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Wattle I plant for wildlife?

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SUMMARY

Wattles (*Acacia* spp) are an important component of most Australian ecosystems and, as a group, are one of the most widely recognised native plants. However, there is surprisingly little recorded about the relationship between wattles and fauna. This paper looks at the ways in which wattles can provide resources for native fauna, brings together published records relating to acacias and fauna in the south-west of Western Australia, and discusses what this means for revegetation.

INTRODUCTION

In the south-west of Western Australia, most vegetation communities contain some wattle (*Acacia*) species. It is generally accepted that in this region there are about 8000 vascular plant taxa, of which some 500 are wattles. In the Wheatbelt the number of taxa is around 3500, of which some 12% (417 taxa) are wattles. Their contribution to the biomass of local ecosystems may be very much higher than may appear from species diversity figures, as they often appear *en masse* in the years immediately following a fire or other disturbance, when the pioneer species grow quickly and dominate the regrowth. After a few years they die off, remaining as seeds in the soil seed bank until another disturbance stirs them into growth once more. Some species, however, are much longer lived.

As an integral part of the vegetation community, wattles provide several ecosystem services, including effects on various stages in the water cycle. The roots of most species host nitrogen-fixing organisms and so contribute usable nitrogen to the soil–they are probably especially important in replacing nitrogen lost to the atmosphere during fire. In the rapid phase of regrowth that occurs after a disturbance, they may act as shelter for slower-growing plants. In addition, they provide resources such as food and shelter for fauna. This paper looks at the relationship between wattles (in both remnant and revegetated areas) and native fauna in the south-west of Western Australia, that is, the developed agricultural area, west of the State Barrier Fence, then discusses this information in the light of current and proposed revegetation practice.

RESOURCES NEEDED BY NATIVE FAUNA

Since a stated aim of much remnant protection and revegetation in the agricultural area is to 'provide fauna habitat', 'create a bush corridor' or just generally to 'maintain biodiversity', it is important to consider what this implies. Animals require resources such as food, water, space and shelter as well as the possibility of meeting an appropriate mate and so reproducing more of their kind. Whether considering the survival of native fauna in general, or of one species in particular, it is necessary to consider food webs, the cycling of nutrients and water, the ability to cope with predators, disease and major changes in the physical environment such as fire and drought, and finally the population size needed for long-term survival (Hussey and Wallace 1993). These needs are, of course, supplied by the entire ecosystem, of which wattles are just a part.

There are surprisingly few published records of fauna using wattles in Australia, and most of what has been written refers to species in eastern Australia or the Mulga zone (see New 1984 for a summary to that date). Details of those south-west Western Australian records that I have been able to locate are given in Table 1. The following sections highlight data for various animal groups.

TABLE 1
Use of *Acacia* species by native fauna in the south-west of Western Australia. Personal communications are indicated by the name of the individual, without date.

Name	Fauna group	Genus, species	Notes	Authority
A. aciphylla	Insecta	bees; *Hyaleus* sp., *Leioproctus*		Houston (2000)
A. acuaria	Bird	Blue-breasted Fairy-wren, *Malurus pulcherrimus*	nest	M Brooker
A. acuminata Jam	Mammal	Dalgyte, *Macrotis lagotis*	eat bardi grubs from roots	Friend (2001)
	Mammal	Grey Kangaroo, *Macropus fuliginosus*	graze foliage,shelter	F Falconer
	Bird	thornbills	use planted corridors	A Baxter
	Gastropoda			Majer *et al.* (2001)
	Arachnida	Arachnida		Majer *et al.* (2001)
	Arachnida	Pseudoscorpiones		Majer *et al.* (2001)
	Arachnida	Acari		Majer *et al.* (2001)
	Malocostrata	Isopoda		Majer *et al.* (2001)
	Diplopoda	Polyxenida		Majer *et al.* (2001)
	Collembola	Arthropleona		Majer *et al.* (2000)
	Collembola	Symphypleona		Majer *et al.* (2000)
	Insecta	Thysanura		Majer *et al.* (2000)
	Insecta	Odonata		Majer *et al.* (2000)
	Insecta	Blattodea		Majer *et al.* (2000)
	Insecta	Mantodea		Majer *et al.* (2000)
	Insecta	Isoptera		Majer *et al.* (2000)
	Insecta	Dermaptera		Majer *et al.* (2000)
	Insecta	Orthoptera		Majer *et al.* (2000)
	Insecta	Phasmatodea		Majer *et al.* (2000)
	Insecta	Psocoptera		Majer *et al.* (2000)
	Insecta	Hemiptera	large numbers	Majer *et al.* (2000)
	Insecta	Thysanoptera		Majer *et al.* (2000)
	Insecta	Neuroptera	adults & larvae	Majer *et al.* (2000)
	Insecta	Coleoptera	adults & larvae	Majer *et al.* (2000)
	Insecta	Mecoptera	adults	Majer *et al.* (2000)
	Insecta	Diptera	adults & larvae	Majer *et al.* (2000)
	Insecta	Trichoptera		Majer *et al.* (2000)
	Insecta	Lepidoptera	adults & larvae	Majer *et al.* (2000)
	Insecta	Hymenoptera	ants	Majer *et al.* (2000)
Majer *et al.* (2001)	Insecta	Hymenoptera	bees, wasps	Majer *et al.* (2000)
	Insecta	bees; *Leioproctus* sp.		Houston (2000)
	Insecta	Bag Shelter Moth, *Ochrogaster lunifer*	defoliates, builds shelters	Tommerup & Bougher (1999)
	Insecta	parasitic fly	eggs seen on head capsule of *Ochrogaster lunifer*	Tommerup & Bougher (1999)
	Insecta	bardi grubs - borer larvae	root/stem borer	Friend (2001)
A. aestivalis Summer Wattle	Mammal	Grey Kangaroo, *Macropus fuliginosus*	graze foliage, shelter	BMJ Hussey
*A. aneura*Mulga	Insecta	ants	harvest seed	V Mischker
	Insecta	ants; *Melophorus* sp., *Pheidole* sp.	harvest seed	Davidson & Morton (1984)
A. aprica	Insects	11 spp	collected on flowers	Prescott (2000)
A. blakelyi	Insecta	bees; *Ctenocolletes* sp.; *Leiproctus* sp		Houston (2000)
A. campylophylla	Bird	Splendid Fairy-wren, *Malurus splendens*	nest	BMJ Hussey
A. celastrifolia Shining Wattle	Bird	Common Bronzewing, *Phaps chalcoptera*,	take seed from ground	BMJ Hussey
	Bird	Port Lincoln Parrot, *Barnardius zonarius*, Red-capped Parrot, *Purpureicephalus spurius*,	take developing seed	BMJ Hussey
	Bird	Silvereye, *Zosterops lateralis*	pollinator?	Brown *et al.* (1997)

TABLE 1 (continued)

Name	Fauna group	Genus, species	Notes	Authority
A. cochlearis	Arachnida	many types		V Mischker
A. cochlocarpa subsp. *cochlocarpa*	Insecta	10 spp		Prescott (2000)
A. colletioides Wait-a-while	Bird	thornbill	nest	H Adamson
A. congesta	Bird	Port Lincoln Parrot, *Barnardius zonarius*	eat seed	BMJ Hussey
	Arachnida	Christmas Spider *Gasteracantha minax*, and other orb-weavers	habitat	BMJ Hussey
A. cyclops Red-eyed Wattle	Mammal	Southern Bush-rat, *Rattus fuscipes*	may eat seed	Gill (1985)
	Mammal	Brush-tail Possum, *Trichosurus vulpecula*	eat seed, digest seed stalk, seeds pass into scats; eats exudate	J Dewing P Mawson
	Mammal	Ring-tailed Possum, *Pseudocheirus peregrinus*	eats phyllodes	P Mawson
	Bird	Pink Cockatoo, *Cacatua leadbeateri*	major seed predator	Gill (1985)
	Bird	Port Lincoln Parrot, *Barnardius zonarius*	eat immature seeds and pods	Powell (1990)
	Bird	silvereye, *Zosterops lateralis*	eat seed stalks, disperse seeds	Gill (1985), Powell (1990)
	Bird	Red Wattlebird, *Acanthochaera carunculata*	eat seed stalks, disperse seeds Powell (1990)	Gill (1985),
	Bird	Grey Currawong, *Strepera versicolor*	eat seed stalks, disperse seeds	Gill (1985)
	Bird	Singing Honeyeater, *Meliphaga virescens*	eat seeds	Gill (1985)
	Bird	Brush Bronzewing, *Phaps elegans*	eat seeds	Gill (1985)
	Bird	Australian Magpie, *Gymnorhina tibicens*	eat seeds	Gill (1985)
	Insecta	ant-longicorn beetle	Larva burrows into twigs, adults on flowerheads	Powell (1990)
	Insecta	ants, *Iridiomyrex* sp.	moved seed + aril	Gill (1985)
	Insecta	ants, *Campanotus* sp.	moved seed + aril	Gill (1985)
	Insecta	ants, *Melophorus* spp (2 spp)	carryed seed + aril or removed aril	Gill (1985)
	Insecta	ants, *Monomorium* sp.	removed arils	Gill (1985)
	Insecta	ants, *Pheidole*, sp	moved seed + aril, or removed arils	Gill (1985)
	Insecta	ants, *Rhytidoponera* (2 spp)	moved seed + aril	Gill (1985)
	Insecta	shield bug, *Coleotichus ?costatus*	eats developing seed	Gill (1985)
	Insecta	Alylidid bug, *Riportus* sp.	eats developing seed	Gill (1985)
	Insecta	Pentatomid bug, *Dictyotus* sp.	red & khaki nymphs eat developing seeds	Gill (1985)
	Insecta	weevil, *Melanterius* spp	larvae eat developing seeds	Gill (1985)
	Insecta	lepidoptera, *Xerometra crocina*	larvae eat developing seeds	Gill (1985)
	Insecta	shield bug, *Adrisa* sp.	eats seed on ground	Gill (1985)
	Insecta	Cosmopterygidae	mines foliage + young pods	New (1984)
	Insecta	Lepidoptera, 26 spp		New (1984)
	Insecta	88 spp		New (1984)
A. dentifera	Bird	Red-capped Parrot, *Purpureicephalus spurius*	eat developing seeds	BMJ Hussey
	Bird	Port Lincoln Parrot, *Barnardius zonarius*	eat seeds	J Seabrook
*A. erinacea*Wattle	Bird	Blue-breasted Fairy-wren, *Malurus pulcherrimus*	nest	M Brooker
A. extensa Wiry Wattle	Mammal	Grey Kangaroo, *Macropus fuliginosus*	selectively graze	BMJ Hussey
	Insecta	ants, 9 spp, incl. *Rhytidoponera inornata* and *Melophorus* sp.	harvest seeds	Majer (1982)
A. fragilis	Insecta	bees; *Lasioglossum* sp.; *Leioproctus* sp.		Houston (2000)
	Bird	Blue-breasted Fairy-wren, *Malurus pulcherrimus*		nest M Brooker
A. hemiteles Tan Wattle	Mammal	Grey Kangaroo, *Macropus fuliginosus*	shelter	F Falconer
	Bird	Crested Pigeon, *Ocyphaps lophotes*	nest	F Falconer
	Bird	Blue-breasted Fairy-wren, *Malurus pulcherrimus*	nest	M Brooker

TABLE 1 (continued)

Name	**Fauna group**	**Genus, species**	**Notes**	**Authority**
A. jacksonioides	Bird	Blue-breasted Fairy-wren, *Malurus pulcherrimus*	nest	M Brooker
A. jutsonii	Bird	Blue-breasted Fairy-wren, *Malurus pulcherrimus*	nest	M Brooker
A. lasiocarpa var *sedifolia* Wandoo Prickly Moses	Arachnida	Christmas Spider, *Gasteracantha minax*, other orb-weavers		BMJ Hussey
A. leptopetala	Insecta	bees; *Hyaleus* sp., *Leioproctus* sp., *Nomia* sp.		Houston (2000)
A. ligulata	Insecta	bees; *Chalicodoma* sp., *Ctenocollete*s sp., *Leioproctus* sp.		Houston (2000)
	Insecta	ants; *Iridomyrmex purpureus*; *Pheidole* sp.	seed dispersal	Davidson & Morton (1984)
	Bird	Singing Honeyeater*, Lichennostomus virescens*; Spiny-cheeked Honeyeater *Acanthegenys rufogularis*	seed dispersal	Davidson & Morton (1984)
A. ligustrina	Insecta	Ants	harvest seeds (red aril)	BMJ. Hussey
A. merinophthora Zigzag Wattle	Bird	Red-capped Parrot, *Purpureicephalus spurius,* (in garden outside plant's natural range)	squeeze developing seed out of pod, eat	BMJ. Hussey
A. microbotyra Manna Wattle	Mammal	Grey Kangaroo, *Macropus fuliginosus*	shelter	F Falconer
	Bird	Major Mitchell Cockatoo, *Cacatua leadbeateri*	eat seeds	F Falconer
A. nyssophylla	Bird	White-winged Fairy-wren, *Malurus leucopterus*	good habitat	A Doley F Falconer
	Bird	Variegated Fairy-wren, *Malurus lambertii*	good habitat	F Falconer
	Bird	White-fronted Chat, *Epthianura albifrons*	good habitat	A Doley
	Insecta	locusts	eat foliage	A Doley
A. oncinophylla Hills Minniritchi	Bird	Red-capped Parrot, *Purpureicephalus spurius*	take unripe seed	BMJ Hussey
A. pulchella Prickly Moses	Mammal	Grey Kangaroo, *Macropus fuliginosus*	graze, eliminate seedling regrowth after fire	Shepherd *et al.* (1997), BMJ Hussey
	Mammal	Black-gloved Wallaby, *Macropus irma*; tammar wallaby, *Macropus eugenii*	graze	Shepherd *et al.* (1997)
	Bird	fairy-wrens, and other small birds	shelter	J Dewing
	Bird	Silvereye, *Zosterops lateralis*	pollinator?	Brown *et al.* (1997)
	Bird	Splendid Fairy-wren, *Malurus splendens*	nest - use both live or, after fire, dead plants	Brooker (2001)
	Insecta	ants, *Rhytidoponera inornata*	harvest seed	Majer (1982)
	Insecta	scarab beetle, *Diphucephala* sp.	pollinator?	Brown *et al.* (1997)
	Insecta	bees, *Hyaleus* sp., *Lasioglossum* sp., *Leioproctus* sp.		Houston (2000)
A. redolens Scented Wattle	Bird	fairy-wren	saline reveg planting, supported nest in fifth year of growth	K Vaux
A. restionaceae	Bird	Red-capped Parrot, *Purpureicephalus spurius*	eat developing seed - removed each individually	BMJ Hussey
A. rostellifera Summer Scented Wattle	Mammal	Tammar, *Macrotis eugenii*	forage beneath thickets	Powell (1990)
	Mammal	Quokka, *Setonix brachyurus*	forage beneath thickets, eat seeds	Powell (1990)
	Insecta	bag shelter moth	defoliate, make bag shelters	Powell (1990)

TABLE 1 (continued)

Name	Fauna group	Genus, species	Notes	Authority
A. saligna Golden Wreath Wattle	Mammal	Brush-tail Possum, *Trichosurus vulpecula*	love eating blossom	Nannup Wildlife Carers
	Mammal	Grey Kangaroo, *Macropus fuliginosus*	shelter	F Falconer BMJ Hussey
	Bird	Brown Honeyeater, *Lichmera indistincta*	pollinator?	Brown *et al*. (1997)
	Bird	Splendid Fairy-wren, *Malurus splendens*; Yellow-rumped Thornbill, *Acanthiza chrysorrhoa*	nest	M Brooker
	Collembola	3 spp		Majer (1978)
	Arachnida	17 spp		Majer (1978)
	Insecta	ants	carry seed into their nests, eat seed stalks, disperse seeds, use phyllode nectaries, may deter other herbivores	Majer (1978) listed 9 spp of ants Powell (1990)
	Insecta	92 spp		Majer (1978)
	insecta	*Castiarina rufipennis*	larvae bore through stem, sever it to exit	Powell (1990)
	Insecta	weevil	cause galls	Powell (1990)
	Insecta	weevil, *Melanterius* sp.	eat developing seeds	New (1983)
	Insecta	weevil, *Diethusa* sp.	eat developing seeds	New (1983)
	Insecta	borers in *Uromycladium* (fungal) galls		New (1984)
	Insecta	Cosmopterygidae, *Labdia* sp.	phyllode miner	New (1984)
	Insecta	Lepidoptera, 36 spp		New (1984)
	Insecta	Coleoptera, Lepidoptera, Hemiptera, 131 spp		New (1984)
A. sessilis	Bird	Splendid Fairy-wren, *Malurus splendens*	nest	M Brooker
A. sp. Dandaragan	Insecta	15 taxa incl: fly, midge, parasitic wasp, brown wasp, honeybee, hoverfly, beetle	collected on flowers; muscid and syrphid flies eat pollen and may be pollinators	Prescott (2000)
	Insecta	caterpillars and other larvae	among florets, but not collected	Prescott (2000)
A. stenoptera, wing-fruited wattle	Mammal	Black-gloved Wallaby, *Macrotis eugenii*	occasionally graze	Wann & Bell (1997)
A. strigosa	Insecta	ant, *Melophorus* sp.	harvests seed, removes elaiosome	Majer (1982)
A. tetragonophylla Kurara	Bird	Singing Honeyeater, *Lichennostomus virescens*; Spiny-cheeked Honeyeater *Acanthegenys rufogularis*	seed dispersal	Davidson & Morton (1984)
	Bird	White-browed Babbler, *Pomatostomus superciliosus*	nest	BMJ Hussey
	Insecta	bees; *Chalicodoma* sp., *Ctenocolletes* sp., *Leioproctus* sp.		Houston (2000)
	Insecta	ant; *Rhytidoponera mayri*; *R. metallica*; *Melophorus* sp.	seed dispersal	Davidson & Morton (1984)
A. ulicina	Insecta	locusts	eat stem, phyllodes	A Doley
A. urophylla	Insecta	ants, *Rhytidoponera inornata*	harvests seed	Majer (1982)
A. victoriae Bardi Bush	Mammal	Dalgyte, *Macrotis lagotis*	eating bardi grubs	Friend (2001)
	Insecta	ants; *Rhytidoponera mayri*; *R. metallica*; *Iridiomyrmex purpureus*	seed dispersal	Davidson & Morton (1984)
	Insecta	bardi grubs	stem/root borers	Friend (2001)
A. xanthina White-stemmed Wattle	Insecta	jewel beetles, *Agrilus australasiae*, *Cisseis* sp., *Melobasis terminata*.	in flowers, taking pollen	Powell (1990)
	Insecta	ants, *Crematogaster* sp.	harvest secretions from phyllode glands	Powell (1990)
	Insecta	native bees	in flowers	Powell (1990)
	Insecta	parasitic wasps	examine foliage for moth larvae	Powell (1990)
	Insecta	long-horned beetle (2 spp)		Powell (1990)

WATTLES AND MAMMALS

Many wattles are palatable and young foliage may be grazed preferentially by marsupials, including Brush-tailed Possums (*Trichosurus vulpecula*). Those known to be grazed by kangaroos include wattles often used in revegetation–*A. acuminata*, *A. aestivalis*, *A. brumalis*, *A. microbotrya* and *A. saligna*, but almost certainly large numbers of others are also taken, especially when young.

Preferential grazing by macropods can alter the composition of a plant community regenerating after fire or other disturbance. This is especially important in a small area. For example, on a small block in the Helena Valley, 93% of *A. pulchella* seedlings that germinated after a regeneration fire in autumn 2000 were removed by Western Grey Kangaroos (*Macrotis lagostis*) during the subsequent very dry summer. A similar effect probably occurs in other vegetation communities. For example, there are far fewer young wattles on Nangeen Hill Nature Reserve where, since 1982, fox control has allowed the Black-flanked Rock Wallaby (*Petrogale penicillata*) to build up to large numbers, in contrast to nearby rock nature reserves where there are no wallabies.

In eastern Australia, there are records of Sugar Glider (*Petaurus breviceps*) deliberately tapping acacias and drinking the sugary sap which is thereby exuded (Smith 1992). *Acacia microbotrya* is known as Manna Gum because of the way it weeps sap, and older settlers record that Brush-tailed Possums were often seen in this shrub. Were they, too, eating the sap? Perhaps, as fox control enables possums to return to their former range, someone will find out.

Wattle seed has not been recorded as a food source for native mammals in the wheatbelt, though native rodents probably utilise it. Gill (1985) hypothesised that *Rattus fuscipes* is an important agent of seed dispersal for *A. cyclops* on the south coast. It is not known whether animals such as Gilbert's Potoroo (*Potorus tridactylus*) and Woylie (*Bettongia penicillata*) which utilise large numbers of soil fungi in their diet, also eat wattle seed. The oily elaiosome of some species might contribute vital nutrients not obtained elsewhere.

Apart from direct consumption of the plant, some mammals may feed on the invertebrates attracted to it. If any wattles are within their range, phascogales and antichinuses probably hunt on them and historical references to the Dalgyte (*Macrotis lagotis*) record that it digs to remove bardie grubs (larvae of longicorn beetles or other borers) from *Acacia* roots (Friend 2001).

In common with other shady shrubs, wattles provide shelter for macropods, and kangaroos frequently make resting scrapes under them. On Garden Island Tammar (*Macropus eugenii*) and on Rottnest Island Quokka (*Setonix brachyurus*) rest during the day under the shade of shrubs such as *A. rostellifera*.

WATTLES AND BIRDS

Wattle flowers do not seem to attract nectar-eating birds, but many insectivores work the plants, taking insects that are attracted to them. A mixed aggregation of thornbills, honeyeaters, silvereyes and wrens will work their way along a hedge, taking small insects from flowers and foliage. Red Wattlebirds (*Anthochaera carunculata*) will take orb-weaving spiders and Pied Butcherbirds (*Cracticus nigrogularis*) the small skinks that prey on the insects.

Many wattles produce a large quantity of nutritious seed and granivorous birds take advantage of this, especially Bronze-wing Pigeons (*Phaps chalcoptera*) and Malleefowl (*Leipoa ocellata*), though the latter has perhaps changed principally to wheat. Many parrots consume the seed, commonly when it is still green. Red-capped Parrots (*Platycercus spurius*) will carefully peck seeds individually from pods of *Acacia celastrifolia*, *A. dentifera* and *A. oncinophylla* and, in a garden, have been observed on *A. merinthophora*, pulling the pods crosswise through their beak, presumably popping the tiny seeds into their mouth. Some seeds may survive ingestion by birds and germinate in their droppings, making this an important method of seed distribution (Gill 1985).

The architecture of a shrub is an important factor in determining which bird will build a nest in it. Some birds, such as fairy-wrens, like dense low bushes, and acacias often are a suitable shape. On Gooseberry Hill, Kalamunda, 31% of nests of Splendid Fairy-wren (*Malurus splendens*) were in *A. pulchella*, including dead bushes (Brooker 2001). At Wyalkatchem, 25% of nests of Blue-breasted Fairy-wren (*Malurus pulcherrimus*) were in wattles, primarily *A. acuaria* and *A. erinacea*, though four other species have been used (M.Brooker, pers. comm.). At Bolgart, Splendid Fairy-wrens nested in *A. campylophylla*, a fiendishly prickly low plant. In salt-land revegetation at Ongerup, fairy-wrens nested in planted *A. redolens* by the fifth year after planting (K.Vaux, pers. comm.).

Taller shrubs are utilised by other birds, but the most popular architecture remains dense growth, a wide, strong branch structure and, really importantly, prickly. One presumes that the prickliness deters predators. In the northern and eastern wheatbelt a widely used plant is Kurara, *Acacia tetragonophylla*. A clear example of this was seen on an excursion to a 140 ha reserve near Perenjori. Fifteen small bird nests (eight of them active) were noted in only one site, a clump of six Kurara bushes. The aptly-named Wait-a-while, *A. colletioides*, native to most of the wheatbelt, is also a favoured nesting site.

Mistletoes growing on wattles are important nesting sites for many species which build in or on top of the mistletoe clump, even if it has died. They provide nesting sites in species of *Acacia* (e.g. Jam, *A. acuminata*) which the plant itself may not provide. Birds using this resource include Yellow-rumped Thornbills (*Acanthiza chrysorrhoa*), Whiteface (*Aphelocephala leucopsis*) and Zebra Finch (*Poephila guttata*) (M.Brooker, pers. comm.).

Further mention of wattles and birds in south-western Australia may be found in journals such as *Emu* and other specialist publications. This literature is huge, however, and is indexed by bird names, not plants or places, hence trawling it for other information would be a project in itself.

WATTLES AND REPTILES

Herbivores such as the Bobtail (*Tiliqua rugosa*) consume seeds and other edible material (Gill 1985) but most reptiles using wattles are insectivores. Bearded Dragons (*Pogona minor*) hunt and bask on logs and vegetation, including wattles. The Fence Skink (*Cryptoblepharus plagiocephalus*) has been observed consuming small insects on *Acacia dentifera* and *A. microbotrya*, and *Menetia greyii* forages in leaf litter, including under acacias. The Spiny-tailed Gecko (*Strophurus spinigerus*) rests during the day in shrubs, including *A. pulchella,* presumably hunting through them at night. This is probably true for many other arboreal reptiles.

WATTLES AND AMPHIBIANS

The Slender Tree Frog (*Littoria adelaidensis*) basks during the day on vegetation which is close to or overhangs a pond or creek, for example on *A. saligna* and *A. alata*. I have not seen any records of amphibians taking prey from wattles.

WATTLES AND INVERTEBRATES

Most investigations of the relationships between acacias and fauna concern invertebrates, principally arthropods.

Any casual observer would note that there are large numbers and many species of invertebrate animals associated with wattles, foraging in and on flowers, foliage and seeds, sucking sap and boring into stems and roots. There is also a wide suite of animals feeding on the herbivores. A summary of the use of acacias by arthropods on a world scale was given by New (1984), but he noted that overall the associations between insects and wattles in Australia have been little studied.

Bernhardt (1983) noted that many Australian acacia species have flowers producing only pollen, thus are not likely to attract honey bees, unless they are males collecting pollen, but Houston (2000) stated that, in Western Australia, Mimosaceae is the sixth most attractive family to native bees. He recorded 18 genera of bees on *Acacia* but many species are not yet identified.

Where specific wattles have been investigated, large numbers and a high diversity of invertebrates have been recorded, for example 130 species from *A. saligna* (Majer 1978), and 25 taxa and a mean of 1268 invertebrates per tree on Jam wattle (Majer *et al.* 2001). Prescott (2000) studied three endangered *Acacia* species in the wheatbelt and recorded 10-15 insect taxa on each.

Many acacias may show very high levels of defoliation, presumably by insects but, though this markedly affects growth and vigour, it does not generally kill the plant. This is noticeable in remnant vegetation, but particularly so in monospecific plantings such as alleys of *A. saligna*, and could have a severe effect on production for stock fodder. As always in revegetation, a mixed stand is likely to promote a more balanced regime.

One insect, the Bag-shelter Moth (*Ochrogaster lunifer*), can completely defoliate large wattles (van Schagen *et al.* 1992). It seems to occur more commonly along road verges than in larger patches of remnant vegetation, and this may be related to a dearth of predators such as insectivorous birds in these linear strips.

Wattle seeds often have structures, called elaiosomes, designed to encourage collection by seed predators, often ants. For example, *Acacia ligustrina* has shiny black seeds enclosed in a bright red cup-shaped structure, and it is easy to watch the procession of ants carrying seeds down the plant and across the ground to their nest. Presumably the ants eat the elaiosome and discard the seed underground, as *A. ligustrina* is one of the species that regenerates after fire in clumps from a subterranean seed store. Majer (1982) discussed this ant-plant inter-relationship in the northern Jarrah forest, finding that nine species of ant consistently collect seed.

Seed predation by insects can be quite high; the author has noted that, on 12 local wattle species in a seed orchard west of York, an average of one in five pods contains larvae, presumably of weevils (New 1983). However, one non-local plant, *A. congesta*, planted to provide seed for revegetation elsewhere, has never been observed to contain larvae. It does get heavily smothered in spider webs–could there be a relationship?

OTHER INTER-RELATIONSHIPS

Wattles are important hosts for semi-parasitic plants such as Sandalwood (*Santalum spicatum*) and Quandong (*Santalum acuminatum*) and their role in supporting mistletoes (*Amyema* and *Lysiana*) has already been mentioned. Mistletoe foliage is heavily grazed by brush-tailed possums, many birds take nectar from the flowers, and others utilise the seeds. The larvae of the wood white butterfly (*Delias aganippe*) feed exclusively on these hemiparasites.

Since wattles usually set good seed crops (at least the seeders do; resprouters, as is often the case with this regeneration strategy, consistently produce fewer seed) they are presumably being pollinated, though the pollinator has not often been identified. Brown *et al.* (1997) noted that very little is known about *Acacia* pollination, and a great deal more work must be done. This comprehensive pollination database for Western Australia lists only 21 records of pollinators on 12 identified *Acacia* species, plus 10 on *Acacia* 'sp.' Of these records, only five refer to the south-west of Western Australia!

WATTLES IN REVEGETATION AND LANDSCAPE RECONSTRUCTION

To survive, all animals require resources such as food, space and shelter. They need to escape predators and survive disease outbreaks and disasters, natural or unnatural. Finally, to reproduce they need a mate. In Australia's fragmented agricultural landscape, the quality, quantity and availability of these resources are vastly different from those in uncleared land, favouring some species of plants and animals but disadvantaging others. Introduced organisms also complicate the picture. The result is that, if we wish to conserve indigenous biodiversity, we need to look beyond a simple strategy of maintaining conservation reserves to redesigning the total landscape for the benefit of both production and conservation. The techniques to do this are known (Hussey and Wallace 1993; Lefroy *et al.* 1993) although reliable commercial options based on perennials have not yet been proven.

Conserving biodiversity in a landscape which needs to be reconstructed is hampered by lack of knowledge of both past and present organisms, especially of invertebrates and the microcomponent of soil flora and fauna. In this respect the work of Inez Tommerup and her associates in CSIRO on fungi in wheatbelt remnants (Tommerup and Boucher 1999), and of Jonathan Majer and his associates at Curtin University on insects in paddock trees and in revegetation (Majer *et al.* 2000; Majer *et al.* 2001) are filling in some obvious gaps, but there are still many interactions about which little is known.

Reconstruction ecology therefore looks at groups of species that perform similar functions and can, in a changing environment, take over from each other to carry out critical ecosystem functions. Main (1992) called this 'functional substitutability' and listed four important functions that should be maintained. They are: to fix carbon and nitrogen; to provide an architectural structure or habitat; to interact with other species so that one or several do not dominate the use of resources; and to recycle the resources so that the net loss from the system is minimised. Wattles are useful in all these areas.

As an example, consider nitrogen fixation in a wheatbelt woodland. Apart from contributions from lightning and free-living or micro-organisms of the soil crust, a large amount of nitrogen comes via the activity of micro-organisms in the root nodules of certain plants. Acacias have the ability to form nodules, so do plants in the pea family (Fabaceae) and sheoaks (Casuarinaceae). In many Western Australian woodlands a major nitrogen fixer, appearing in huge numbers after a disturbance, is one of the poison peas (*Gastrolobium* spp.). These plants contain sodium monofluoroactetate, better known as 1080. Eating this substance kills stock but, through co-evolution, many native fauna have developed tolerance to it, and seed-eating fauna such as the Bronze-wing Pigeon may rely heavily on plants that contain it. Many farmers deliberately eradicated poison plants from their property, without replacing them with a plant having a similar ability to fix nitrogen. When revegetating, there are several wattles that could be used as substitutes.

Studies of birds in feeding guilds have noted how important the structural diversity of habitat–especially understorey habitat–is for feeding, foraging, perching or shelter to maintain a wide suite of birds (e.g. Recher and Davis 1998). Creating an architectural structure in a reconstructed habitat that will favour a wide diversity of fauna requires a change in the traditional pattern of revegetation. Currently, for reasons of speed and economy, most revegetation projects use seedlings planted mechanically. This generates a series of rows of trees, or trees and large shrubs, with paddock grasses or weeds as a ground layer. This does not accurately mimic the previous diversity of habitat sufficiently to provide resources for a diverse suite of fauna. Lower shrubs (especially prickly ones) and a more natural ground layer are also required.

Almost all revegetation projects now incorporate at least one large wattle, usually *A. saligna* or *A. acuminata*. Landholders like them because they grow fast and so show that something is happening, as well as providing stock shelter or emergency stock feed. These plants have an average life expectancy in a wheatbelt situation of about 15 years, after which they tend to collapse. Their seeds remain in the soil seed bank, however, until the next fire or other disturbance, and their seeds are large enough to cope with the heavy weed infestations likely to occur on such sites.

Smaller wattles are a different matter. Revegetators are often reluctant to replant these species, precisely because they are small, and so do not provide an immediate buzz of satisfaction at having done something. They are also perceived to be short-lived and so a waste of scarce time and financial resources. Considerably more public information and extension must be done to counteract these perceptions, and explain the plants' role in overall ecology. Direct seeding can reintroduce this structural diversity, even onto difficult sites.

Take the example of the wandoo (*E. wandoo*) woodland studied by Recher and Davis (1998). This study was undertaken in a conservation reserve, but there are many similar woodland remnants in farmland, where a long history of grazing has removed all or most of the native understorey which these authors found to be so important for bird diversity. But wandoo woodland is not easy to revegetate, as the tree is strongly competitive for resources and even allelopathic. Several wattles grow well in this situation, however, and one, *A. lasiocarpa* var. *sedifolia*, the Wandoo Prickly Moses, is easy to collect seed from; direct seeds well, growing even directly under the crown of mature Wandoo; and is relatively long-lived, persisting in such a revegetated site at York for 15 years so far.

The study of birds in road verges undertaken by Newbey (2000) shows that, in linear strips, a good structural diversity and a wide variety of species–whether remnant or revegetated–are factors that make them more likely to be utilised by birds. Over the last 20 or so years, Main Roads Western Australia has demonstrated that, if fauna needs are considered at the time of planting, excellent long-term fauna habitat can be created. Many individual landholders have also demonstrated this but the fact remains that it is necessary to plan for fauna needs at the time of undertaking the project. If the revegetation consists principally of commercial species, then a landholder can incorporate the needs of fauna by creating habitat islands among the commercial plantation (Hussey 1998). The use of land to create these habitat islands should not be considered as a financial loss, but as a long-term investment leading to long-term gains. These gains, in water-table management, erosion control, shelter and, most especially, pest insect control, should not be ignored just because they are difficult to quantify (Smart 1997).

In the south-west of Western Australia, most plant communities are extremely diverse (and, on the evidence of the few detailed studies yet completed, so are the invertebrate communities that depend upon them) and the diversity can vary widely over relatively short distances. This means that, for every revegetation site a suite of wattles may be selected to fill habitat criteria for each different soil and topographic position. As an example, consider revegetation of a 2.5 ha property in the Helena Valley. Seven wattles occur naturally on this site, of which four are prolific seeders, easy to collect and easy to grow, which between them produce the structural elements of habitat for all the soil types on the property (Table 2). The larger the property and the more diverse the landscape, the wider will be the choice of wattles to include in the revegetation mix.

It is therefore suggested that all revegetation projects in the south-west of Western Australia include a minimum of five species of *Acacia* for each soil type or topographic position. They should be selected to cover as wide as possible a range of size, architecture and prickliness. Larger species could be introduced as seedlings, but in every project at least some areas should be direct-seeded with low or medium shrubs and ground covers, some of which will be wattles.

SUMMARY

It is clear that wattles provide resources for numerous animals throughout the south-west of Western Australia, and that they are a vital component of natural ecosystems. It is equally clear that that a great deal more research into the inter-relationships between wattles and fauna needs to be undertaken before we can clearly delineate the role of wattles in ecosystem functioning. Nevertheless, it can be seen that wattles can and should be included in multi-purpose revegetation projects throughout the agricultural area, to provide a multitude of benefits to both production and conservation.

Wattle I plant? Wattlever I can!

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TABLE 2
Species of *Acacia* native to a 2.5 ha property in Helena Valley, Western Australia.

A. alata	Medium upright shrub, seeder, alluvial soil or on water-gaining site among granite rocks, grows in dense shade, short-lived, regenerates by seed after fire, relatively soft ‘foliage’ heavily attacked by invertebrate herbivores
A. dentifera	Large shrub, regenerates by seed after fire, grows on clay derived from dolerite dykes or on alluvium, can tolerate shade, huge seed crop important for seed-eating birds and ants
A. ericifolia	Small shrub, under wandoo, lignotuberous resprouter after fire, flowers seldom and seeds never recorded on this property
A. oncinophylla	Medium to large shrub, grows among granite rocks, lignotuberous resprouter after fire, flowers sparsely, few fruit produced and these are heavily predated by red-capped parrots, no mature seed recorded on this property
A. pulchella	Small to medium shrub, prickly, grows on all rocky areas, short-lived, regenerates from seed after fire, seed crop used by fauna
A. saligna	Very large shrub, grows on alluvium and among granite, regenerates from seed after fire, short-lived, seed crop important for seed-eating birds
A. willdenowiana	Very small shrub, grows under wandoo, short lived, regenerates from seed after fire

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