council is establishing land management agreements and has issued some legal notices to enforce control of olives on recalcitrant landholders. However, the cost of this program is high for both the Council and landholders.

The olive problem is exemplified in the Brownhill Creek Catchment where ideal environmental conditions, steep terrain, small landholdings and controls on development

have resulted in dense olive infestations, which are now invading remnant areas of native vegetation. In many cases control of these infestations could cost more than the value of the land. Where land has been cleared of dense olives by one landholder, severe infestations of bridal creeper, boneseed and blackberries are now established. Difficulty of access to much of this area means that fire fighting is very high risk.

Regional NRM plans and investment strategies

Feral olive control has been included in the Natural Resource Management plan for the Mount Lofty Region, but has not been identified as a priority for the first year. Funds for this purpose should be identified in the Regional Investment Strategy.

The Natural Resource Management Act establishes a funding mechanism for managing of proclaimed species including feral olives. Educating the community and enforcing control of feral olives will be the responsibility of regional NRM boards and sub-regional groups in accordance with the priorities identified in regional plans and investment strategies. A significant investment is required to map infestations and identify properties, educate landholders and prepare land management agreements, and enforce the Act as required.

LEGISLATION

There are two pieces of legislation relevant to the regulation of olive developments and the control of feral olives.

- *The Animal and Plant Control Act,* which focuses on the externalities caused to production and the environment by pest animals and plants, is the appropriate tool for management of existing feral olive infestations and abandoned olive groves. These legislative functions are incorporated into the Natural Resources Management Act, which takes a broader holistic approach to promote sustainable and integrated management of natural resources.

  The *Natural Resources Management Act 2004* provides more flexibility for management of weeds such as feral olive by protection orders and reparation orders in addition to legal control notices to prepare enforcable action plans. It also provides for Codes of Practice for industries within the regulations. A Code of Practice for olives under the Act could also apply to the *Development Act.* The Code would be developed from the Animal and Plant Control Commission's current olive risk assessment and management document, with input from industry representatives via Olives SA.

- *The Development Act* is the appropriate tool for development planning, but has no effect on existing olive groves. Olive developments that constitute a change in land use require approval under the Act; such approvals are the responsibility of local Councils. Olives may be planted without approval if this does not constitute a land use change, for example the addition of olives to an existing fruit growing enterprise. Approval to plant an olive grove under the Development Act does not by itself give a grower any exemption from the proposed requirements of the Natural Resources Management Act. However, by linking the Acts it would be possible to exempt any olive grove that had received planning approval.

Legislative options

On 4 September, Members of the taskforce met with Crown Law officers who offered the following suggestions for managing future commercial olive developments:

1. Require applications under the *Development Act* for olive planting to consult NRM Boards. Schedule 8 of the Development Regulations establishes a referral process and lists Government bodies that must be consulted on particular types of development. Regional NRM Boards could be empowered by this schedule to assess olive applications in accord with the Regional NRM Plan, and direct Councils in their decision. Compliance with the Code of Practice could be used as a condition for approval.

2. Declaration under the *Natural Resources Management Act.* Section 174 of this Act will empower the Minister to make declarations regarding specified classes of

plants or animals in specified parts of the State; section 182 provides for enforced control of plants, and section 232 allows general exemptions from provisions of the Act. Olives could be proclaimed for enforced control under section182 and; this declaration could apply in all parts of the State, or in a region provided under section 174. The Code of Practice would then be incorporated in the Regulations under the Act, and a general exemption from enforced control granted under section 232 to all growers who have planning approval and comply with the Code.

3. List olive plantings as a non-complying development. All Development Plans across the State could be amended simultaneously by a Ministerial PAR. Councils would then be empowered to refuse approval for olive planting in inappropriate areas. Councils and Regional NRM Boards could exempt developments as appropriate through local Development Plan changes. Alternatively, a Ministerial PAR applying only to areas identified as having native vegetation at high risk could be contemplated.

4. A suggestion that olives could be added to the definition of development in Section 4 of the *Development Act* was rejected as this is beyond the objectives of this Act and would establish an undesirable precedent.

IMPACT

Impact of doing nothing

Unless we intervene to control the spread of feral olives, we must accept that olives will continue to invade, displace and erode native vegetation communities and idle cleared land. Once established, olives develop into dense thickets with a continuous canopy that excludes native regeneration. Olives become a stable climax vegetation community that supports few if any native species and has low conservation value. Amenity values in areas will be severely compromised and olives will restrict access for bushwalkers and decrease the aesthetic value of the landscape.

The encroachment of feral olives will also result in a permanent increase in fuel loads, leading to more frequent destructive bushfires. DEH recognises this problem and is spending $300K on woody weed removal in the area under the Government's specific allocation for fire prevention.

The Hills Face Zone is at particular risk. If olives continue to spread unabated, then the Zone will be dominated by a dense canopy of olives within fifty years, compromising the natural open character, biodiversity and amenity values it was established to protect. Furthermore, the increased fire hazard may make it impossible to defend existing scattered houses in some areas.

CONCLUSIONS

While there are strong arguments for exerting more effective control over new plantings of olives, such controls will have very limited impact unless effective regional programs are implemented to control and progressively eradicate feral populations. Feral olives pose by far the greater threat in terms of fire hazard, biosecurity and degradation of natural ecosystems. Furthermore any feral olive control program must include ongoing management, as idle land will be rapidly colonised by other weeds and eventually by feral olives.

In response to the four points in the Terms of Reference for this taskforce,

1. Gap analysis of current legislation

The taskforce does not believe that separate legislation is required to control the spread of feral olives from olive groves. Existing powers under the *Development Act* are adequate if used in conjunction with those under the Natural Resources Management Act.

2. Resolution of planning issues

The taskforce recommends that three legislative actions be taken:

2.1 List new olive groves as a non-complying development in sensitive areas

The Minister for Urban Development and Planning has power under the *Development Act* to make the establishment of new commercial olive groves non-complying through introduction of a Ministerial Plan Amendment Report. Such a Plan can also insert guidelines on the layout and operation of new olive groves, consistent with the Code of Practice to be established under the NRM legislation. The Plan could apply statewide or to sensitive areas identified either by location, or by measurable criteria. After the mapping of high-risk areas and their identification in regional NRM plans, such a Plan can be prepared to prevent the establishment of new groves.

It should be noted that this approach will not apply to olives planted or allowed to grow as part of an existing use, as the *Development Act* only has application when there is a change in land use. For this reason this strategy must operate alongside the Natural Resources Management Act to manage olives where there is no change of use.

2.2 Require NRM Board consultation on applications for olive planting

Schedule 8 to the Development Regulations lists the agencies that must be consulted by planning authorities (usually the Council for the area) on particular types of development application. It is recommended that Regional NRM Boards be listed as referral agencies for applications to establish new olive groves, with a power of direction. This will allow the Boards to impose conditions where appropriate to manage environmental impact, such as those set out in a Code of Practice for olive growing. In cases of high environmental risk - the Board would have power to direct the planning authority to refuse the application.

A Code of Practice for management of olive groves to minimise the dispersal of seed to sites where feral olives can establish should be developed from the Animal and Plant Control Commission's current olive risk assessment and management document and new distribution data from research at Flinders University. Consultation with Olives SA as representatives of the industry will be sought through PIRSA.

2.3 Declaration under the Natural Resources Management Act

It is recommended that all olives be declared for enforced control with Section 182 of the Natural Resources Management Act applying. Unlike the existing statewide proclamation of olives under section 57 of the Animal and Plant Control Act, this would not exempt olives planted and maintained for production or domestic purposes. The declaration could apply in all parts of the State, or in a particular region defined in section 174

The Code of Practice would then be incorporated in the Regulations under the Natural Resources Management Act, and a general exemption granted under clause 236section 232 to all growers who comply with the Code. This would allow managed olive groves to continue in operation while empowering NRM Boards to remove any abandoned groves.

3. Control of existing feral olives

Powers exist under the Animal and Plant Control Act, and will remain under the Natural Resources Management Act, to legally enforce the removal of feral olive infestations on private and public land, at the expense of the respective landowners.

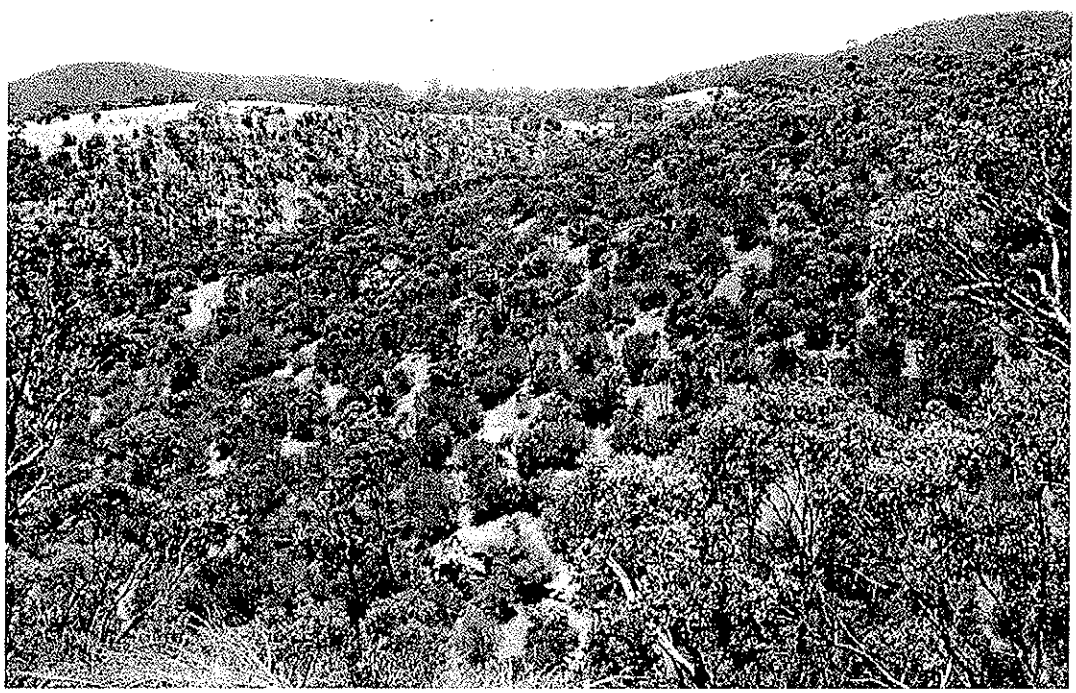
A coordinated regional strategy with multiple components is required for effective long-term control of feral olives. This will require a substantial increase in the level of resources allocated. Many infestations are so severe that it is unrealistic to expect the full cost of control to be borne by the landholders. On some sites, control of feral olives may be achieved by poisoning the trees and following up by spraying seedlings as they emerge. This may cost from $750 to $3,000 per hectare depending on topography, with around $500 per hectare for annual follow-up treatments. This figure of $500/ha/year is typical for maintenance weed control in native vegetation. However, more often the felling and removal of olive trees is necessary as dead trees left in situ are unacceptable, especially in peri-urban areas, and would prevent access for treatment of olive seedlings and other weeds. This would cost $15,000 to $20,000 per hectare for dense infestations of mature trees, but could be as low as $7,000 for younger olive regrowth.

In practice, the resources available limit the extent of control work. A significant allocation of funds will be needed to reduce severe infestations to a level where ongoing management by landholders is a reasonable prospect. Feral olive control should be therefore be considered in consultation with stakeholders when developing regional Natural Resource Management Plans and Investment Strategies.

Feral olives in the Hills Face Zone are a symptom of the land management problems in this zone. The existing allotments cannot support viable enterprises, changes of ownership are frequent and landholders often lack expertise in land management, as a result much of the land is idle and vulnerable to invasion by woody weeds, particularly olives. The Hills Face Review is considering feral olives in developing a vision for long-term sustainable land management across the zone.

The Taskforce concludes that managing and containing the spread of feral olives in the longer term is contingent on the establishment of appropriate land uses. This may require establishing commercial enterprises and supporting non-commercial communal partnerships to create a mosaic of sustainable land uses including native revegetation, stock grazing, horticulture and vines. The Lakes District in the United Kingdom provides a model where planning integrates the community, enterprises and government to achieve a sustainable landscape.

The taskforce recommends that the Government fund a project officer to consult with stakeholders and develop strategies for sustainable long-term land uses to maintain the open natural character of the Hills Face Zone. Such a project would involve mapping and prioritising areas for management, developing models for sustainable land uses, community education and economic analysis. Models for evaluation include environmental management services agreements and the Community Title system under the Real Property Act.



Feral olives form the dominant vegetation in many areas of the Hills Face Zone.

RECOMMENDATIONS

1. List new olive groves as a non-complying development in sensitive areas under the *Development Act* through the introduction of a Ministerial Plan Amendment Report.

2. List the proposed Regional Natural Resource Management Boards as the referral agencies for applications to establish new olive groves, with a power of direction under the Development Regulations.

3. Proclaim all olives for enforced control under clause 182 of the Natural Resources Management Act.

4. Funds for olive control and the development of long-term sustainable land use strategies to maintain the open natural character of the Hills Face Zone to be identified in the Regional Investment Strategy for the proposed Adelaide-Mount Lofty Natural Resource Management Region.

Olives – new industry or environmental threat

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Summary

The olive tree is known worldwide for its symbolism, aesthetics and gastronomic value. Unfortunately the olive have also naturalised and invaded native vegetation in many areas, reducing biodiversity.

The olive industry in Australia is rapidly developing with many groves being established in new areas. The increased number and distribution of olive groves threatens native vegetation. South Australia and Tasmania have addressed this issue by developing management strategies. Despite significant industry development in Victoria, the government and industry has not yet addressed the issue.

This paper considers the influence of the environment and potential management on olive dispersal and growth. This data was incorporated into distribution models which showed Victoria's climate and environment is well suited to olives. Unless properly managed, the current expansion in olives plantings will pose a very high risk to Victoria's remnant bushland.

It is recommended that: 1). The Victorian government and olive industry address the issue of feral olives; 2). A stakeholder group be formed to examine the issue; 3). An education and awareness campaign be implemented; 4). Risk management guidelines be developed for olive groves; 5). Existing and new feral olive trees be controlled; and 6). The potential for preventing new olive groves in high-risk areas using a weed risk assessment be further investigated.

Introduction

The olive tree (*Olea europaea* ssp. *europaea*) is known worldwide for its symbolism, aesthetics, hardiness and the gastronomic value of the olive fruit (drupe). The olive industry is currently undergoing a period of significant expansion in Australia. Large numbers of new olive groves have been established throughout the country, many of them in Victoria. The current industry expansion is in somewhat of a renaissance, as there have been past expansions and contractions in the olive industry, particularly in South Australia.

The early development and contraction of the olive industry, resulted in olive seeds dispersing from abandoned groves, causing a major weed problem of feral olives. There is

concern that if not properly managed, the current industry expansion with increased numbers and distribution of groves will provide a seed source for new generations of feral olives with a much wider distribution (Bass et al. 2004).

In response to this concern South Australia and Tasmania have initiated strategies to manage the risk of olives dispersing off farm. These have included education campaigns, grove registration, research activities, and the development of Weed Risk Assessments for the approval of new olive groves (APCC 1999; Hanson 2002).

Despite significant olive industry development in Victoria, the industry or government has not yet developed any management strategies for the issue of feral olives. The management strategies devised by South Australia and Tasmania could provide a guideline for developing strategies for Victoria. However, differing legislative and natural environments require a strategy specific to Victoria.

Present Industry Situation

The olive industry in Australia has rapidly developed in the past decade. The new and existing groves range in size from very small to large investment driven corporate groves (Kailis and Sweeney 2002). Most growers entering the industry are small, with farm diversification projects or hobby farms of less than 5,000 trees (D'Emden 2001; Davies 2002). While estimations and surveys of olive tree numbers in Australia have ranged between 3.8 – 9.6 million trees (Table 1), there is a lack of accurate information about the size and distribution of the olive industry in Australia (Davies 2002; King 2004).

Table 2. Estimations of tree numbers in Australia

	Tree numbers from 2000/2001 census [1]	Tree numbers based on nursery sales and orders 1990-2002 [2]	Approximate olive tree numbers as of 2001[3]	Sales as at June 2002 + orders for 2002-2003 [4]
VIC	596,040	1,561,677	2,300,000	2,657,416
NSW	785,965	1,926,117	2,000,000	2,209,050
SA	856,443	1,255,792	1,500,000	1,767,519
WA	843,989	1,602,790	1,300,000	1,418,240
QLD	746,429	1,096,520	1,200,000	1,241,020
TAS	53,864	107,730	170,000	170,799
NT		2,300	5,000	2,300
ACT	1,700		Included in NSW	
Unknown		100,000		100,100
Australia	**3,884,432**	**7,652,926**	**8,475,000**	**9,566,344**

[1](ABS 2001); [2](RIRDC 2002); [3](Miller 2002 in Kailis and Considine 2002); [4](Sweeney 2002)

Victorian Olive Industry

There is little information about the current size and distribution of the industry in Victoria. Various estimates of industry size place the Victorian industry between 596,000 (ABS 2001) and 2.6 million (Sweeney 2002), (Table 1). Importantly, the census indicated a large number of recent plantings with 89% of the trees less than 6 years old (ABS 2001), suggesting many trees were yet to come into full production.

Olives are grown throughout Victoria with the ABS finding the largest concentration of olive trees is in the Swan Hill region (233,529). There are also large numbers of trees in the South Grampians (54,696), Horsham (54,013), Loddon (33,866), and Moira regions (32,252) (Figure 1). Current data sets (Table 1, Figure 1) are likely to underestimate the distribution of olive trees, as there have been significant plantings since the time of the census.

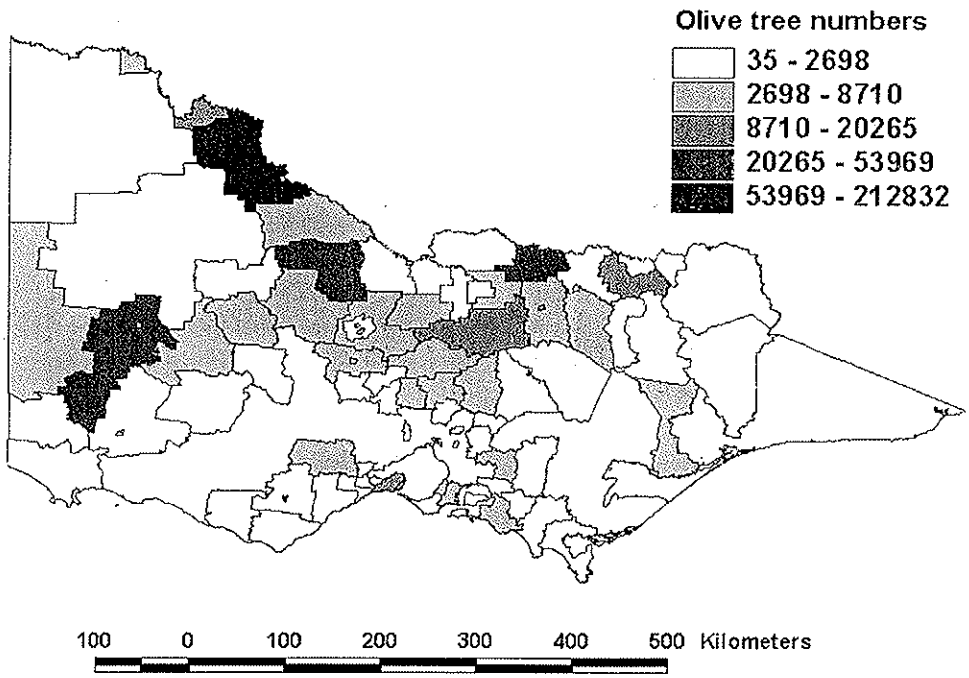

Figure 1. Victorian olive tree numbers by Local Government Area from the 2000/2001 census (ABS 2001).

Olive ecological attributes

Rainfall

While it is considered commercial production of olives should receive between 700 to 1100mm of water annually (Booth and Davies 1996). Feral olives are able to grow, reproduce and invade new areas with much lower annual rainfall, being highly invasive

where annual rainfall is 500-800mm (Cooke 1989; Parsons and Cuthbertson 1992; Muyt 2001) but capable of surviving in regions with less than 400mm annual rainfall(Crossman et al. 2002), but this may be associated with run-off (Muyt 2001) or abnormally wet seasons (Spennemann and Allen 2000).

Temperature

A vernalisation temperature of approximately 12 C average daily temperature is required for flowering and fruit set to occur (Denney and McEachern 1983). Growth of olives can occur up to 33 C, with mature tree entering dormancy above this (Renowden 1999). Temperatures below zero will damage tree extremities(Renowden 1999) but temperatures need to be below -5 C to kill young seedlings and less than -10C for large mature trees(Sibbett and Osgood 1994), with a LD_{50} of 3 year old trees ranged between $-11.39^{\circ}C$ to $-18.16^{\circ}C$, depending on the cultivar (Bartolozzi and Fontanazza 1999).

Soil characteristics

Olives are capable of growing on hilly and rocky areas and will generally grow in any soil type, with the exception of pure sands or clays (Burr 1999). The soil pH_{CaCl_2} parameters for suitable for olive production range between 5 and 8.5 (Sibbett and Osgood 1994; Burr 1999), though have been observed growing as a weed, in quite acidic soils(<5 pH_{water}) (Hamilton 1999). The olive is a moderately salt tolerate tree (Connell and Catlin 1994), with soil salinity greater than 8.4 dS/m unsuitable for commercial olive production (Burr 1999).

Olive dispersal

Birds are considered the main dispersal mechanism for feral olives. While the common starling is generally recognised as the main avian vector for olive dispersal numerous bird species have been seen to feed on olives, including emus (Cleland 1952; Black 1965; Forde 1986; Mladovan 1998; Spennemann and Allen 2000). Whether the birds can ingest the olive depends on olive size (Fabbri et al. 2004) and the gape size of the bird (Rey et al. 1997).

The main non-avian vectors are Foxes (Lowe 1982; Paton et al. 1988). Unlike most bird predation, foxes are likely to be long distance vectors of olive seeds (Burr 1999), with a potential dispersal range up to 5km (Spennemann and Allen 1998). Kangaroos have also been reported as feeding on olive fruits (Burr 1999). Other possible dispersal vectors of olives include mice (*Mus musculus*), rats (*Rattus rattus, R. noregicus*), flying foxes (*Pteropus sp.*), sugar squirrels (*Petaurus breviceps*), possums (*Pseudocheirus; Trichosurus*), rabbits (*Oryctolagus cuniculus*), goats (*Capra hircus*), sheep (*Ovis aries*) and wombats (*Wombatus ursinus*) (Spennemann and Allen 1998). Farm animals including pigs, cattle and poultry will eat olive seeds and could contribute to dispersal (Tompson 1888, in Spennemann and Allen 1998).

Management options to reduce dispersal

Vector Management

Effective bird management in orchards use many different methods such as visually scaring (scarecrows, reflective mirrors, bird silhouettes or kites),auditory methods (bangers or other explosive devices) can be used to cause fear, disorientation, disrupt communication and to mimic distress calls (Sinclair 1999). Population reduction by shooting birds is generally an inefficient control measure, but can be used successfully to reinforce auditory control methods. Emus can be controlled by frequent harassing (Temby 2003). They can also be excluded by installing a sloping electric fence (APCC 1999; Temby 2003) or an extra high non-electric fence (APCC 1999).

Alternatively, is to utilize birds perching habits to ensure dispersal is close to the orchard. The South Australian APPC (1999) code of practice for olive trees, recommends a 25-50m olive free amelioration zone, for monitoring and fire control and a 50-200m buffer zone within the property boundary. The required width of the buffer zone depends on the number of perching sites (APCC 1999), as the aim of the buffer zone is to encourage feeding birds to perch and drop the seed near the orchard.

As most bird damage is done when alternative food sources are scarce (Feare 1980), providing alternative food sources could reduce bird predation of olives (Feare 1980; Sinclair 1999). This requires knowledge of the nutrition requirements and feeding habits of different age and sex groups (Feare 1980) and the availability of alternative food sources..

The most effective control is physically excluding birds from orchards by the use of netting. The cost of netting means it is generally only appropriate to high value crops with a high level of fruit loss (Sinclair 1999; Bomford and Sinclair 2002). The cost of netting varies between $15,000 to $30,000 per ha (APCC 1999) at least tripling the present, establishment costs (Trapnell and Carmichael 1998; Burgess 1999; Kailis and Considine 2002).

Effective fox management requires a group of landholders conducting a widespread baiting program (APCC 1999).

Harvesting

Greater efficiencies in harvesting reducing the amount of fruit left on the trees or on the ground is required. Hand harvesting is more effect in getting the majority of fruit (up to 95%) compared to mechanical harvesting (65 – 80%), but can be improved by either using chemical loosening agents (80-95%) or if followed by hand picking (99%)(Booth and Davies 1996; ABC 2003).

Increasing Fruit size

As smaller olive seeds are likely to be swallowed by a greater number of birds, thereby dispersing the seeds (Sinclair 1999), the growing of larger size varieties should be

encouraged. Thinning the number of olives shortly after fruit set will also increase the size of fruit (Maranto and Krueger 1994; Martin et al. 1994). Similarly pruning can also be used to adjust the levels of fruit on the tree, with less fruit the large fruit size(Fowler 1940).

Time of ripening

Unevenness in ripening is likely to result in a smaller harvesting efficiency (Burr 1999)with more fruit remaining on the tree, which could be eaten and dispersed. As variety influences maturity time, having a region with similar varieties will leave only a small window of opportunity for food sources to vectors, reducing build up of vectors over time.

Victoria at Risk

The computer program CLIMATE was used to analyse the potential distribution of olives based on climatic suitability. Weather data utilised by the program was weather station data from the Mediterranean region where olives originated from, and Weather stations matching the FIS locations of feral olives in Victoria (DSE 2004) were added to the data. Weather stations were removed where a) temperatures below –5 °C . b) Stations with annual rainfall below 350mm and c) Stations above 45° N.

The Mediterranean based CLIMATE map of Victorian suitability was joined in Arcview to the vegetation data from of land classes where olives could establish (Crossman et al. 2002) and included: Lowland grassland, grassy woodland, dry sclerophyll forest, dry sclerophyll woodland, riparian vegetation and rock outcrop vegetation, but excluded grazing and cropping land use areas. The CLIMATE map for the Mediterranean locations was also joined in Arcview to a layer of roads in Victoria supplied by the Department of Primary Industries Frankston.

The CLIMATE prediction for Victoria using all naturalised locations suggests that the majority of Victoria's climate is very highly suitable for olives. However after factoring in land use (i.e. discounting grazing and cropping land use areas), it is the area of remnant vegetation that is most at risk particularly in the central and Gippsland areas (Figure 2). When this prediction is compared with recorded sites of olive invasion in Victoria these sites occur outside of the suitable vegetation (Figure 2). Many of these sites are likely to have occurred in non-arable areas such as roadsides or small reserves that are not included in the vegetative map.

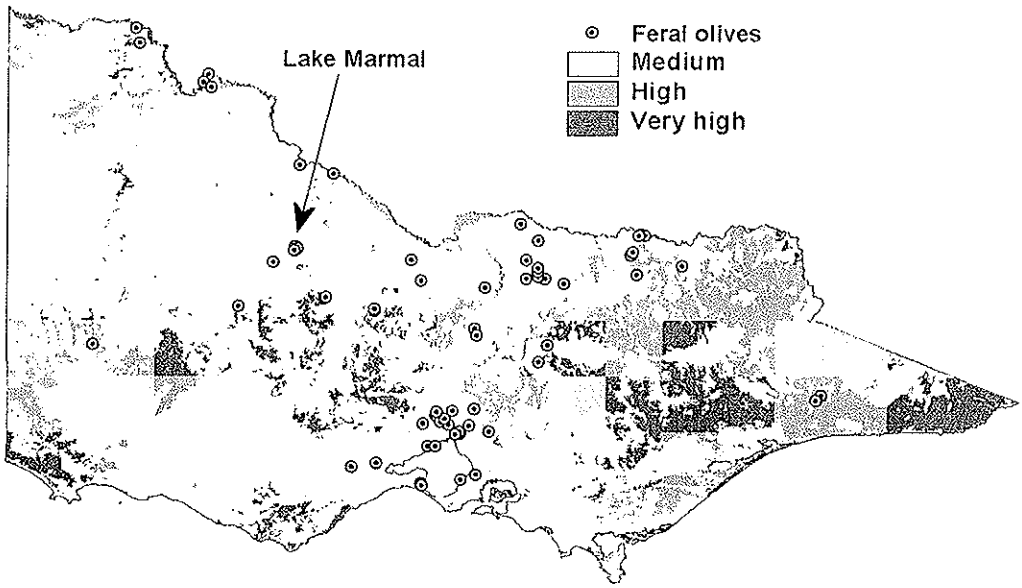

Figure 2. Climatic and vegetative suitability of *Olea europaea* L. in Victoria from CLIMATE modelling of Mediterranean locations overlayed with recorded sites of olive invasion.

Recommendations

The continued development of the Victorian olive industry will have major economic and social benefits for the state, particularly in rural areas. However, from the evidence presented in this paper it can be concluded that olives in Victoria will pose a serious environmental weed risk if they are not properly managed.

1. Victorian government and olive industry must address the issue of feral olives.
2. A stakeholder group must be formed to examine strategies for reducing weed risk.
3. Implementation of an education and awareness campaign.
4. Risk management guidelines must be developed for olive groves.
5. Control of feral olives
6. Establishment of new olives should be prevented in high-risk areas.
7. An effective grove registrar must be established.

Victorian government and olive industry involvement

The conflict of interest between the potential economic and cultural benefits of olives versus the potential negative environmental externalities, suggests that the Victorian

government and olive industry must address the issue of feral olives. If the government was not to address the issue of feral olives they would be disregarding their own visions of "sustainable development" and "protecting the environment for future generations" (DPC 2001). Addressing the issue of feral olives may provide a precedent and lessons for resolving future weedy conflicts of interest.

Victoria is currently well behind other Australian states in tackling the issue of feral olives despite the olive industry developing significantly in recent years. The olive industry in South Australia and to a lesser extent Tasmania, have set a precedent in the control of feral olives. Their strategies such as an education campaign, industry code of practice and grove database would be relatively easy to implement in Victoria.

Formation of stakeholder group

The way forward is for the Victorian government and industry to form a stakeholder group to examine the options for reducing the weed risk of olives. It must widely incorporate all stakeholders in the olive industry including ornamental growers, as their involvement and ownership in of the process is likely to increase their cooperation with strategies developed from the group.

Education and awareness campaign

An education and awareness campaign must be implemented. At present, cultivated and even feral olives tend to be perceived as good plants. Many small growers are likely to be unaware of the weed threat of olives. Although such an education program may only have limited success in reducing the risk of olives spreading in the short to medium term, the increased awareness of the issue would over a longer-term, increase the acceptance and success of other initiatives such as a code of practice. Lessons on involving the industry and public could be learnt from the South Australian and Tasmanian education campaigns for feral olives or more general campaigns such as Weedbusters.

Risk management guidelines

Guidelines for olive growers on reducing the risk and harm caused by dispersal of olives must be developed. The actual form of such guidelines should be decided by the stakeholder group but could be a Code of Practice or incorporated into Environmental Management Systems for the olive industry. Experience from other states has shown a poor level of cooperation with voluntary measures. Stronger incentives and promotion are needed for such guidelines to be adopted by growers.

Control of feral olives

The long non-reproductive period of juvenile feral trees presents a good opportunity to control these trees before they disperse seed. Controlling existing feral trees must be given a much greater priority than they are presently as it these feral trees that produce smaller seed which pose a much greater risk of dispersal than cultivated fruits. Feral olives could be controlled regionally or locally, however as olives appear to pose a weed risk throughout the state, a statewide approach should be adopted.. Although the current Victorian noxious

weed legislation doesn't currently have the capacity to differentiate between commercial and feral plants, as the South Australian legislation does, it is recommended that unharvested or feral olives should be declared a noxious weed, requiring control and a legally enforceable requirement to control or remove unharvested groves..

Olives in high-risk areas.

The single most effective method to prevent invasion of feral olives into ecologically sensitive areas is by not allowing high-risk groves to be established near those areas. This could be done in Victoria, as it has been in South Australia by developing a Weed Risk Assessment for new olive groves. Such a Weed Risk Assessment would need to assess the likelihood of dispersal and the harm caused by successful dispersal. The South Australian model provides a good example where groves assessed as higher risk are more restricted.

A detailed study of dispersal from commercial groves would benefit both the development of a WRA and code of practice. The study should include historical studies of distances and pattern of dispersal and current studies of dispersal, examining the dispersal characteristics of commercial groves, particularly the relationship between management, drupe size and dispersal. Some of this information may arise from current and planned research activities around the Dookie district by the University of Melbourne (Hamilton pers. comm. 2004).

Grove registration

A complete grove register is particularly important for groves in high-risk areas as it would provide information for implementing monitoring and control programs. The experience from South Australia and Tasmania suggest voluntary grove registers are unlikely to be effective in Victoria, without significant incentives. Victoria should investigate the potential for compulsory registration or compiling a register of existing groves using techniques such as remote sensing or drive by surveys.

A national approach

There have been calls for a national approach to the problem of feral olives (Bass et al. 2004) and a levy to help fund olive removal (ABC News 2003). Initiatives such as an education program led by the Australian Olive Association would have long-term benefits and should be implemented. The Adoption a similar weed management strategy to other states (eg. WRA and COP), would be beneficial in presenting a united effort to tackle the issue.

Conclusion

Victoria is well suited to grow olives as is demonstrated by the increase in the number of orchards being established. This suitability also presents a risk to the native vegetation as olives have proven to be a major invasive species in Australia and overseas. It is imperative that both the olive industry and the Victorian government implement strategies to stop or at least minimise off farm dispersal of olives, while allowing for the expansion of this industry.

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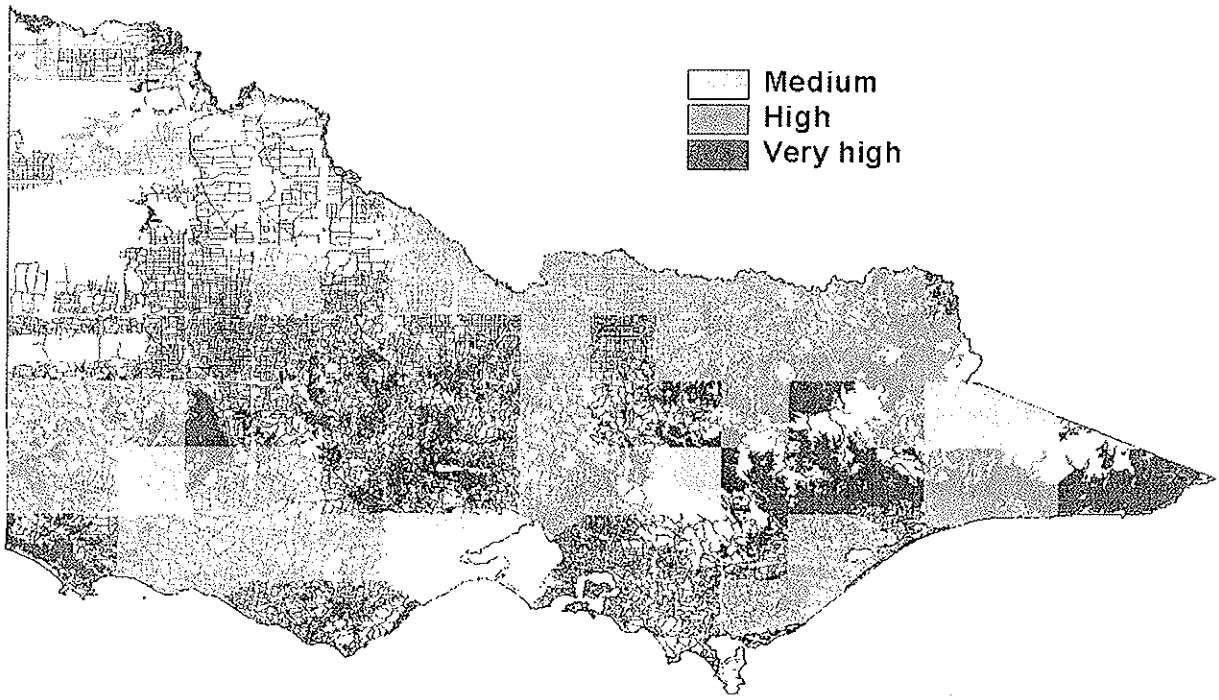


Risk areas in Victoria: CLIMATE, Vegetation + Roadsides

WEED MANAGEMENT SOCIETY OF SOUTH AUSTRALIA INC.

WMSSA
WEED MANAGEMENT SOCIETY OF SOUTH AUSTRALIA INC.

Position statement on management of feral olives in South Australia

The Weed Management Society of South Australia Inc. seeks actions to minimise the weed risk to the South Australian environment of an expanding olive industry.

Background:

- The WMSSA Inc. convened a forum in April 2001 to examine the conflict of interest between a developing olive industry in South Australia and the increasing problem of feral olives invading bushland.
- Much of the current distribution of feral olives in South Australia is sourced from orchards abandoned during the late 1800s/ early 1900s after low prices made harvesting uneconomic. Feral olives infestations occur in all agricultural regions of South Australia.
- Feral olives have been found to be the cause of major reductions in biodiversity with a loss of greater than 50% in the species richness and abundance of native vegetation having been measured in the Adelaide hills.
- Control of feral olives is difficult and expensive. Costs of **up to $10-15,000/ha** can be incurred for labour and equipment costs of chainsawing, herbicide treatment and follow-up measures. Such costs are being borne by Councils, the National Parks & Wildlife Service, Friends/Bushcare groups, Catchment Management Boards and private landholders.
- The olive industry is undergoing a significant expansion in South Australia, with considerable small and large-scale enterprises being established in many regions.
- There are concerns over the long-term economic viability of small and/or isolated orchards, particularly with respect to cheap imported oil. Primary Industries and Resources South Australia (PIRSA) is able to provide information on the economic viability of new olive orchards.
- The Animal and Plant Control Commission (APCC) has developed risk assessment and management guidelines for olives, in consultation with the olive industry and conservation groups. A number of Councils have adopted these guidelines to assess the weed risks posed by new orchards, prior to approval or rejection of a development application. However, there has not been a uniform adoption by Councils.
- Feral olive plants are proclaimed under the Animal and Plant Control Act in South Australia. However, according to the Act, landowners are responsible for control on their lands even if the olives originate from another property. Local Animal and Plant Control Boards can elect to declare planted olives feral if they remain unharvested for two years.

Issue:

The Weed Management Society of South Australia Inc. is concerned that new olive orchards, unless appropriately located and managed, will become a source of new infestations in natural areas of conservation significance.

Responsibilities and Actions sought:

Councils (Local Government)

1) Have uniform adoption of the APCC's olive risk assessment and management guidelines by Councils across SA.
2) Use Memorandum of Understanding agreements between Council and the orchard manager to ensure best management practices to minimise olive spread are adhered to.

State government

1) Regularly update economic information for prospective investors in olive production in South Australia.
2) Ensure olive developments are treated as a merit form of development and listed as a category 2 for public notification purposes in Local Government Development Plans. Category 2 is notification of adjoining owners is required. Redefine horticulture under the Development Act (1993) so that olives are treated separately.
3) Develop a legal framework for olive orchards via the Development Act (1993) to ensure best practice guidelines are observed. Land Management agreements should be promoted to Local Government.
4) Produce weed risk maps to define suitable and unsuitable areas for olive production in SA.
5) Consider a cost sharing approach with landholders and the olive industry to eradicate new olive infestations in previously clean areas.

Animal and Plant Control Commission/Boards

1) Review the APCC risk assessment and management guidelines to ensure it meets best practice and has been satisfactorily adopted by local government and the olives industry in SA.
2) Monitor new orchards in high risk areas for regular harvesting and control of feral olives (on the orchard property). Also significant amenity plantings (e.g. windbreaks). Seek control action under the provisions of the APC Act if needed.
3) Ensure community and industry awareness of the biodiversity threats posed by feral olives.
4) Develop regional plans to strategically manage feral olives populations.

Olive Industry

1) Maintain industry awareness of the APCC's risk assessment and management guidelines for new and existing orchards.
2) Foster an industry responsibility to control escapees from orchards, in consultation with adjacent landholders.
3) Ensure that investors are fully informed of the economic viability of small and/or isolated orchards.

Weed Management Society of South Australia Inc.

1) Increase community awareness of the weed risk of unmanaged or inappropriately placed olive orchards.
2) Foster research into the improved management of feral olives and promote the research outcomes to weed managers.
3) Provide support for WMSSA Inc. members seeking to minimise threats posed by olive orchards to significant native vegetation in their local area.

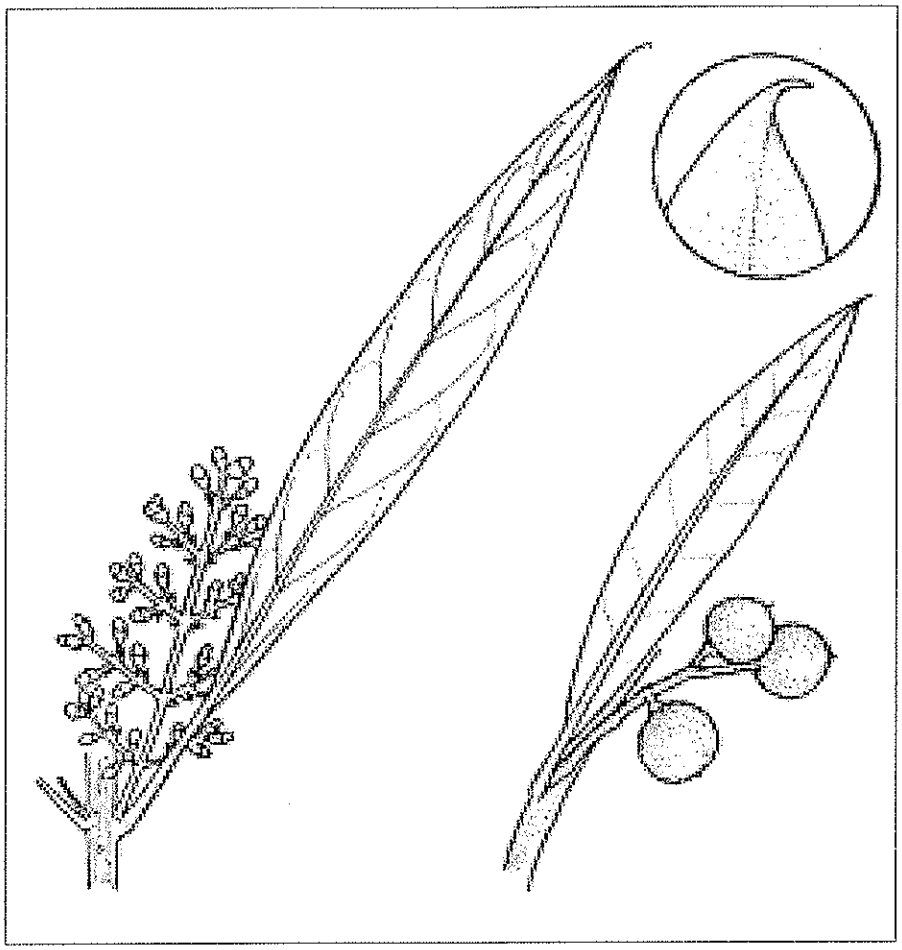


Figure 1. African Olive (*Olea europaea* subsp. *cuspidata*), detail of leaf and fruit. Source: Hardin (2006)*.

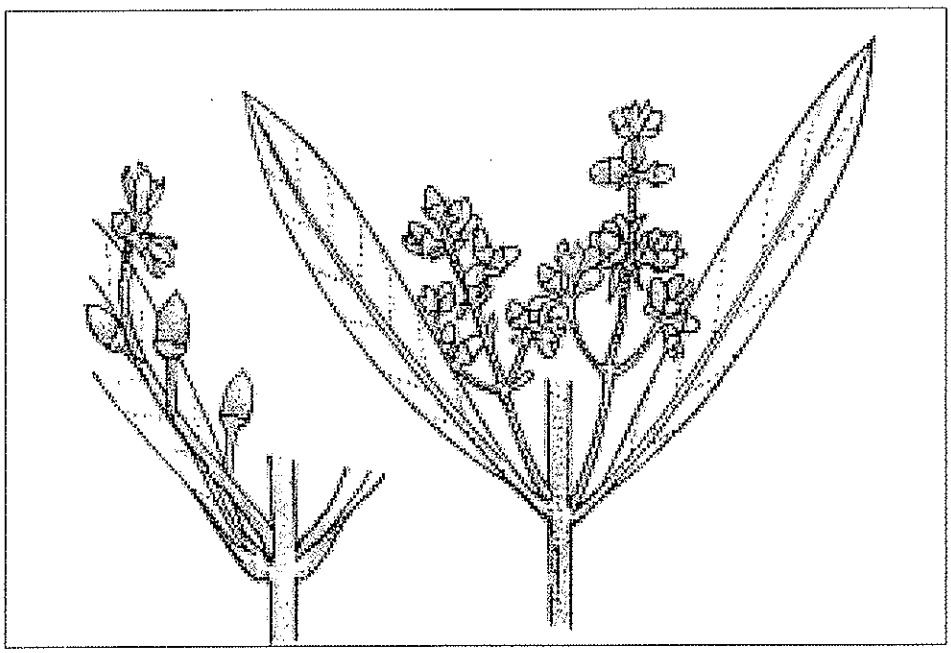


Figure 2. European Olive (*Olea europaea* subsp. *europaea*), detail of leaf and buds. Source: Hardin (2006)*.

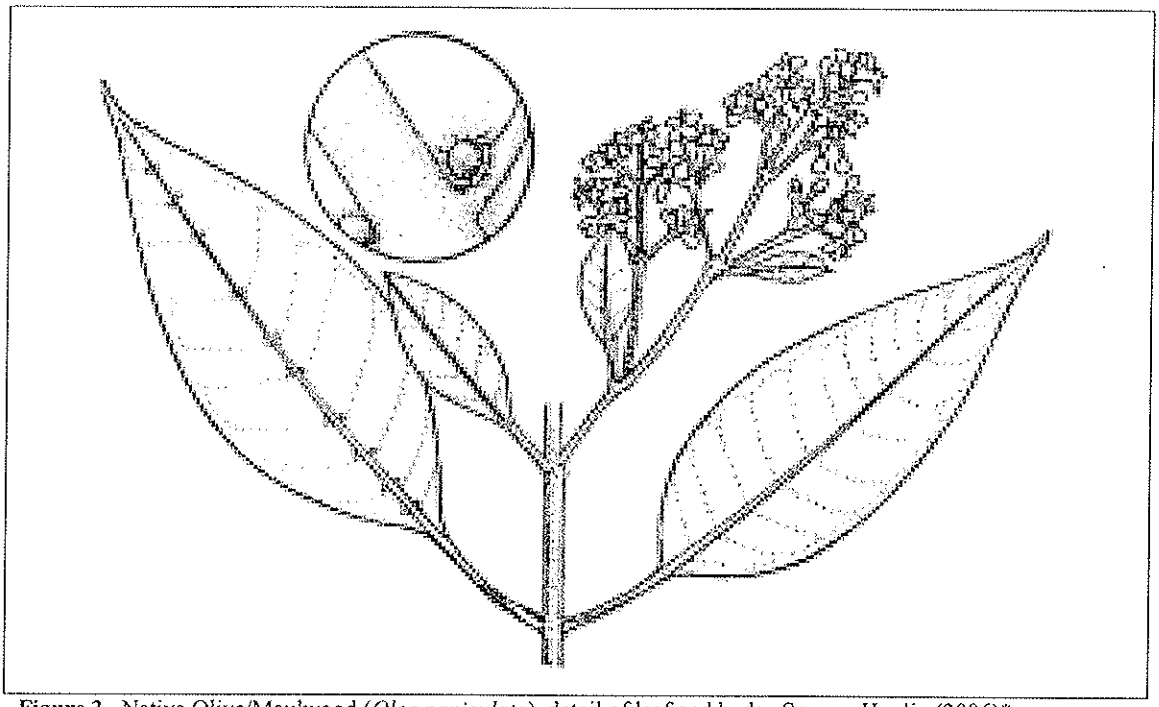


Figure 3. Native Olive/Maulwood (*Olea paniculata*), detail of leaf and buds. Source: Hardin (2006)*.

*Hardin, D. W. (2006). *Olea europaea*. *In* PlantNET, the Plant Information Network System of Botanic Gardens Trust, Sydney, Australia. http://plantnet.rbgsyd.nsw.gov.au/search/simple.htm Access date 26 July 2006.

Unsure of what olive you have got?

Olive (*Olea europaea*) has two subspecies. These are African Olive (*Olea europaea* subsp. *cuspidata*) and European Olive (*Olea europaea* subsp. *europaea*). The existing commercial varieties of European olive are a good example of the variation that can exist within a subspecies.

A good way to ensure that accurate identification of any feral olives occurs is to submit the plant for identification to the Botanical Information Service (address below). NSW DPI personnel may be able to submit the plant on your behalf.

The part of the plant chosen should include flowers and/or fruit and a piece of the stem that has typical leaves on it. If variation exists, for example adult and juvenile leaves then samples of both should be taken. It is important to record other information including precise locality, collectors name, date, notes on the plant habit, colour of fruit and leaves (especially the underside when fresh, contact Dr Stephen Johnson on 02 6391 3146 or stephen.johnson@dpi.nsw.gov.au for comparison pictures). Information on surrounding vegetation, soil type and a plant description is also useful.

Plants should be pressed as soon as possible between sheets of newspaper and thick cardboard in a plant press. The newspaper should be changed daily until the paper is no longer wet.

Botanical Information Service
National Herbarium of NSW
Botanic Gardens Trust
Mrs Macquaries Road, Sydney 2000
Fax 02-9251 1952

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

agnote
ISSN 1034-6848

www.dpi.nsw.gov.au

Collecting and preparing plant specimens for identification

Agnote DPI–492, October 2004
Andrew Storrie
Weeds Agronomist, Tamworth Agricultural Institute

The key to accurate identification of plants is to supply the agronomist or botanist with good quality specimens and sufficient information about the plant, including details of the area from which it was collected and, if possible, supplementary photographs of the plant growing in its habitat.

Supplying inadequate information or poorly preserved and presented specimens often leads to plants not being identified or being misidentified.

A well-prepared specimen of ***Acanthus mollis*** mounted and in a herbarium box. Large specimens can be dissected and mounted to show the main distinguishing characteristics. Many species require basal leaves, stem leaves and flowers for correct identification.

However, prior to collecting specimens, check with local authorities whether specimens may be collected. Collecting specimens from national parks or state forests in NSW requires a permit. Laws vary from state to state.

Always collect several sets of the same specimen so that, following correct identification, you can retain a specimen for later reference. When you send a specimen to a herbarium for identification, it won't be returned. Good quality specimens may be kept for herbaria reference collections.

MATERIALS REQUIRED FOR SUCCESSFUL PLANT COLLECTING:

- A digging implement such as a mattock or spade to ease small plant specimens from the soil, leaving the roots and other underground organs intact. Never just pull the plants from the soil.
- secateurs or a small saw for removing small branches from trees and shrubs
- plastic bags, rubber bands and a portable cooler if the weather is hot, or non-gloss newspaper and a portable plant press
- pencil or permanent marker, jeweller's tags (to record the name and collection number) to tie to individual specimens
- notebook for recording details
- camera for recording plants in-situ and their habitat
- GPS for accurate location of collection site.

COLLECTION DETAILS

Supply enough information about the size and habitat of the plant to help in identification. By completing the Plant identification template you will be providing sufficient detail.

WHAT TO COLLECT

General

Many plants have similar characteristics and it is not possible to identify them from leaves alone. Therefore, it is important to supply representative portions of the plant for correct identification, particularly flowering parts and seedpods.

Identification of perennial species will often require bark or underground parts such as rhizomes or corms to be included.

For plants with separate male and female flowers collect both sets of flowers.

Record flower colour, as this may change when specimens are dried.

Submit multiple specimens of small (immature) plants as leaf shape may vary within a species.

Grasses, sedges and small plants

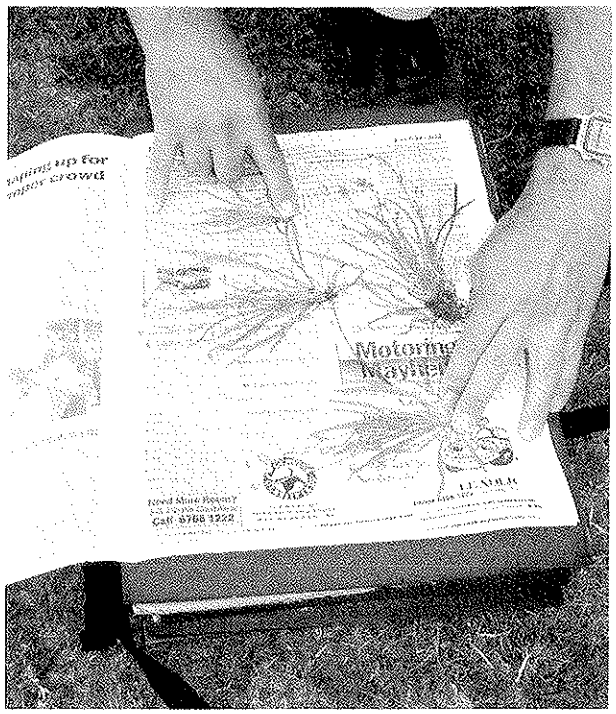
Include roots, basal leaves, flowers and fruits. (Examples of basal leaves are the rosette leaves of brassicas.) Always include, if present, underground parts such as rhizomes, corms, tubers, and bulbs.

Larger plants such as shrubs and trees

For shrubs collect a portion of stem that shows the branching pattern, preferably with flowers and fruits. If flowers and fruits are not present on the same stem collect several samples.

Eucalypts require collection of buds, fruits, juvenile and mature leaves plus a written description of the bark. Juvenile leaves are often on young plants, so keep this material separate.

Record the dimensions of the plant and, for trees, note the trunk diameter at a height of 1.2 metres.



Small plants before pressing. Note how leaves are spread apart to give the correct plant shape.

SPECIMEN PREPARATION

All specimens should be free of soil. Gently wash the roots to remove wet soil. Hard-set soil may need to be soaked off to prevent damage to the roots.

Large plants such as tussock grasses and sedges can be carefully pried apart and a few tillers with seed heads can be kept for identification.

There are two methods of preparation depending on whether the specimens will be identified locally within a few days of collection or have to be either sent away or stored longer term.

Storage for a few days

1. Put plants or plant parts in a plastic bag with a few millilitres of water, with roots toward the bottom of the bag.
2. Have plants tagged with specimen number, date, collector and locality.
3. If the specimen is in sections give each sample the same number.
4. It is preferable to have a written label in the bag as, even if written with a waterproof pen, the writing on the bag will often rub off.
5. Tie off the top of the bag. This will maintain humidity and help keep the specimens fresh.
6. Keep the specimens out of the sun. Most specimens can be kept in a refrigerator for a few days. The main exception would be specimens with large, soft flowers.

Longer-term storage

Use this method when sending specimens for identification or storage in a collection.

1. Place the specimens between several sheets of A3 newspaper or folded broadsheet.
2. Arrange the samples so that leaflets/leaves and flowers can be clearly seen.
3. Larger specimens can be bent into a zigzag to fit the sheet.
4. Multiple samples in newspaper can be laid upon each other. These are then placed between rigid boards with weights such as bricks or books supplying enough pressure to flatten them.
5. Change the newspaper daily for the first few days then weekly until the specimens are dry.

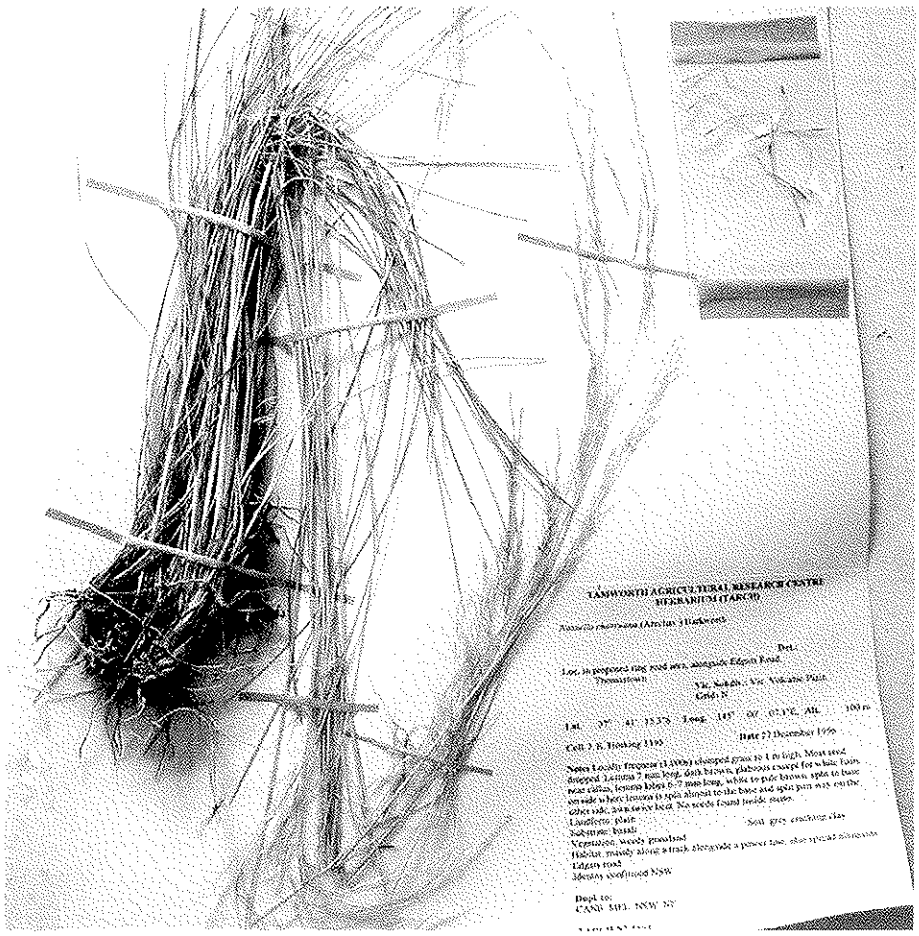
Fleshy or succulent specimens such as cacti may need to be frozen for a few days before pressing. This ruptures the plant cells and aids drying.

Aquatic plants should be gently washed then placed in 70% alcohol. Ethanol is preferred but methylated spirits is the second choice. It is advisable for thin specimens to be placed in alcohol overnight. Bulky specimens need to be placed in the ethanol or methylated spirits for one to two days. Remove from alcohol and place in a well-sealed plastic bag before mailing. Never post aquatic specimens wet or in water.

Keeping track of the correct specimen details during drying is made a lot easier if the specimens are individually tagged.

SENDING SPECIMENS TO THE HERBARIUM

1. Keep the specimens between sheets of newspaper.
2. Insert a sheet with all the collection details, such as the one attached, and place between two pieces of firm cardboard.
3. Attach a covering letter outlining your request for identification.



A mounted, large-grass specimen. Note the bending of the specimen to fit the page. This is done at the start of pressing.

To prevent a loss of the seeds they are placed in a small plastic bag.

For further plant collecting information see:
http://une.edu.au/botany/plant_collecting.htm
http://www.anbg.gov.au/cpbr/herbarium/collecting/index.html

CONTACT DETAILS FOR HERBARIA

National Herbarium of New South Wales
Royal Botanic Gardens
Mrs Macquaries Road
SYDNEY NSW, 2000
Phone: 02 9231 8111
Fax: 02 9251 7231
Email: herbarium@rbgsyd.gov.au
Web: http://www.rbgsyd.nsw.gov.au/conservation_research/herbarium_&_services

Australian National Herbarium
Centre for Plant Biodiversity Research
GPO Box 1600
CANBERRA ACT, 2601
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ACKNOWLEDGEMENTS

New England Herbarium specimen recording book

J Milson, *Plant identification – preparing samples for identification,* DPI note, 2001, Department of Primary Industries, Queensland.

C Rose, *Plant collecting and identification on the farm.*

Thanks go to JJ Dellow and JR Hosking for advice on the manuscript and SWL Jacobs, RBG Herbarium, Sydney for advice on aquatic-specimen preparation.

This press consists of layers of cardboard and foam separating specimens in newspaper. These are then held between two frames with the use of simple tie-down straps.

Photographs by Andrew Storrie

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

5119 10/04

Plant Identification

Name

Postal address

Phone

Date submitted

Specimen or file No.

Submit a separate form, in duplicate, for each specimen.

Send only specimens which have been pressed flat between sheets of newspaper.

Information required (Identification only will be supplied unless otherwise requested).

Collection details: Fill in relevant sections

Collector: **Date Collected:**

Locality (Distance and direction from nearest town):

Latitude: Longitude:

Habitat: Crop (specify)..... Pasture ☐ Roadside ☐ Garden ☐

Native vegetation (specify).....

Occurrence: Growing naturally ☐ Cultivated ☐

Habit: Annual ☐ Perennial ☐

Tree ☐ Shrub ☐ Herb ☐ Vine ☐ Other (specify)

Height *m*

Trunk diam. @ 1.2m (trees) *m*

Area covered *ha*

Abundance: Rare ☐ Occasional ☐
>10 ☐ >100 ☐ >1000 ☐

Flower colour:

Bark colour & texture:

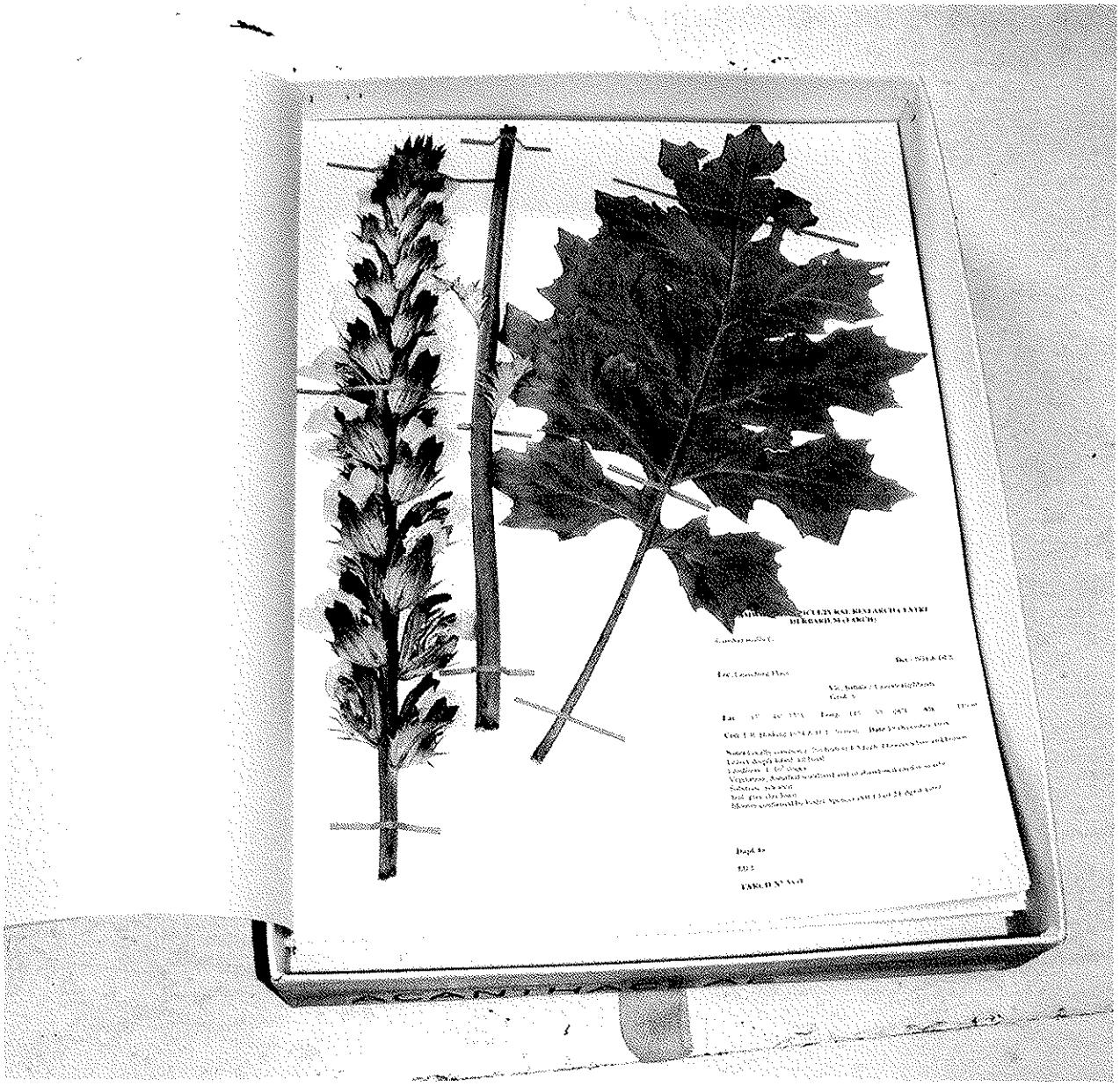
Substrate (rock type):

Soil type:

Remarks:

Herbarium Response—Plant Identification:

Identified by: Date:



SEND COLLECTION SPECIMENS AND COMPLETED FORM TO ONE OF THE HERBARIA LISTED BELOW:

National Herbarium of New South Wales
Royal Botanic Gardens
Mrs Macquaries Road
SYDNEY NSW, 2000
Phone: 02 9231 8111
Fax: 02 9251 7231
Email: herbarium@rbgsyd.gov.au
Web: http://www.rbgsyd.nsw.gov.au/conservation_research/herbarium_&_services

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