Gnangara Sustainability Strategy

An across-government initiative

Groundwater – Biodiversity – Land use

TIME TO FLOWERING EXAMINED ACROSS A FIRE CHRONOSEQUENCE

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Report for the Gnangara Sustainability Strategy and the Department of Environment and Conservation

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Front cover photos (clockwise from top right): *Eremaea pauciflora* (photo credit: Janine Kuehs), *Banksia menzesii*, *Lysinema ciliatum* (photo credit: Marnie Swinburn).

Introduction

Australian plants have many adaptive vegetative and reproductive traits that enable them to persist in fire-prone environments (Gill 1981). However if intervals between fires are shorter than the time to first flowering (juvenile period) for plants killed by fire and those that are reliant on plant or soil stored seed, then too frequent fires can result in species declines (Burrows 2008). Vital attributes such as regeneration requirements, post-fire regeneration strategies, juvenile periods and the longevity of longer-lived woody species that mostly reproduce after fire are useful criteria to determine minimum and maximum intervals between lethal fires for a particular ecosystem (Burrows 2008).

As part of the Gnangara Sustainability Strategy (GSS), modifying the current burn regime by increasing the frequency of burning native vegetation on Crown land above the Gnangara groundwater system has been suggested as a cost effective technique that may increase groundwater recharge (Canci 2005; Yesertener 2007). CSIRO is undertaking an adaptive management project from 2008-2010 to examine the hypothesis that burning increases groundwater recharge. However, prior to the potential application of increased burn frequency as a management option, the biodiversity consequences of burning must be understood and the water yield and biodiversity balance quantified. DEC undertook complementary projects to assess the impacts of burning on the biodiversity of *Banksia* woodland, in particular the effect of grazing on plant juvenile periods following a prescribed burn (Mickle *et al.* 2010) and the first time to flowering across a fire chronosequence (this report).

The flowering age or 'primary juvenile period' (time to flowering after germination) of some common plant species found in the Gnangara Sustainability Strategy study area were assessed by Muir {, 1987 #1721}. Additionally, the Vegetation Species List and Response Database (DEC 2008) provides a valuable resource providing information on, amongst other things, flowering times, juvenile periods and post-fire regeneration strategies of plants through many parts of their distribution in the south west of Western Australia. However this information predominantly relates to plant populations occurring outside of the Swan Coastal Plain.

Results

Juvenile Period

152 plant species were observed within four replicate plots across nine fire ages (n=36; see Appendix 2). Based on a species' presence in consecutive fire ages starting from 12 months post-fire until juvenile period was attained, only 33 species provided enough information to estimate juvenile period, and only 15 of these species were present in all fire ages (Table 2). Nineteen plant species reached their juvenile period in the first 12 months following fire increasing to 30 species by 45 months post fire. 60 species were found to reach juvenile period within five years (60 months) of fire although the exact timing could not be pinpointed for all species (Table 2). Of the 60 plants attaining juvenile period within 60 months, 35% regenerated following fire by plant or soil-stored seed, and 65% by sprouting from underground structures or apical or epicormic growth.

Table 3: Juvenile period (months) of 62 plant species within *Banksia* woodland of the GSS study area and the number of fire ages in which they were present (maximum of 9). The maximum juvenile period is indicated by <45 months, for example. All juvenile periods were attained within 5 YSLF (60 months) except those indicated with #. * indicates targeted species; 'A' indicates alien species.

	Family	Species	Estimated Juvenile Period (months)	# Fire Ages
	Haemodoraceae	*Anigozanthos humilis*	12	9
	Papilionaceae	*Bossiaea eriocarpa*	12	9
	Colchicaceae	*Burchardia congesta*	12	9
	Centrolepidaceae	*Centrolepis drummondiana*	12	3
	Proteaceae	*Conospermum stoechadis* subsp. *stoechadis*	12	5
	Epacridaceae	*Conostephium pendulum*	12	8
	Crassulaceae	*Crassula colorata*	12	3
	Goodeniaceae	*Dampiera linearis*	12	5
	Droseraceae	*Drosera menziesii*	12	9
	Dilleniaceae	*Hibbertia huegelii*	12	2
	Dilleniaceae	*Hibbertia hypericoides*	12	4
A	Cyperaceae	*Isolepis marginata*	12	6
	Iridaceae	*Patersonia occidentalis*	12	9
	Rutaceae	*Philotheca spicata*	12	8
	Loganiaceae	*Phyllangium paradoxum*	12	9
	Thymelaeaceae	*Pimelea sulphurea*	12	2
	Asteraceae	*Podotheca gnaphalioides*	12	4
*	Proteaceae	*Stirlingia latifolia*	12	9
	Apiaceae	*Trachymene pilosa*	12	8
	Poaceae	*Amphipogon turbinatus*	24	5
	Myrtaceae	*Calytrix flavescens*	24	9

	Family	Species	Estimated Juvenile Period (months)	# Fire Ages
	Droseraceae	*Drosera pallida*	24	2
*	Myrtaceae	*Eremaea pauciflora*	24	3
	Haemodoraceae	*Haemodorum spicatum*	24	5
	Dilleniaceae	*Hibbertia subvaginata*	24	9
	Restionaceae	*Lyginia barbata*	24	9
*	Myrtaceae	*Melaleuca trichophylla*	24	9
*	Proteaceae	*Petrophile linearis*	24	9
	Cyperaceae	*Schoenus caespititius*	24	8
	Apiaceae	*Xanthosia huegelii*	24	9
	Cyperaceae	*Schoenus curvifolius*	48	8
	Poaceae	*Austrostipa compressa*	<24	5
	Rutaceae	*Boronia ramosa*	<24	4
	Haloragaceae	*Gonocarpus pithyroides*	<24	4
	Asparagaceae	*Laxmannia squarrosa*	<24	5
	Stylidiaceae	*Stylidium diuroides*	<24	7
	Stylidiaceae	*Stylidium rigidulum*	<24	5
	Mimosaceae	*Acacia pulchella*	<45	7
	Epacridaceae	*Andersonia lehmanniana*	<45	4
	Myrtaceae	*Beaufortia elegans*	<45	7
	Rutaceae	*Boronia purdieana*	<45	8
	Epacridaceae	*Conostephium minus*	<45	6
	Haemodoraceae	*Conostylis juncea*	<45	8
	Dasypogonaceae	*Dasypogon bromeliifolius*	<45	3
	Restionaceae	*Desmocladus flexuosus*	<45	7
*	Myrtaceae	*Eremaea beaufortioides*	<45	6
	Papilionaceae	*Gastrolobium capitatum*	<45	7
	Papilionaceae	*Gompholobium tomentosum*	<45	6
	Epacridaceae	*Leucopogon conostephioides*	<45	6
	Epacridaceae	*Leucopogon squarrosus*	<45	6
	Asparagaceae	*Lomandra caespitosa*	<45	2
	Haemodoraceae	*Phlebocarya ciliata*	<45	6
	Asteraceae	*Podotheca chrysantha*	<45	6
	Stylidiaceae	*Stylidium araeophyllum*	<45	5
	Stylidiaceae	*Stylidium crossocephalum*	<45	7
	Orchidaceae	*Caladenia flava*	<48	7
	Epacridaceae	*Lysinema ciliata*	<48	6
	Stylidiaceae	*Stylidium bicolor*	<48	2
	Myrtaceae	*Calytrix sapphirina*	<60	3
	Orchidaceae	*Elythranthera brunonis*	<60	5
*	Proteaceae	*Banksia menziesii*	90#	9
*	Proteaceae	*Banksia attenuata*	90#	9

Only two species provided enough data to confirm their juvenile period was attained more than 5 years following fire. These include the target species *Banksia attenuata* and *Banksia menziesii* with juvenile periods of approximately 90 months (8 and 7 YSLF, respectively). Juvenile periods were able to be determined from only seven of the initial 26 targeted species including the two *Banksia* species, *Stirlingia latifolia, Eremaea pauciflora, E. beaufortioides, Melaleuca trichophylla* and *Petrophile linearis*. The flowering pattern of

Appendix 2. Regeneration strategies and matrix of post-fire juvenile periods and for plant species identified in fire chronosequence plots, northern Swan Coastal Plain

Number of replicates in each fire age of one to nine YSLF where juvenile periods were reached (maximum number of replicates is four). '0' indicates species presence in a fire age which had had not yet reached juvenile period in any replicate, while a blank cell indicates a species was not observed in that fire age. Post-fire regeneration strategy definitions are based on Burrows *et al.* (2008, see Table 2). Regeneration strategies were identified primarily from GSS study area by Mickle et al. (2010) and this study, supplemented by the Vegetation Response Database (DEC 2008) records (indicated by question marks, ?). * indicates the 26 targeted species and 'A' indicates alien species.

	Family	Species	Regeneration Strategy	1	2	3	4	5	6	7	8	9
	Molluginaceae	? Macarthuria sp				1	1		3			
	Mimosaceae	Acacia heugelii	5				0		0			
	Mimosaceae	Acacia pulchella	2	0	0	3	2	3	3	2		
	Mimosaceae	Acacia sessilis	?2							3		
	Mimosaceae	Acacia stenoptera	5			0			0	1		
	Proteaceae	Adenanthos cygnorum	2		0	0	0	0	0	0		3
A	Poaceae	Aira sp	2								1	
	Restionaceae	Alexgeorgea nitens	4		0	0	0	1	0		0	0
	Casuarinaceae	Allocasuarina humilis	5						0	1		
	Poaceae	Amphipogon turbinatus	4	1	3	1	1					0
	Epacridaceae	Andersonia heterophylla	5			1	1				2	1
	Epacridaceae	Andersonia lehmanniana	?2			2	1	2				2
	Haemodoraceae	Anigozanthos humilis	4	4	1	2	0	1	1	0	1	1
	Myrtaceae	Astartea ? scoparia	?2							1	0	
	Poaceae	Austrodanthonia occidentalis	2							1		
	Poaceae	Austrostipa compressa	2		3	1			3	2	3	
*	Proteaceae	Banksia attenuata	9	0	0	0	0	1	0	1	2	4
*	Proteaceae	Banksia dallanneyi	9							1		
*	Proteaceae	Banksia ilicifolia	5	0	0	0		0	0	0	0	
*	Proteaceae	Banksia littoralis	5		0							
*	Proteaceae	Banksia menziesii	9	0	0	0	0	0	0	2	1	3
*	Proteaceae	Banksia prionotes	1									
*	Proteaceae	Banksia sessilis	1									
	Myrtaceae	Beaufortia elegans	2		0	3	3	3	3		3	4
	Rutaceae	Boronia purdieana	2		1	2	3	4	2	1	3	2
	Rutaceae	Boronia ramosa	2		3			3	4			1
	Papilionaceae	Bossiaea eriocarpa	9	4	3	4	3	3	2	3	3	4
	Colchicaceae	Burchardia congesta	4	4	1	2	3	3	2	0	2	3
	Orchidaceae	Caladenia flava	4		0	0	2		1	1	0	1
	Dasypogonaceae	Calectasia narragara	5							2		
*	Myrtaceae	Calothamnus quadrifidus	5									
*	Myrtaceae	Calothamnus sanguineus	5	0						1		
	Myrtaceae	Calytrix flavescens	9	0	3	0	0	1	0	0	0	0

	Family	Species	Regeneration Strategy	1	2	3	4	5	6	7	8	9
	Myrtaceae	Calytrix sapphirina	5				0	2				4
	Lauraceae	Cassytha sp	2								1	
	Centrolepidaceae	Centrolepis drummondiana	2	4					1		1	
	Centrolepidaceae	Centrolepis inconspicus	2			1						
	Restionaceae	Chordifex microcodon	4							1		
	Proteaceae	Conospermum ? canaliculatum	5							2		
	Proteaceae	Conospermum acerosum sub sp acerosum	5	1								
	Proteaceae	Conospermum incurvum	5	1	1							
	Proteaceae	Conospermum stoechadis subsp. stoechadis	5	3		1			1	1	1	
	Epacridaceae	Conostephium minus	?5			2	1	1	1		2	2
	Epacridaceae	Conostephium pendulum	5	2		4	3	4	0	4	2	4
	Haemodoraceae	Conostylis aculeata	4							2		
	Haemodoraceae	Conostylis juncea	4		1	3	2	1	1	1	2	2
	Haemodoraceae	Conostylis setigera	4	0						3		
	Crassulaceae	Crassula colorata	2	3		3		1				
	Crassulaceae	Crassula decumbens	2			1						
	Cyperaceae	Cyathochaeta teretifolia	4		1							
	Goodeniaceae	Dampiera linearis	5	2		3	3	1			1	
	Dasypogonaceae	Dasypogon bromeliifolius	4			2				1	0	
	Papilionaceae	Daviesia divaricata	2							1		
	Papilionaceae	Daviesia podophylla	5	0	0							
	Restionaceae	Desmocladus flexuosus	4			3	3	3	0	1	0	3
	Droseraceae	Drosera erythrorhiza	4	0	0	0	0	0	0	0	0	0
	Droseraceae	Drosera menziesii	4	3	3	4	4	1	0	0	2	4
	Droseraceae	*Drosera pallida*	4	0	2							
	Droseraceae	Drosera parvula	4		0	1	0	0		0	0	0
	Orchidaceae	Elythranthera brunonis	4		1	1	1	2		2		
	Myrtaceae	Eremaea asterocarpa	5							1		
*	Myrtaceae	Eremaea beaufortioides	5			4	4	4	3	2		4
*	Myrtaceae	Eremaea pauciflora	5	0	3						3	
	Myrtaceae	Eucalyptus rudis	5							1	0	
	Myrtaceae	Eucalyptus todtiana	9							0		
	Papilionaceae	Gastrolobium capitatum	?2	0	1	3	1	2		3		1
	Papilionaceae	Gompholobium tomentosum	5			2	1	1	4	4	2	
	Haloragaceae	Gonocarpus pithyroides	5		3	1			0	2		
	Haemodoraceae	Haemodorum divaricatum	4							2		
	Haemodoraceae	Haemodorum spicatum	4	0	2	0			0			0
*	Proteaceae	Hakea costata	1									
*	Proteaceae	Hakea prostrata	5									
*	Proteaceae	Hakea ruscifolia	5	0						0		
*	Proteaceae	Hakea trifurcata	1									
*	Proteaceae	Hakea varia	1									
	Lamiaceae	Hemiandra pungens	5		1							
	Hemerocallidaceae	Hensmania turbinata	5			1	0					1
	Dilleniaceae	Hibbertia aurea	5			1	1	1			1	1
	Dilleniaceae	Hibbertia huegelii	5	4						2		
	Dilleniaceae	Hibbertia hypericoides	5	2	2		1			3		
	Dilleniaceae	Hibbertia sp 8b									1	
	Dilleniaceae	Hibbertia sp Gnangara	5		1					1	3	1
	Dilleniaceae	Hibbertia subvaginata	5	1	2	4	3	4	2	3	4	4
	Papilionaceae	Hovea trisperma	5					0		1		
	Violaceae	Hybanthus floribundus	5							1		
*	Myrtaceae	Hypocalymma angustifolium	5			1			1	1	1	
*	Myrtaceae	Hypocalymma robustum	5									
A	Asteraceae	Hypochaeris glabra	2		1				0	0	0	
A	Cyperaceae	Isolepis marginata	2	4	2	3			2	1	2	
	Papilionaceae	Isotropis cuneifolia	5	0								
	Papilionaceae	Jacksonia floribunda	2	0		0	1	0	0		0	0
	Papilionaceae	Jacksonia furcellata	2						0	0		

	Family	Species	Regeneration Strategy	1	2	3	4	5	6	7	8	9
	Papilionaceae	Jacksonia sternbergiana	8							0		
	Myrtaceae	Kunzea recurva	2								2	
	Asteraceae	Lagenophora huegelii	2							0		
	Asparagaceae	Laxmannia ramosa	2			0						
	Asparagaceae	Laxmannia squarrosa	2		2	2		1	0		1	
	Goodeniaceae	Lechenaultia floribunda	2	0								
	Cyperaceae	Lepidosperma aff scabrum	4			1						
	Santalaceae	Leptomeria empetriformis	?2				0			1		1
*	Myrtaceae	Leptospermum spinescens	5									0
	Epacridaceae	Leucopogon conostephioides	2			3	3	4	4		4	3
	Epacridaceae	Leucopogon insularis	?2						3			
	Epacridaceae	Leucopogon squarrosus	2			4	4	4	2	1		4
	Asparagaceae	Lomandra caespitosa	4	1		2						
	Asparagaceae	Lomandra hermaphrodita	4			0	0	0	0	0	0	0
	Asparagaceae	Lomandra sp					1	1	1			
	Restionaceae	Lyginia barbata	4	0	2	4	4	3	2	3	1	4
	Epacridaceae	Lysinema ciliata	2		0	1	2	2	1			2
	Zamiaceae	Macrozamia fraseri	7						0			
	Myrtaceae	Melaleuca preissii	6						0	0	0	
*	Myrtaceae	Melaleuca trichophylla	5	0	3	3	2	1	2	1	0	3
*	Myrtaceae	Melaleuca viminea	1									
	Cyperaceae	Mesomelaena pseudostygia	9	0				1		3		
	Euphorbiaceae	Monotaxis occidentalis	2		1							
	Euphorbiaceae	Monotaxis occidentalis ?	2		1					1		
	Papilionaceae	Papilionaceae sp	2		1				1		1	
	Orchidaceae	Paracaleana nigrita	4							1		
	Iridaceae	Patersonia occidentalis	9	4	2	4	2	1	0	3	0	0
	Proteaceae	Persoonia comata	9	0	0				0	0		
*	Proteaceae	Petrophile linearis	5	0	2	3	4	2	4	4	1	2
*	Proteaceae	Petrophile macrostachya	9	1						0		
*	Proteaceae	Petrophile serruriae	5									
	Rutaceae	Philotheca spicata	5	3	2	3	3		2	2	2	3
	Haemodoraceae	Phlebocarya ciliata	4			2	1	3	0	2	2	
	Loganiaceae	Phyllangium paradoxum	2	4	2	3	2	3	3	1	2	1
	Thymelaeaceae	Pimelea sulphurea	2	2						1		
	Eliocarpaceae	Platytheca galioides	2								1	
	Asteraceae	Podotheca angustifolia	2	1	1	1						
	Asteraceae	Podotheca chrysantha	2	1	1	2			3	2	3	
	Asteraceae	Podotheca gnaphalioides	2	4	4	1				0		
	Euphorbiaceae	Poranthera ericoides	2				1		1		1	
	Orchidaceae	Pterostylis ? aspera	4						1	1		
	Orchidaceae	Pterostylis aff nana	4									3
	Orchidaceae	Pyrorchis nigricans	4						0			
*	Myrtaceae	Regelia ciliata	5		0					1	0	
	Cyperaceae	Schoenus caespititius	4	1	2	4	4	1	2	1		1
	Cyperaceae	Schoenus curvifolius	4	1	1	1	2	2	1	2		0
	Cyperaceae	Schoenus subfascicularis	4		1							
	Myrtaceae	Scholtzia involucrata	9	0	0	0	0	0	0	0	0	1
*	Proteaceae	Stirlingia latifolia	5	4	3	1	0	0	0	1	0	0
	Stylidiaceae	Stylidium adpressum	2							1		
	Stylidiaceae	Stylidium araeophyllum	4			4	1	4	2	2		
	Stylidiaceae	Stylidium bicolor	4			1	2					
	Stylidiaceae	Stylidium carnosum	4	1								
	Stylidiaceae	Stylidium crossocephalum	?4		1	3	4	2	2	2	0	
	Stylidiaceae	Stylidium diuroides	?4		3	3	3	4	1	3	3	
	Stylidiaceae	Stylidium neurophyllum	?4		1					4		
	Stylidiaceae	Stylidium paliducola	?4					0				
	Stylidiaceae	Stylidium piliferum	?4	0	1	1				2		
	Stylidiaceae	Stylidium repens	?4			0				1		

	Family	Species	Regeneration Strategy	1	2	3	4	5	6	7	8	9
	Stylidiaceae	Stylidium rigidulum	?2		2	1	3	1	1			
	Stylidiaceae	Stylidium scariosum	?4		1							
	Asparagaceae	Thysanotus sp	4							0		
	Apiaceae	Trachymene pilosa	2	3	1	0	0	2	2	3	3	
	Celastraceae	Tripterococcus brunonis	5		1							
A	Asteraceae	Ursinia anthemoides	2							1	2	
	Myrtaceae	Verticordia nitens	2			0	0	1	0	0	0	0
	Campanulaceae	Wahlenbergia sp	2	1							1	
	Asteraceae	Waitzia suaveolens	2	1		0			2	2	1	
	Xanthorrhoeaceae	Xanthorrhoea preissii	7			0	0	0	1	0	0	
	Apiaceae	Xanthosia huegelii	5	0	2	3	0	0	1	1	2	0