Is sustainable superficial aquifer production possible in areas with vulnerable phreatophytic vegetation? A test case in Mediterranean Southwest Australia

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Australian Government
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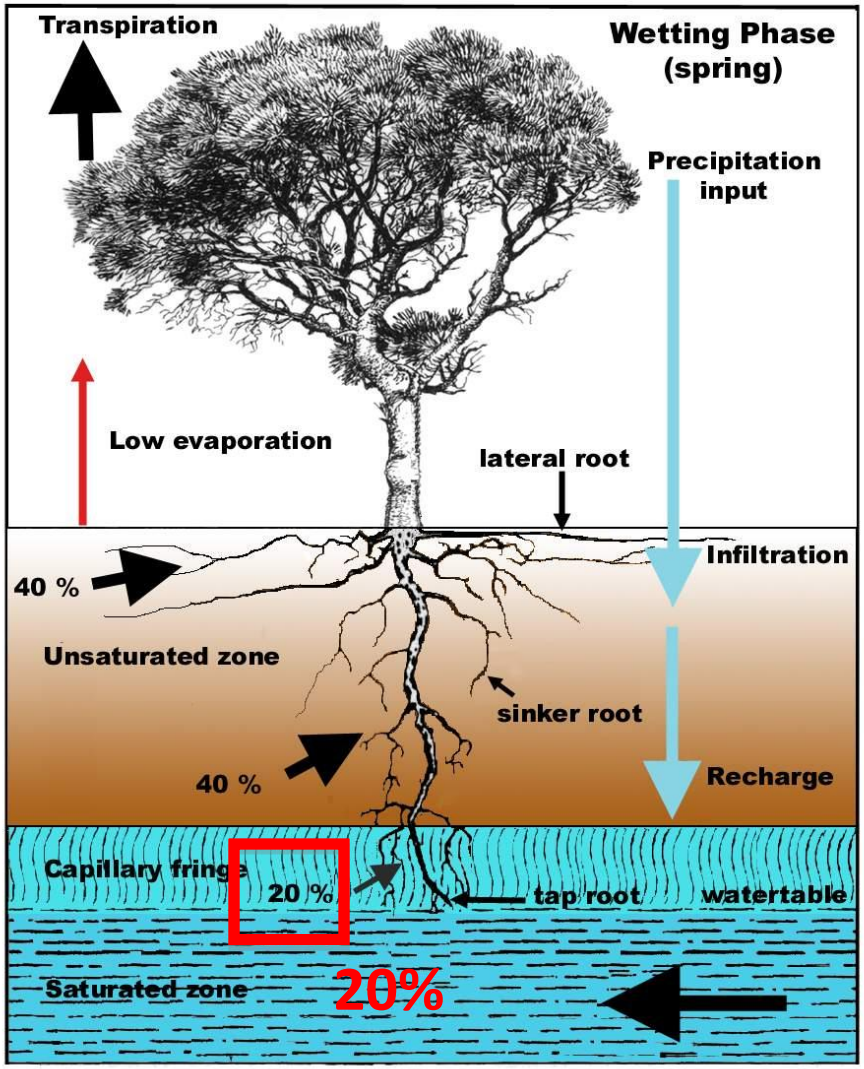
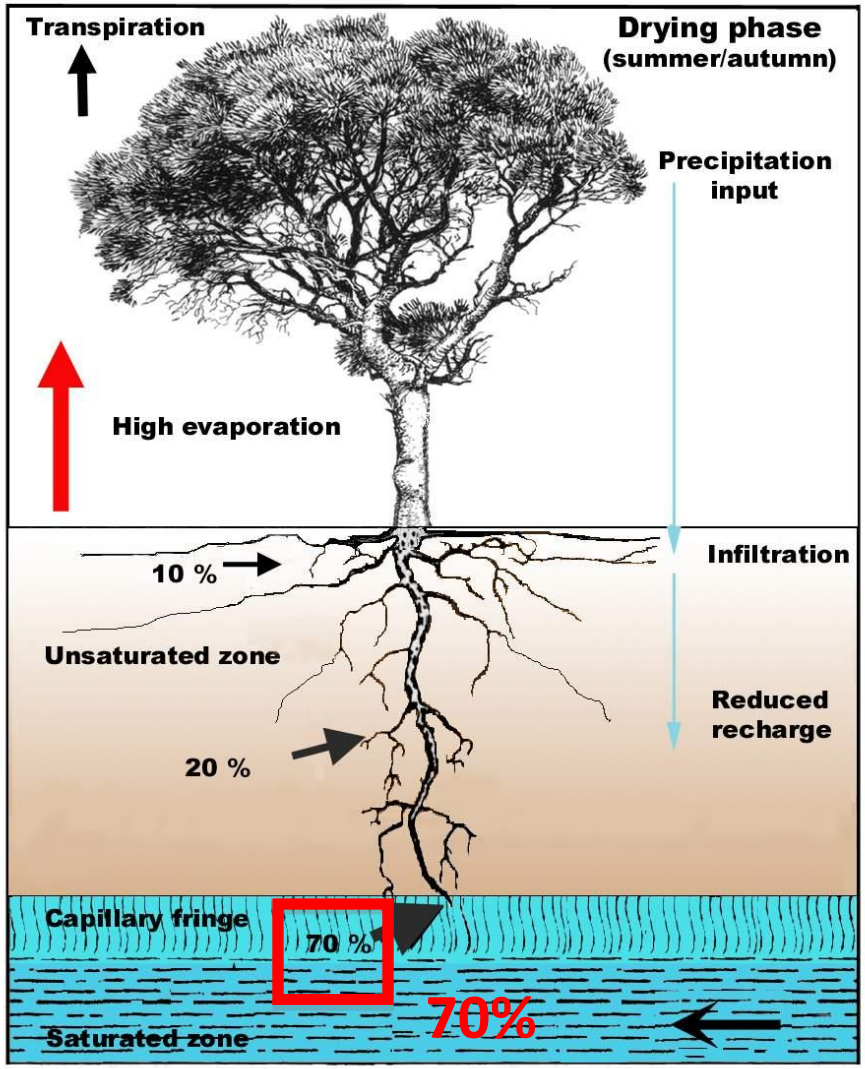
Sharing the Aquifer

- Competing uses and a shrinking resource
  - Abstraction for consumption
  - Groundwater dependent vegetation
  - Climate change
- Planning for 'environmental sustainability'
  - Requires awareness of short (seasonal) and long-term (decades or longer) **variability in ecosystem groundwater requirements.**
- Can we accommodate ecosystem requirements by acknowledging this variability in **bore field design and operation**?
  - Locating bores near/in ecosystems with low/no groundwater requirements
  - **Operating bores at times of lower environmental groundwater demand**

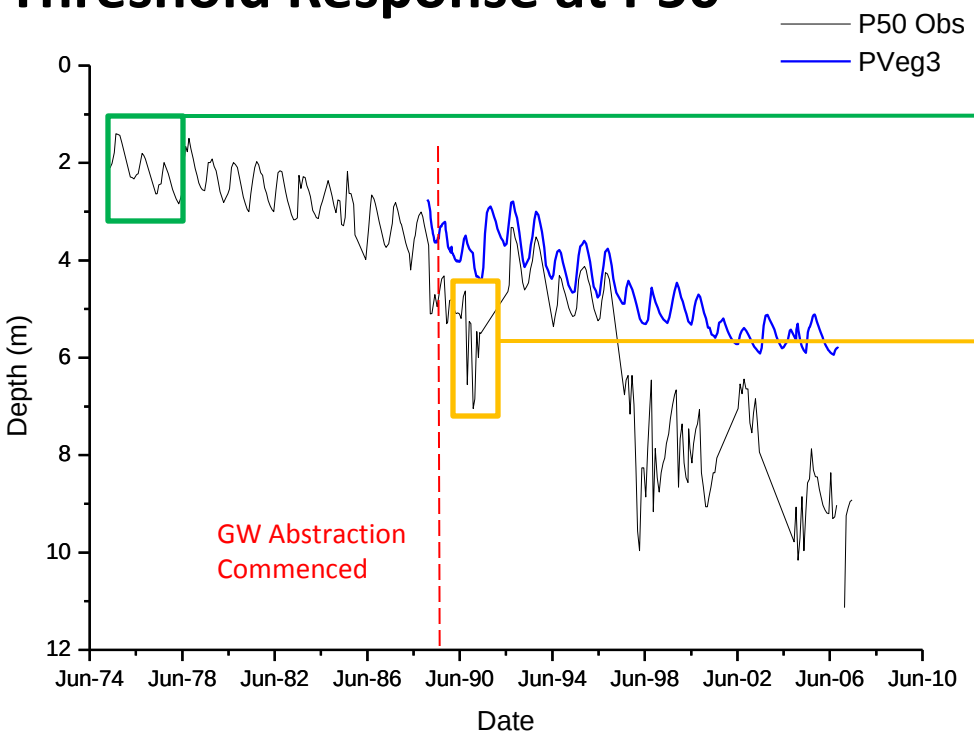
Seasonal Variability in Water Source Use: *Banksia* Water Source Partitioning, Winter vs Summer





Zencich *et al* 2002

Summer Abstraction vs Peak Vegetation Requirement: Threshold Response at P50



1975-1978
Banksia Woodland
(shallow)
1.6-3 m to GW

1990-1991
Sudden Decline
In vegetation
4–7 m to GW

Potential for threshold response when operating bores during peak environmental demand in sensitive ecosystems

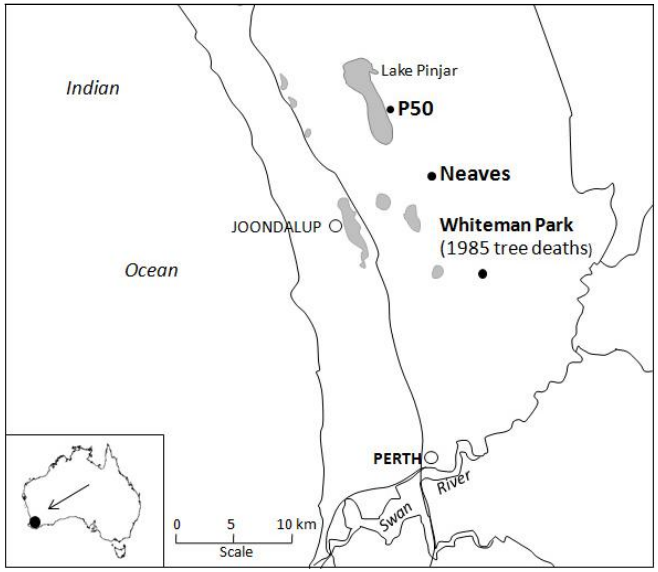
Sommer and Froend 2010

Mirrabooka Winter Pumping Trial Research Questions

- What are the hydrological changes and support mechanisms for vegetation during a winter abstraction scenario?
- Is there risk in vegetation drought stress during subsequent summers?
- Is it possible to abstract groundwater during winter in a sensitive area without unacceptable impacts to phreatophytic vegetation?

Mirrabooka Winter Pumping Trial Study Site: Whiteman Park, Mirrabooka Bore Field

- Phreatophytic *Banksia* woodland
- Previous summer drawdown impacts in 1985
- Depth to watertable 1-2m (1985) to 3-5m (2009)
- 3 winter pumped sites (treatment) and 3 un-pumped sites (control/reference)
- Sandy superficial aquifer
- Hot, dry summers

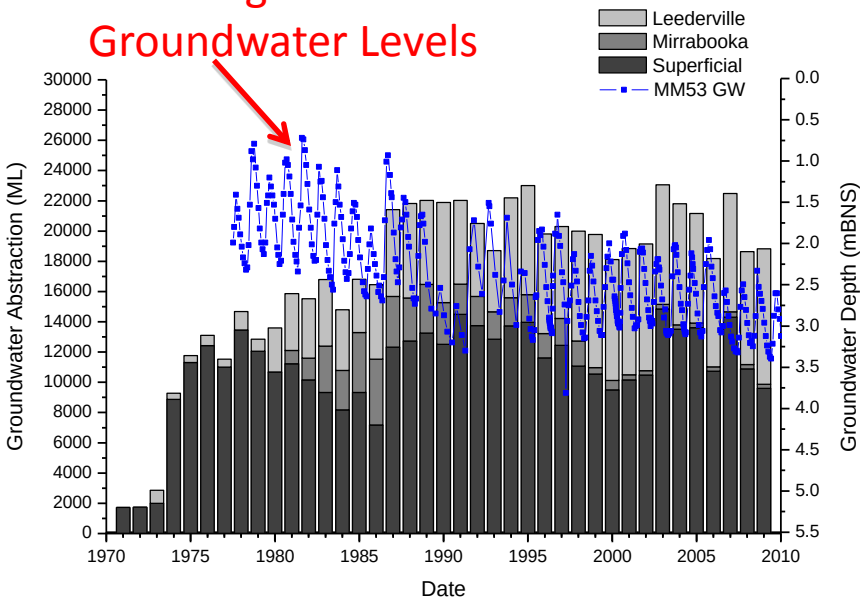


Shrinking Resource Scenario

Mirrabooka Bore Field Operation, WA (Gnangara Mound)

Annual bore field production 1970-2009

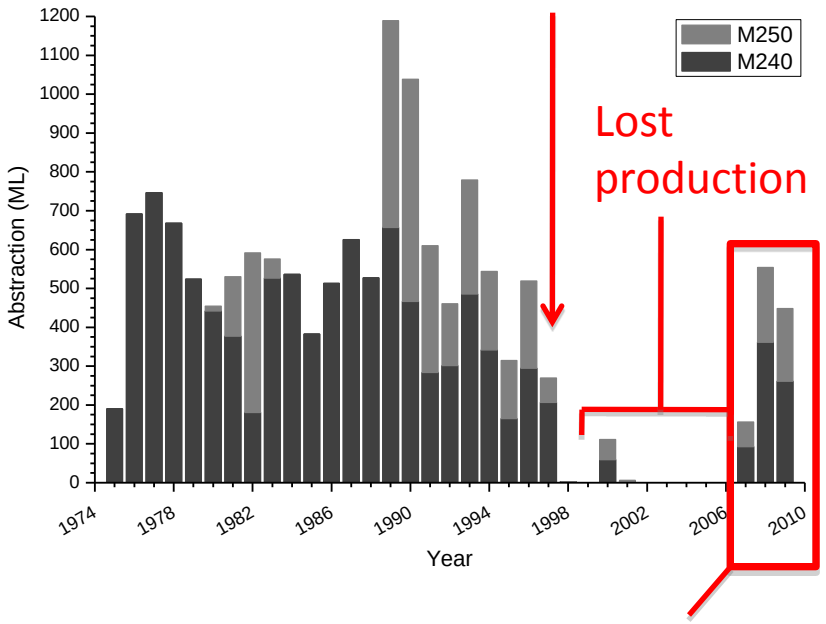
Declining Groundwater Levels



Variation in production due to rainfall patterns, env. concerns and consumption demand.

Annual production 1974-2009 M240/M250

Breach of env. criteria



Commencement of ‘winter’ pumping trial, avoidance of conflict with summer env. need

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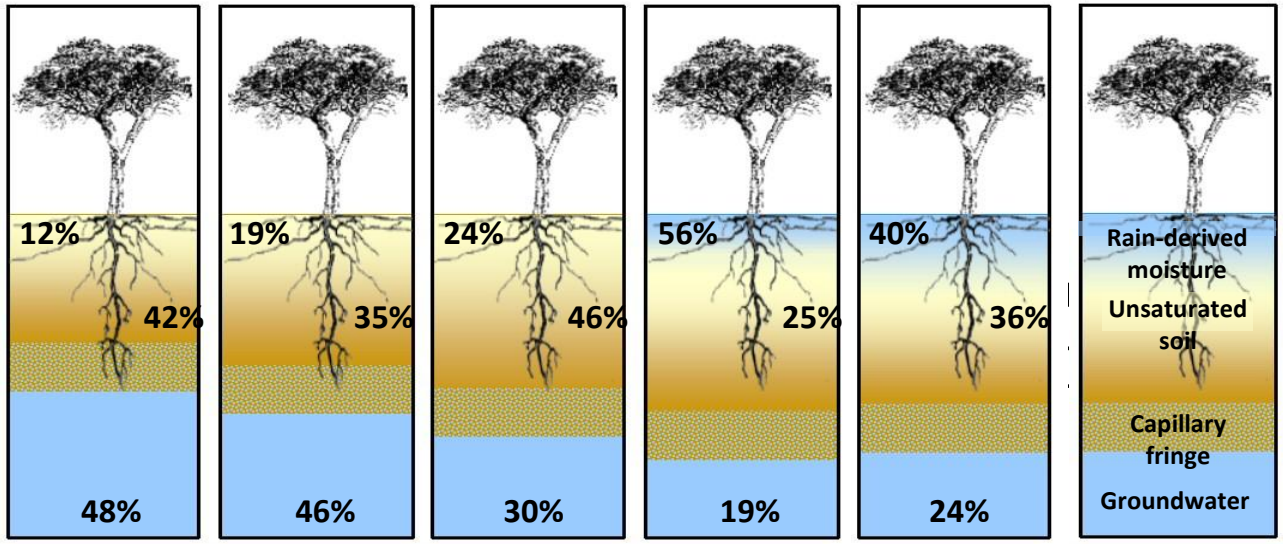
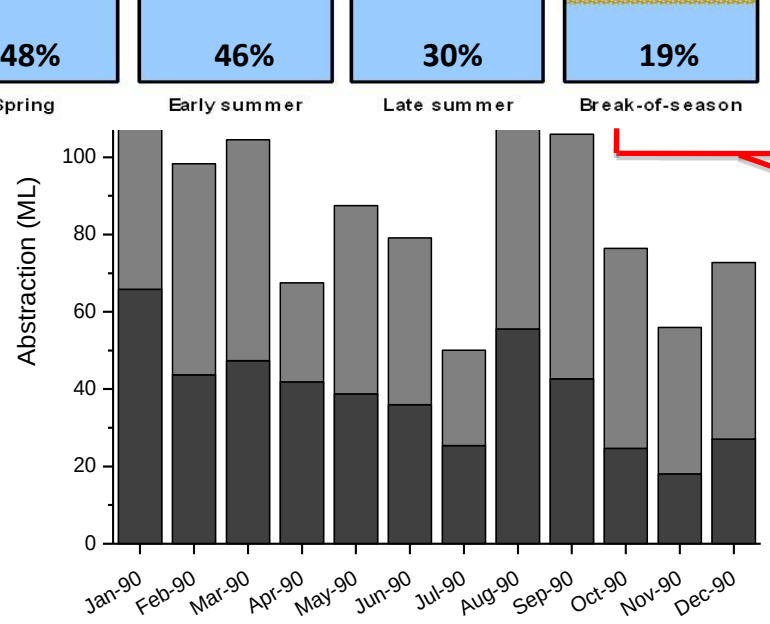
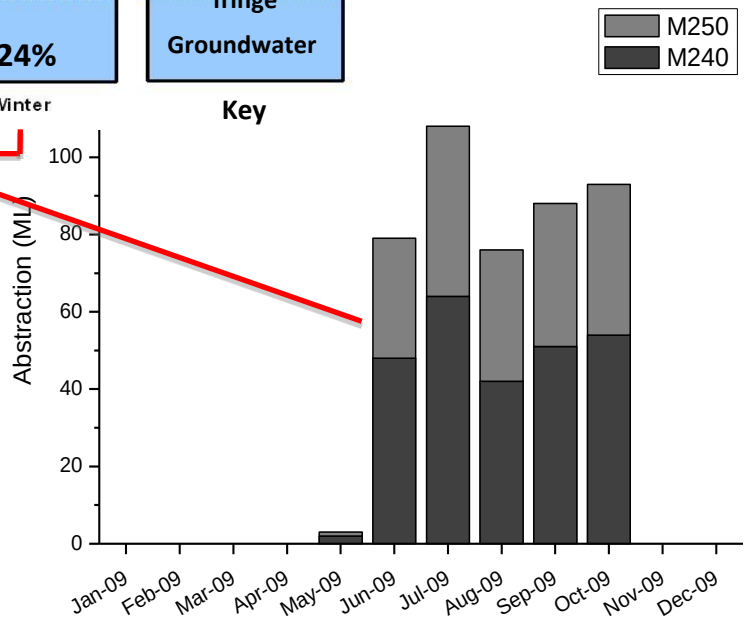


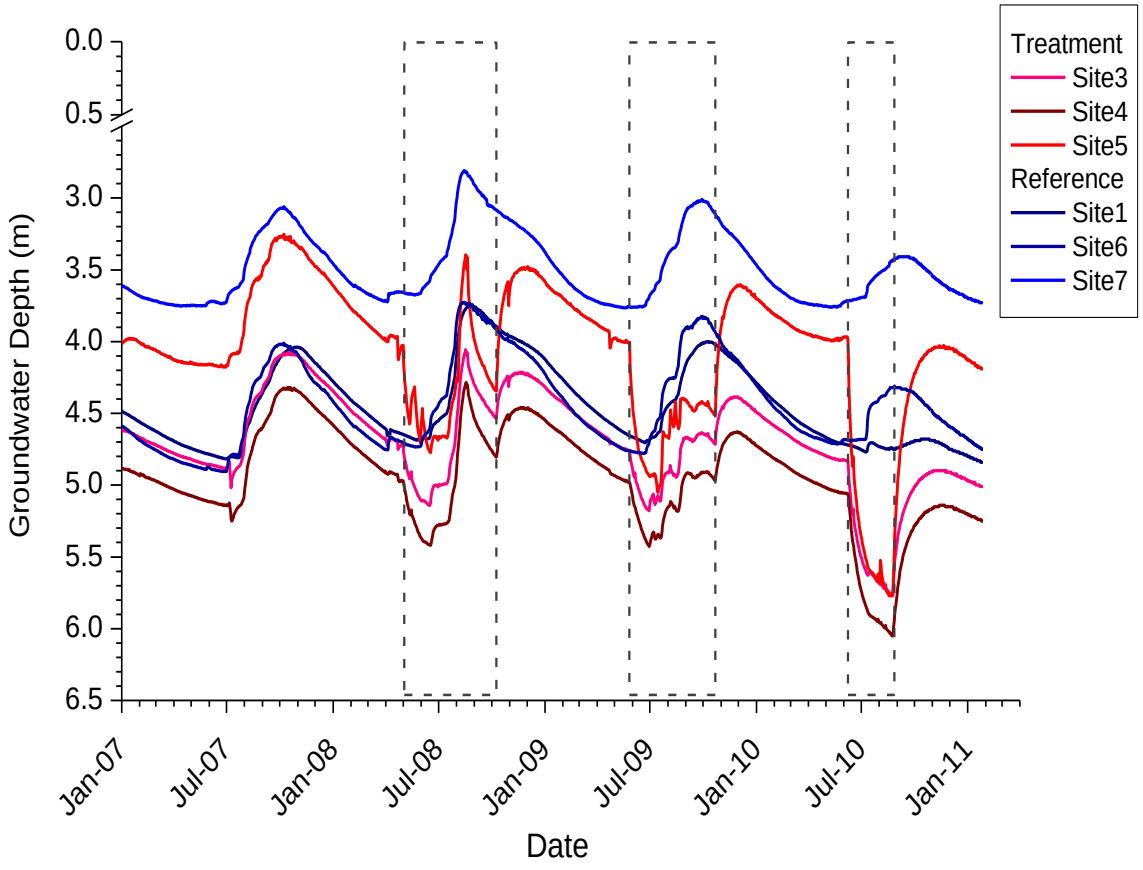




Example of monthly production, pre-breach of env. criteria

'Winter' production to avoid conflict with summer env. water needs

What are the hydrological changes and support mechanisms for vegetation during a winter abstraction?

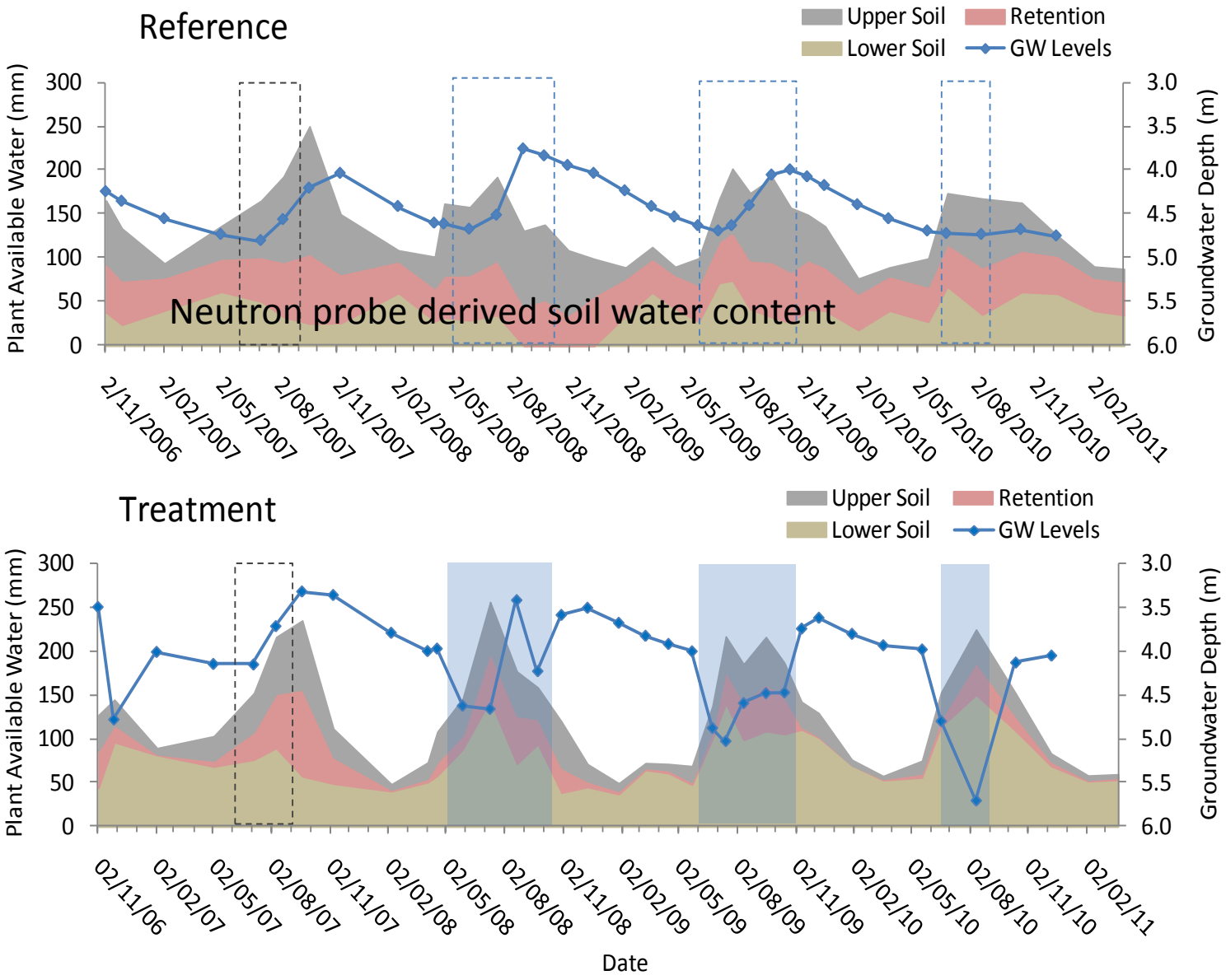


Rapid hydraulic response at pumped sites

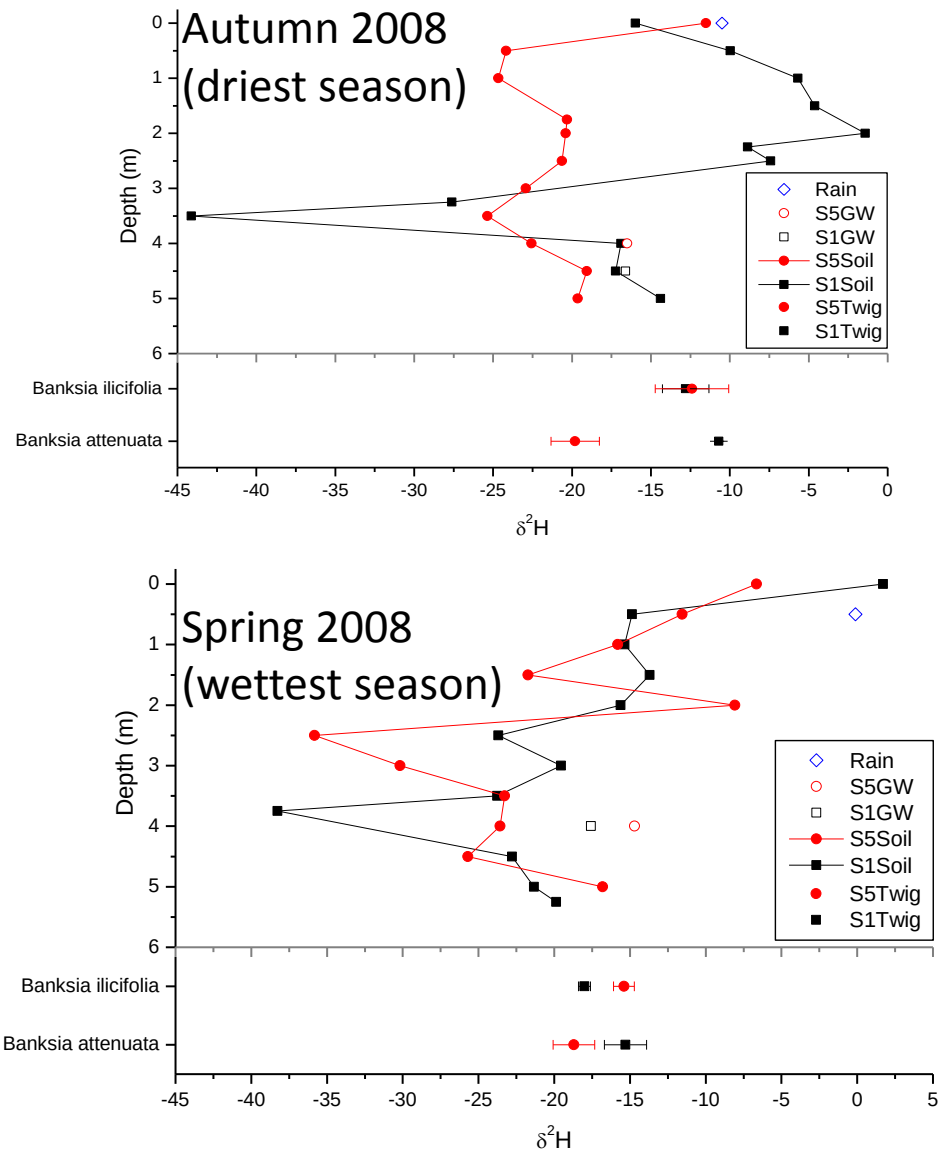
Magnitude of pump –induced drawdown <1m at treatment sites

Watertable recovery < 3 weeks after pumping ceased.

Plant Available Water



Plant Water Source Partitioning: Isotopic Analysis.



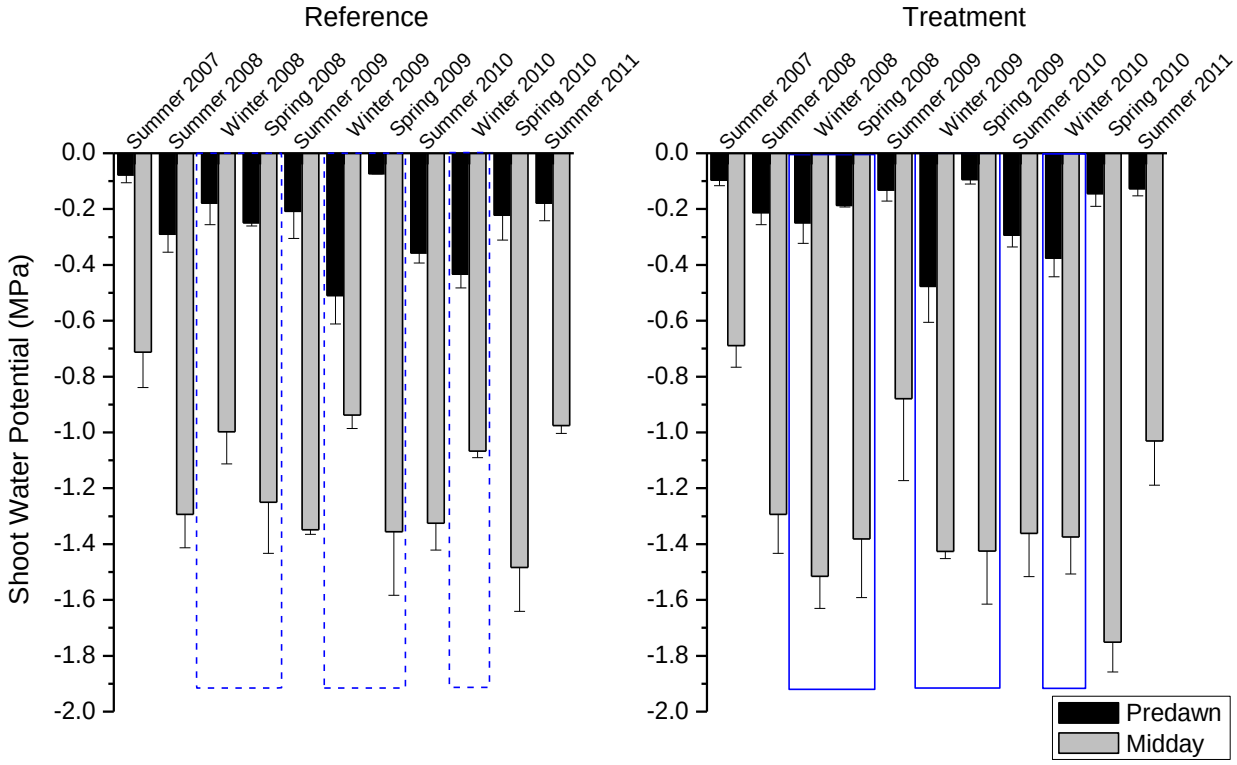
Consistent groundwater and deep soil water use during driest and wettest periods of the trial.

Shallow soil water use evident

Indication of retention layer water use in both periods

No isotopic evidence of clear separation from groundwater (or CF with a similar isotopic signature to GW) during winter pumping.

Is it possible to abstract groundwater during winter in a sensitive area without unacceptable impacts to phreatophytic vegetation?



No difference in predawn *Banksia* shoot water potential between treatment and control sites.

Weak seasonal variation indicating no seasonal limitation in water sources

Conclusions

- No detectable (unacceptable) impacts recorded over 3 years (3 winter drawdowns and 2 subsequent summers…2010 summer still to come).
- Includes average winter rainfall years, near-record dry spell and second summer of high temperatures.
- Overrated threat of drawdown impacts? Vegetation adapted to a ‘drier’ habitat.
- Success of this option is conditional on:
  - Applicability to bore field management history
  - Hydrogeology, lithology
  - Storage vs immediate use of production volumes
- Highlights the possibilities for adaptive management in a shrinking resource scenario.