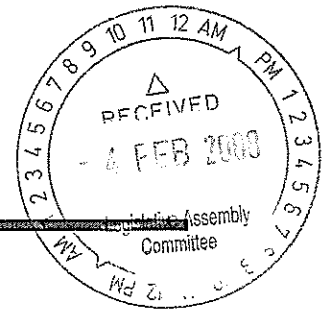


Farm Forestry and Water Use Seminar Further Information



Scientific Research

“Measuring the Water Use of Plantation Trees” is an article from CSIRO Scientist Richard Benyon on research he and his CSIRO / Ensis colleagues conducted on pine and blue gum plantations in south-east South Australia and their impact on water resources. It gives a brief look at the research, the outcomes and the further research that is still required.
<http://www.csiro.au/csiro/content/standard/ps9p...html>

“The Short Report – No. 39 Water Use by Trees,” written by the Rural Industries Research and Development Corporation (RIRDC), is a summary of a larger report “Agroforestry water use in Mediterranean Regions of Australia.” It provides information about the impacts on groundwater that different revegetation regimes and plant species can have in the agricultural regions of Western Australia. <http://www.rirdc.gov.au/pub/shortreps/sr39.htm>

“Plantations, Farm Forestry and Water – Proceedings of a national workshop, 20-21 July 2000, Melbourne: Water and Salinity Issues in Agroforestry No. 7” is a report written for the RIRDC/LWA/FWPRDC Joint Venture Agroforestry Program. It brings together a range of scientific papers which focus on the impacts of plantations and farm forestry on catchment run-off and water balance, water use by tree crops, forestry for salinity management and land use change and water management. <http://www.rirdc.gov.au/reports/AFT/01-20sum.html>

“Plantations, Farm Forestry and Water – A Discussion Paper: Water and Salinity Issues in Agroforestry No.8” is another report written for the RIRDC/LWA/FWPRDC Joint Venture Agroforestry Program. This site has a summary and link to the full report. The report addresses issues regarding the effects on downstream water users, tree crop species, effects on floods, groundwater and the watertable and the use of plantations for salinity control. The report also reveals the knowledge gaps that exist in regards to management of plantations and their interactions with the environment. <http://www.rirdc.gov.au/reports/AFT/01-137sum.html>

The Science for Decision-Makers papers, written by the Bureau of Rural Sciences, provide up to date scientific information on specific topics. This website has the **“Plantations and Water: Plantation Impacts on Stream flow”** paper which highlights key points of this topic and provides an overview of the scientific knowledge that is available to date and areas requiring research in a short, easy to read report.
http://www.affashop.gov.au/PdfFiles/sfdm_plantations.pdf#search=%22plantations%20and%20water%20use%20-%20western%20australia%22

The Bureau of Rural Sciences produced an extensive review of plantations and water use (**“Plantations and Water Use: A Review”**) for the Forests and Wood Products Corporation in 2004. The report provides information on 5 particular plantation regions in Australia with the South West of Western Australia being one of the major regions. The review deals with the triple bottom line in relation to plantations, the research limitations of plantations and their water use and impacts of land use changes. <http://affashop.gov.au/product.asp?prodid=12974>

“The Impact of Forest Plantations on Water Yield, A Statement Clarifying Key Scientific Issues” is a statement derived from a meeting run by the Bureau of Rural Sciences including representatives of CSIRO, CRC for Catchment Hydrology, Murray Darling Basin Commission, Department of Prime Minister and Cabinet, Department of Environment and Heritage, Australian Greenhouse Office and Department of Agriculture, Fisheries and Forestry. The statement addresses areas of science that have had contrasting views.

http://www.daff.gov.au/corporate_docs/publications/pdf/rural_science/forest_vegetation/plantwater.pdf#search=%22Plantations%2C%20Farm%20Forestry%20and%20Water%20Use%22

Farm Forestry and Plantation Planning

These two websites cover the planning bulletins for the **Farm Forestry Policy** (draft and final) written by the Western Australian Planning Commission. The policy addresses planning issues related to farm forestry and ways in which the Commission can deal with proposals within the current town planning schemes.

<http://www.wapc.wa.gov.au/Publications/185.aspx> and

<http://www.wapc.wa.gov.au/Publications/172.aspx>

“Impacts of Landuse Change on Groundwater Resources” is an issue paper produced by the National Groundwater Committee, Department of Environment and Heritage. The paper highlights the need for planning to be an integral part of ensuring that adverse impacts do not occur from land use changes, particularly plantations, and that a strong scientific understanding is gained for good management practices to be implemented.

<http://www.deh.gov.au/water/groundwater/committee/issue-3/index.html>

This website is part of the CSIRO Heartlands program to help promote sustainable land use in the Murray-Darling Basin. Two of the fact sheets: **Low Rainfall Farm Forestry** and **Tree Planting and Catchment Water Yield** give aspects and management regimes that need to be considered when looking at developing a property for farm forestry and also a model that has been used to understand catchment water yields in the basin and can assist in planning for tree planting locations. http://www.clw.csiro.au/heartlands/publications/fact_sheets.html

Plantations as an Industry – Information on their future and viability

This website provides information on the **Plantations 2020 Vision Strategy**. The project is a joint initiative between state, territory and commonwealth governments and the plantation industry. The information on this website highlights the community, industry and environmental involvement with plantations as well as the role which plantations play within our landscape. It outlines the background behind the strategy and also has an extensive number of reports about the range of different issues relating to the plantation industry including Plantations and their effect on Water Quality and Quantity. Plantations 2020 can also be contacted on

Phone: (02) 6273 8111 Facsimile: (02) 6273 8011 Email: INFO@PLANTATIONS2020.COM.AU

<http://www.plantations2020.com.au/index.html>

The **Infinintree** program was initiated by the Forest Products Commission to assist farmers in incorporating forestry and plantations on their properties throughout Western Australia. This website provides information about the tree farming program which endeavours to use farm forestry to provide social, economic and environmental benefits to regional areas of WA.

<http://www.infinintree.com.au/default.asp>

The National Water Initiative and Water Reform Agenda – Plantations and Land Use Change

“The Intergovernmental Agreement on a National Water Initiative - Between the Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and the Northern Territory.” Western Australia signed onto the National Water Initiative in April 2006 and now needs to consider this agreement when looking at water resource management policy and planning. Part of this Initiative (Pages 9-10) looks at consideration for water interception activities including large-scale plantation forestry.
http://www.coag.gov.au/meetings/250604/iga_national_water_initiative.rtf

The Plantations and Water Roundtable, organised by Tree Plantations Australia (an industry group affiliated with the National Association of Forest Industries) in 2005, was a forum prepared in response to the release of the National Water Initiative and to gain an understanding of the scientific information that is available on plantations and water use. This site has links to the background and summary of the roundtable and a discussion paper which shows the implications of the National Water Initiative from an industry perspective and highlights the areas in which industry can assist water management departments in gaining further understanding of plantations and their impacts on catchments. It also has the presentations of each of the speakers at the roundtable dealing with various aspects of the plantation and water debate. <http://www.nafi.com.au/waterroundtable.html>

This site gives a brief overview of the plantations and water use topic from the Australian Plantation Products and Paper Industry Council. Water has been identified by the industry group as a key issue in the sustainability of plantations and the council has given a background to the issue with strategies and targets which are being planned for implementation.
http://www.a3p.asn.au/keyissues/water_plantations.html

Plantation Legislation of other States and Territories in Australia

The Government of South Australia (Department of Water, Land and Biodiversity Conservation) has an **“Approval Process for Plantation Forestry: Under the Natural Resources Management Act 2004”** document, which stipulates the requirements for new commercial plantation approvals for South Australia. Farm forestry, whereby commercial forestry is not the predominant use of the farm, and farms where an area of commercial forest does not exceed 10% of the farmland, are not covered under these regulations.
<http://www.dwlbc.sa.gov.au/licensing/projects/forestryregulationsse.html>

This report **“Establishing Plantations in Australia: A Review of Legislative and Regulatory Frameworks”** is a compilation of the different regulations and legislation that may be associated with plantations and commercial forestry in each state and territory of Australia. The report was written as part of the Plantations 2020 Vision program in November 2004 to determine from an industry perspective what legislation and regulatory processes may affect the plantation industry both now and in the future.
http://www.plantations2020.com.au/assets/acrobat/2020Vision_LegRevRpt231104.pdf

Blue gums, water and the wheatbelt

JR Bartle Manager Revegetation Systems Unit DEC, Leader Subprogram 4 (Woody Germplasm) CRC for plant based management of dryland salinity

Whicher Water Resource Management Committee
Blue gum plantation and water use seminar
Tuesday the 5 September 2006

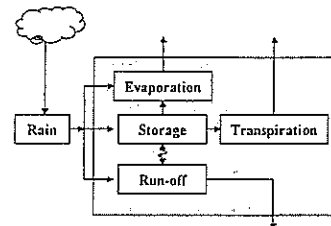


Department of
Environment and Conservation

DEC FOR PLANT-BASED MANAGEMENT OF DRYLAND SALINITY



What is water balance?



$$\text{Rain} = \text{Evaporation} + \text{Transpiration} + \Delta \text{Storage} + \text{Run-off}$$

$$P = Et + \Delta S + RO$$

Typical water balances

Rain	=	Et	+	ΔS	+	RO	Vegetation type
1000mm		90%		0%		10%	Eucalypt forest
		60%		10%		30%	Annual/perennial pasture
400mm		99%		0%		1%	Eucalypt woodland
		85%		10%		5%	Annual crop/pasture

Some hydrologic principles

- Et is dependent on temperature/humidity (VPD).
- Storage and run-off are strongly affected by slope and soil depth/permeability.
- Vegetation type strongly effects of water balance - easily changed by man
- Change in storage is reflected in groundwater accumulation. This mobilises salt stored in deep profiles. Both these processes can be dealt with conceptually in terms of 'balances'.

Two big water balance issues

- Water quantity or stream flow volume
- Water quality mainly salinity

We will look at these quickly at the higher rainfall end of the range where forestry has traditionally been most at home

Water quantity

Rain	=	Et	+	ΔS	+	RO	Vegetation type
1000mm		90%		0%		10%	Eucalypt forest
		60%		10%		30%	Annual/perennial pasture
400mm		99%		0%		1%	Eucalypt woodland
		85%		10%		5%	Annual crop/pasture

- High rainfall grazing land grows profitable forests/plantations.
- After clearing stream beds erode and reach further upslope but streams generally remain fresh.
- Replanting forests will steeply reduce run-off
- Replanting forests will stabilise erosion, provide shelter.

Water quality

Rain	=	Et	+	ΔS	+	RO	Vegetation type
1000mm		90%		0%		10%	Native forest
		60%		10%		30%	Annual/perennial pasture
400mm		99%		0%		1%	Native woodland
		85%		10%		5%	Annual crop/pasture

- ΔS indicates that groundwater systems are recharging.
- Soil and groundwater storage capacities are large and take 10 - 100s years to fill to the point where discharge comes back into equilibrium with recharge.
- Activated groundwater systems increase discharge of salt.
- No apparent adverse effects until enough new salt discharge 'comes on stream'. This dampens enthusiasm for recharge control.
- Major water supply catchment is in high rainfall areas where there is less risk from salt and more reason to avoid run-off reduction.

Can 'forestry' adapt to a low rainfall water balance?

Rain	= Et	+ A.S	+ RO	Vegetation type
1000 mm	90%	0%	10%	Eucalypt forest
	60%	10%	30%	Annual/perennial pasture
400 mm	99%	0%	1%	Eucalypt woodland
	85%	10%	5%	Annual crop/pasture

- A conventional plantation will only have access to rainfall.
- 396 mm will only grow some 8 tonnes/ha/year of whole biomass, that at a stumpage of \$15/tonne is not commercially competitive with agriculture.
- On the farm 15% of rainfall is going to waste!
- Can we capture enough of this excess water from part of the farm, apply it to a small area of tree crop and achieve a profitable yield?

Surplus water capture will require:

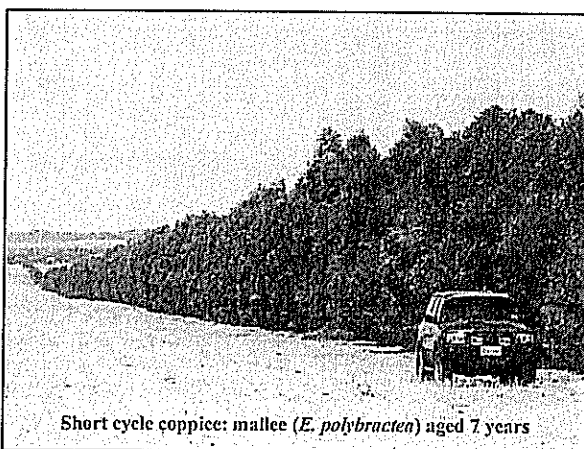
- Tree crop phases in the farm rotation, or permanent tree belts, both of which can passively intercept surplus water.
- Active interception of water to transfer it for recharge under the trees planted area.
- Low woody crop proportions (~10%) for abundant agricultural water surplus to lift woody crop yields.
- New species adapted to these systems and able to produce commercial products.
- Real integration with 'wheat and sheep'.
- A new lexicon, e.g. rotation = cycle; tree/forest/plantation = woody crop.

Low rainfall tree crop industry options

- Extend existing timber industries
 - Conventional long cycle forestry (pine and euc)
- Create entirely new industries
 - Based on low cost biomass and wood chip production from short cycle woody crops □□
 - Long cycle timber crops for specialty products
- Complement existing livestock and fodder industries
 - In-situ grazing (herbaceous pastures and fodder shrubs)
 - Fodder and manufactured feeds

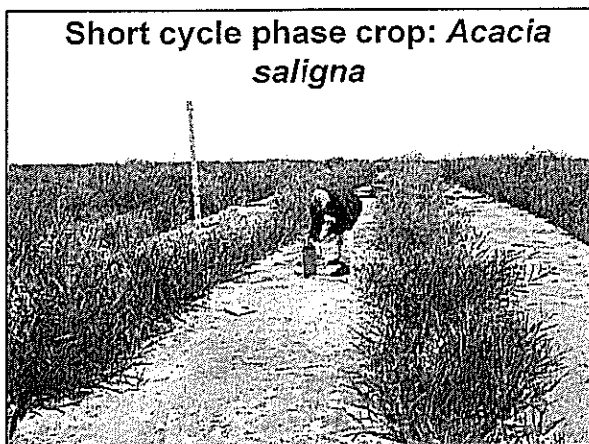
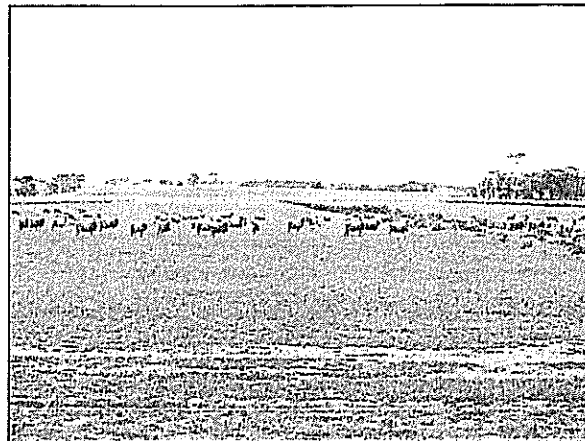
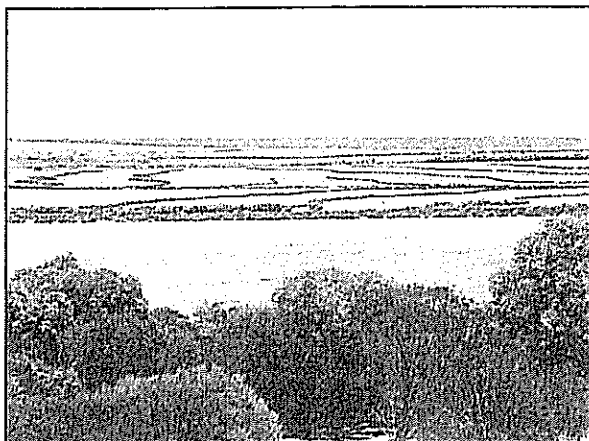
Short cycle woody woody crop types

- Short-cycle coppice crop: short harvest cycle (2 to 5 years), planted in permanent belts that regenerate or coppice from the stump after harvest, many prospective species most notably mallee.
- Short-cycle phase crop: A crop grown as a short (2 to 5 years) phase as part of the agricultural crop rotation, every 20 years or so. Too expensive to establish as seedlings and so will be developed from large seeded species like Acacia that could be direct seeding.

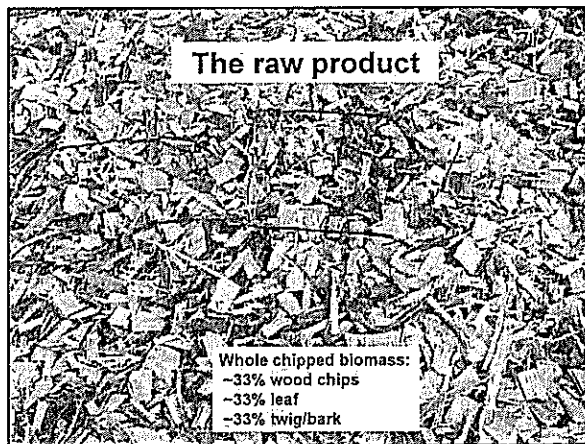


Short cycle coppice: mallee (*E. polybractea*) aged 7 years





Short cycle phase crop: *Acacia saligna*



The raw product

Whole chipped biomass:
~33% wood chips
~33% leaf
~33% twig/bark

Manufactured product options

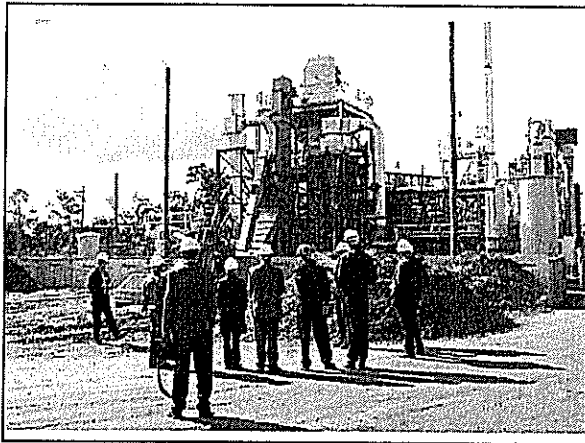
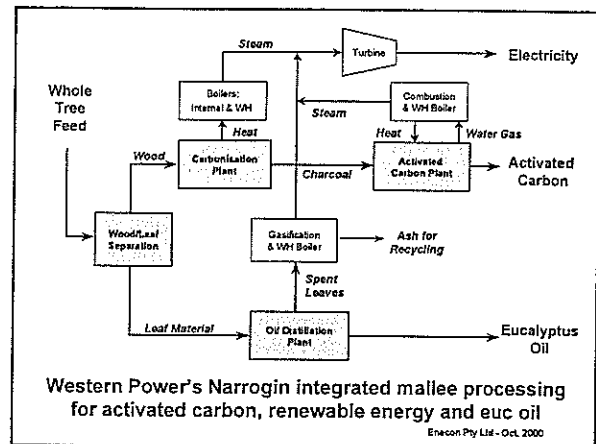
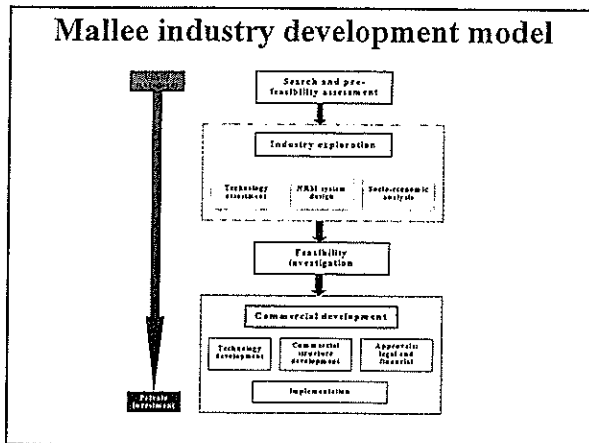
Category	Sub-category	Specific
Wood products	Panel board ¹	Particle board Medium density fibreboard (MDF) Oriented strand board (OSB)
	Processed wood ¹	Pulp and paper Wood plastics Carbon products
Bioenergy	Solid fuel ¹	Electricity Industrial heat Desalinated water
	Liquid fuel	Alcohols Pyrolytic liquids
Chemicals	Chemicals processing	Pyrolysis
	Extracted chemicals	Oils, solvents, tannins, gums, resins
Fodder	Directly grazed	Fodder reserve
	Manufactured	Feed concentrates

¹ Major product areas (but co-products also important)

Mallee development in the wheatbelt

- Started in 1992. Planted 12,000 ha, investment by all parties totals about \$50 million
- Mallees are native, robust, fast growing species suited to short cycle harvest
- Provide wide range of environmental benefits especially salinity control and carbon sequestration
- Planted in belts to harvest excess water for better yield and salinity control with conventional crops grown in between
- Feasibility investigation in 2001 showed that integrated processing to produce activated carbon, eucalyptus oil and electricity should be commercially viable.



Reference: Enecon Pty Ltd (2001) Integrated tree processing of mallee eucalypts. Publication Number D11160, Rural Industries Research and Development Corporation, Canberra. Australian Capital Territory. 81 p. <http://www.rdc.gov.au/industry/AR/011160.pdf>



Conclusions


- New short cycle woody crops offer great potential to improve the productivity, sustainability and diversification of wheatbelt agriculture.
- Woody crops have multiple product options that lock in local processing and promote regional development.
- They offer an alternative source of supply for wood products feedstocks.
- Woody crops provide farmers with the chance to take a slice of cushy domestic markets in major secondary industries like energy.

ensis ...an overview of current knowledge

Ensis Forests and Environment


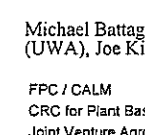

Blue gums and water



ensis **Acknowledgements**


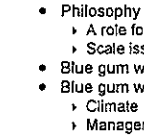

Michael Battaglia, John McGrath (FPC), Craig Macfarlane (UWA), Joe Kinal (FPC) and Richard Benyon

FPC / CALM
 CRC for Plant Based Management of Dryland Salinity
 Joint Venture Agroforestry Project
 CRC Forestry
 Australian Centre for International Agricultural Research
 WA Plantation Resources, Timbercorp, Great Southern Plantations, Albany Plantation Forests Limited, Hansol Plantations International

ensis **Outline**




- Context
- Philosophy behind our approach
 - › A role for process based models – which model
 - › Scale issues
- Blue gum water use at the catchment scale
- Blue gum water use – sources of variation at point scale
 - › Climate
 - › Management – thinning, nitrogen
 - › Landscape position
 - › Groundwater
- Towards a decision support system for water allocation / licensing

ensis **Context**


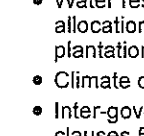
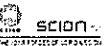
Ensis Forests and Environment

Part 1

ensis **Context**




- Water resources are at, or exceed, full allocation in many high rainfall areas where plantation forestry is an attractive land use
- Climate change
- Inter-governmental Agreement, NWI clauses 55-57. Water access entitlements will be required for plantings above a specified threshold in highly allocated systems

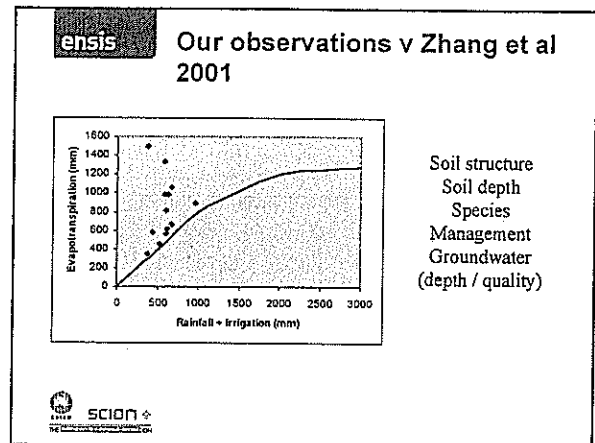
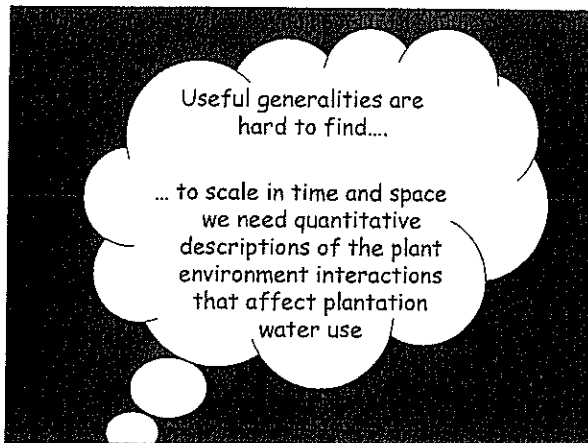




ensis **Philosophy and approach – from process understanding to Decision Support Systems**

Ensis Forests and Environment

Part 2

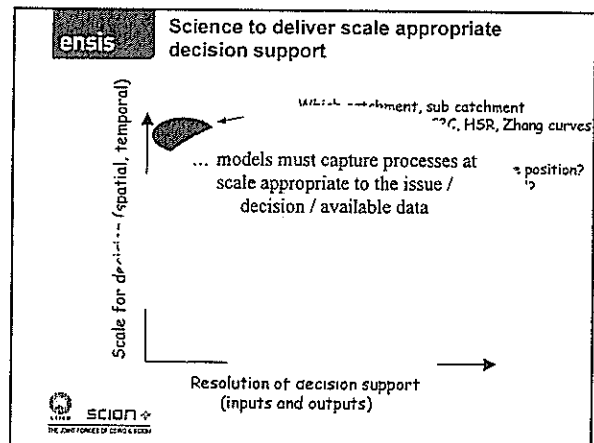






ensis A role for models

- Empirical observations of water use are constrained in time and place
- We can either:
 - Measure the world
 - Understand and capture key processes in models and use these models (with ongoing validation) to play the scenario games

ensis SCION THE JOINT FORCES OF GEORGI & SCION

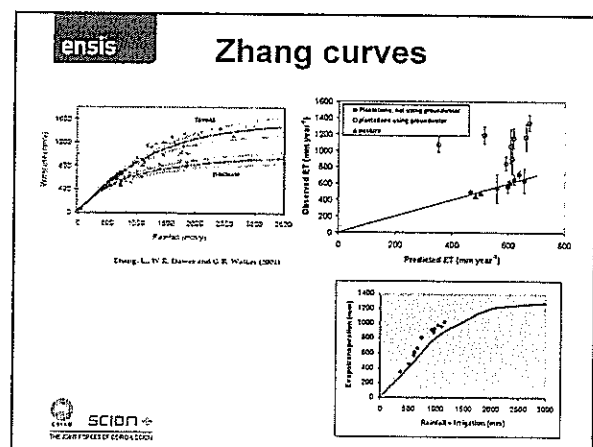


ensis Blue gums and water at the catchment scale

Ensis Environment

Part 3.1

ensis SCION THE JOINT FORCES OF GEORGI & SCION



ensis Blue gums and water – point or compartment scale

Ensis Forests and Environment

Part 3.2

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ensis Blue gums – what has been done?

The early to mid 1990's - Physiological responses to drought – Lewisham, Tasmania

The late 1990's – Craig Macfarlane's PhD, how portable is our understanding of key processes?

From the late 1990's – two sets of experiments, one each in the green triangle and south western WA

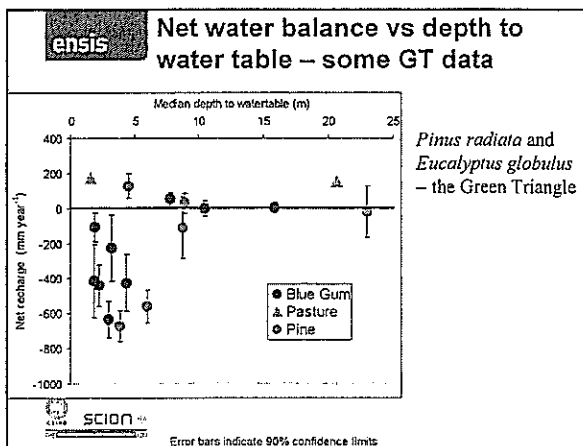
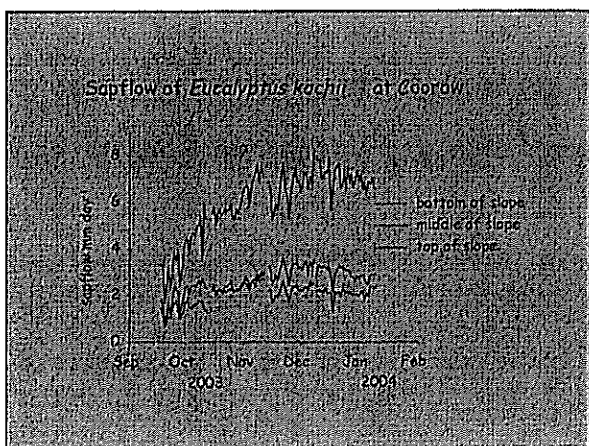
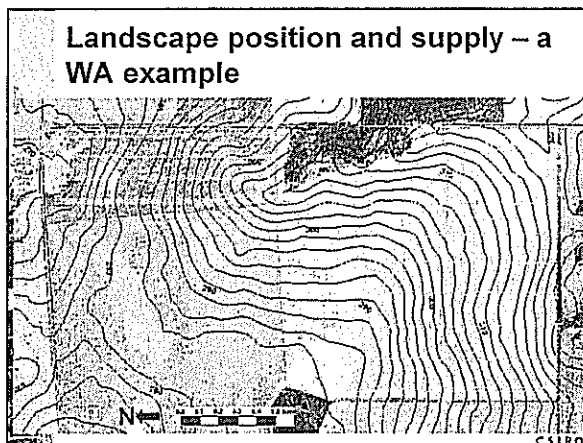
More than one well developed model of growth and water use

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ensis Levers on the relationship between growth and water-use

- Landscape position
- Site – depth to groundwater
- Management
 - Thinning
 - Fertility
 - Pruning

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What about WA?

- There is little (no?) direct evidence of groundwater use by commercial plantations in WA (*Pinus pinaster*, *E. globulus*)
- Modelled production can be explained using a simple 1D water balance in for 98% of 156 sites

E. globulus and drought

- Some deaths in 1985/86
- Major drought deaths in 3-5 year old *E. globulus* in 1994/95
- Scattered deaths:
1997/98
2000/01
2001/02
2002/03
- Soil depth and site selection – 2m, 4m, 5m



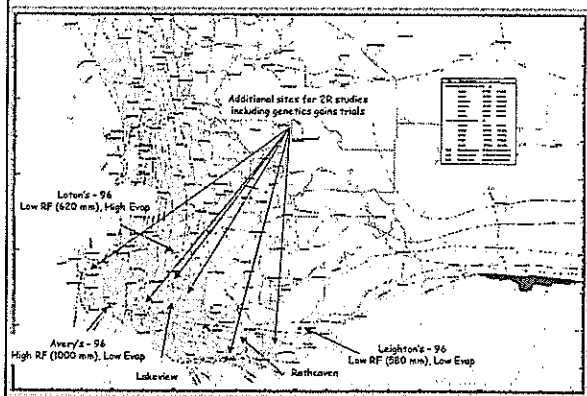
Drought physiology of Eucalypts

Well adapted to moderate, cyclical drought
Poorly adapted to prolonged drought
High leaf area, opportunistic water user
fast growth = high risk

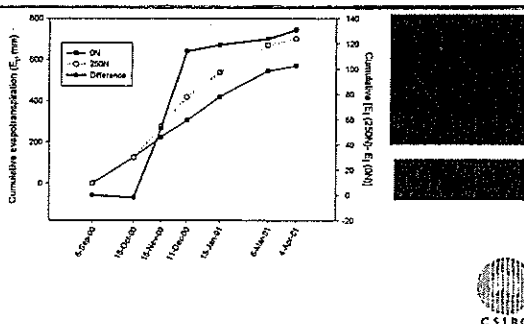


Staying with *E. globulus*
Can we use silviculture to optimise
returns and manage risk?
LAI - link between growth and water
use?

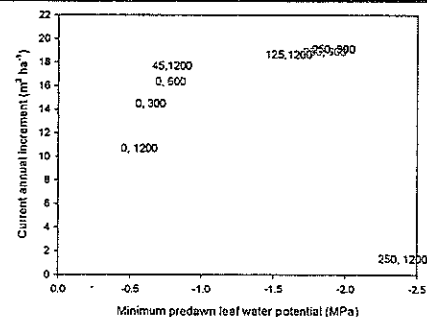
Location of experiments

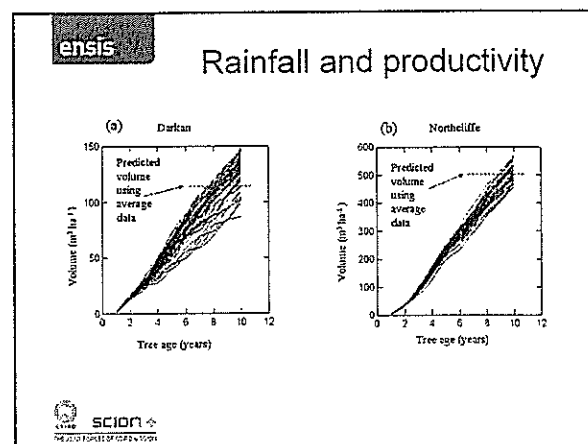
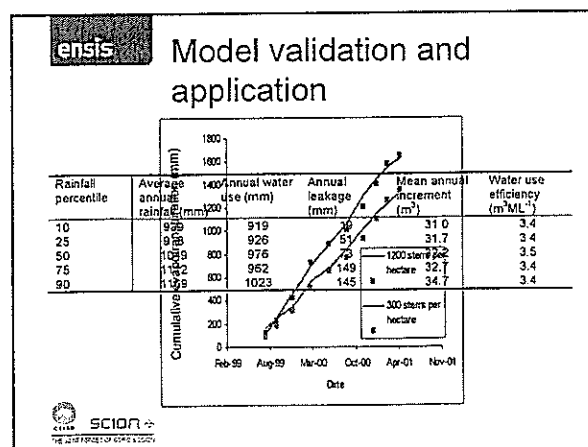
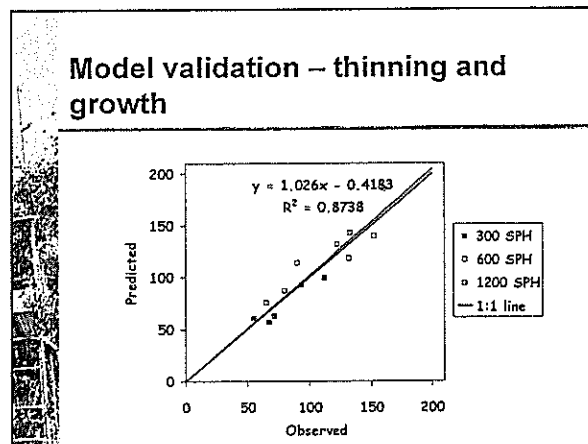
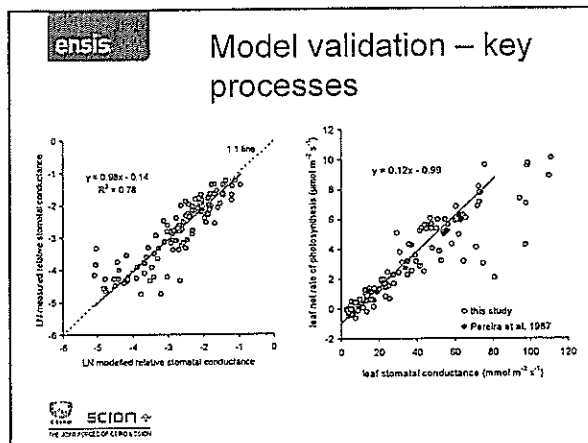
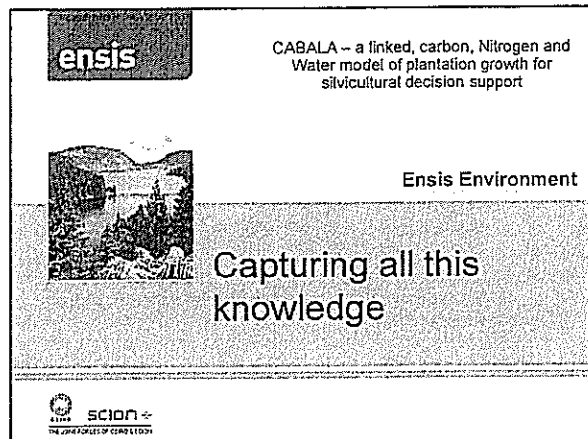
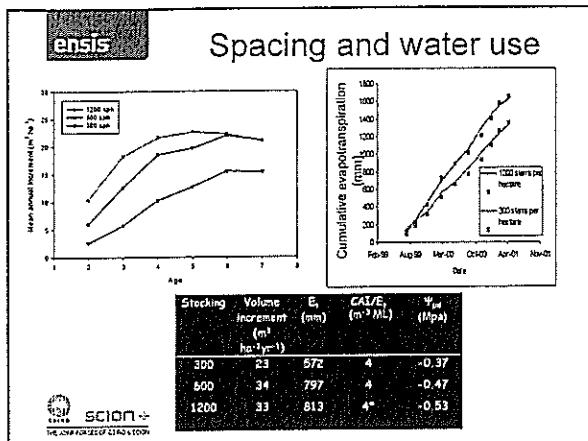


Fertility - nitrogen



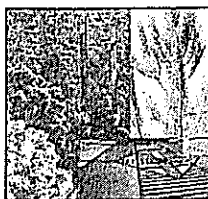
Can we manage growth : risk? Nitrogen, spacing, water stress, growth and survival (Avery's - High RF, Low Evap)





A couple of concluding remarks - to stimulate discussion

- Plantations in the SW have essentially 1D water balance
 - › need to test this on Scott R Plain
- Good point scale (and large scale) models
- Opportunity to test convergence of top down and bottom up approaches using historical data
 - › models of surface of groundwater
 - › linked with models of growth / water use
 - › tested against historical data – streamflow, piezometric, industry growth data
- Water use alone not a good decision criterion for land use
 - › Full TBL analysis of costs and benefits from water use
- Hill slope hydrology??



FPC's Plantation Water Use R & D



WATER IS A PRECIOUS RESOURCE



History

- Forest Dept research began 1970's with the Gnangara Plantation Density vs Water Use, Growth (Butcher and Havel)
- Integrated Trees – Mundaring (Batini *et al.*)
- Catchment Scale Water use Native forests (FD, CALM, Water Authority, Water Corp, DoE etc)
- Blue gums yield studies (Inions, Harper)
- Pinaster in the MRZ (Ritson, Dumbrell)
- Radiata- Blackwood Valley, Swan Coastal Plain and Donnybrook Sunklands (McGrath *et al.*)

All studies highlight water availability as the primary constraint on plantation growth.



Drivers for Current R & D

- Plantation productivity and sustainability
- Provide environmental services through the amelioration of secondary salinity
- Understand comparative water use by various land-use options

(These require similar understanding and data)



Recent research Silviculture/Water use/Productivity

- Main Commercial Species (Radiata, Pinaster, Blue gum)
- Impact of climate, soils, silviculture (Density/Nutrient status)
- Interactions between soils/silvics/climate

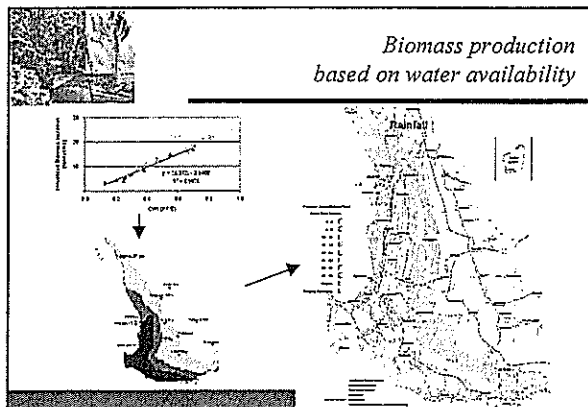
(Collaborative studies with a CSIRO/ensis, Industry)



What has it produced

- Tools- knowledge based tools for growth predictions
- Water availability provides the upper limit to growth
- Capacity to predict growth- mostly driven by water availability (key components rainfall and evaporation)
- Silvicultural knowledge to optimize growth (and water use)
- Under WA conditions the main commercial species do not appear to use ground water (Interception, stored soil water)





Do Plantation Trees Use Groundwater ?

- Evidence from WA based on H/D ratios are inconclusive
- Physiological and productivity evidence suggest they don't.
- Plantations can influence water tables by reducing/restricting recharge (which can be managed).

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Trees affect groundwater recharge

- Recharge potential can be manipulated through plantation (leaf area) management
 - Initial stocking
 - Thinning intensity and timing
 - nutrition

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Gnangara as an example

- Optimize the trade off between
 - Volume production
 - Wood demand scenarios (Industrial demand)
 - Water supply requirements
- Based on knowledge of growth, water use and wood demand

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What do we still need to know?

- Extent of integrated plantings for salinity control MRZ (Can partial plantings control water balance?)
 - Denmark, Helena - full planting is effective
 - Collie modeling
- Extent of water use by landscape scale revegetation in the HRZ
- Impacts on overland run-off by plantations in the HRZ
- Suitability of different species to the WA environment
 - Are there differences in WUE or does it all depend on LAI
 - Capacity to tolerate extreme conditions

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Recent research Paddock to property scale integration

- Putting trees in their place (spatial approach) (Wickepin, Clackline, Dandaragan)
- Phase farming with trees (temporal approach) (Corrigin)


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Recent research
SubCatchment scale water Use


- Design of integrated plantings
- NAP ~ Strategic Tree Farming M & E.
- Forestry CRC Program 4 Hydrology
- Commercial Environmental Forestry
Possible program between ensis/FPC (DAFF Funding)






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National Water Initiative




Interception

- Farm dams
- Large scale plantations
 - Must account for their water use
 - Must be included in Water Plans
 - Must be included in catchment thresholds determinations



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Challenges ahead with respect to
 Bluegum Plantations



Water Resource Manager's Perspective


- Better knowledge
- Water Legislation that can better regulate interception
- Appropriate water policy on Bluegum plantations
- Determination of catchment threshold levels
- Water resource advice to land use planners, LGAs and to enhance industry best practice



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End




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Protecting Catchment Water Use




Steps we can take


- Measure baseline parameters + use & needs
- Account for all use
- Set how much is for the environment
- Set how much can be used (consumptive pool)
- Regulate new and existing use
- Include Land use change impacts



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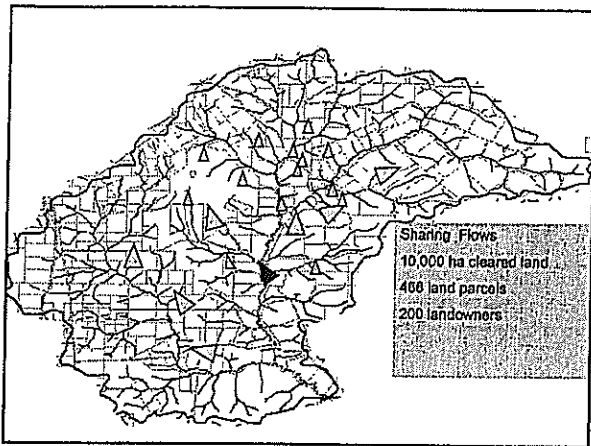


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National Water Initiative



- WA Government signed the NWI in April 2006
- Implementation of NWI linked to receiving federal funding
- Key element
 - Secure water entitlements
 - Environmental Outcomes
 - Statutory Water Plans
 - Water Accounting
 - Facilitate trading
- Sub element
 - Interception



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Most water uses need more water than falls on individual properties

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Protecting Catchment Water Use

Land holder needs

- Reliability
- Security

Environmental needs

- Stream ecosystems
- Riparian vegetation

