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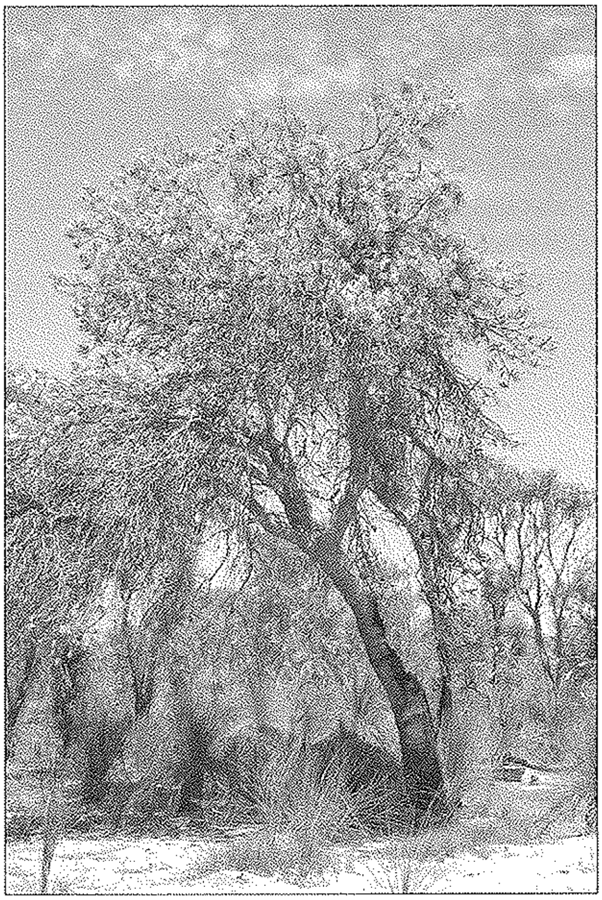
IMPACT OF GROUNDWATER USE AND DECREASED RAINFALL ON BANKSIA

Ray Froend

Throughout Australia the future of groundwater resources is being assessed due to increasing pressure from consumptive uses (pumping) for agriculture, mining and urban developments as well as climate change. The role groundwater plays in influencing the health of major ecosystems across Australia is also being increasingly recognised. Groundwater-dependent ecosystems can be defined as a complex community of organisms where groundwater is a key resource required for consumptive use, biophysical processes or as a habitat. To ensure the continued health of groundwater-dependent ecosystems, their water requirements need to be identified and formally recognised by environmental management agencies so that sufficient water can be allocated to meet those requirements. However, the groundwater requirements of different ecosystems are poorly understood. If environmental policy, planning and management agencies are to consider the groundwater needs of ecosystems, sufficient quantitative information is required to determine how much water can be taken from the environment before significant impacts occur.

One example of a groundwater-dependent ecosystem is the banksia woodland of the Swan Coastal Plain. This ecosystem consists of communities that have constant, seasonal or episodic dependence on groundwater to sustain transpiration, growth and seedling establishment and therefore can be classified as phreatophytic (meaning groundwater-using vegetation). The water requirements and in particular the groundwater requirements of phreatophytic banksia species has received considerable research interest over recent years. Of particular importance is whether there is a seasonal difference in banksia dependence on groundwater. Seasons of high groundwater use by banksia, such as during the dry summer months, when shallow soil moisture is depleted, are times when these plants are most susceptible to groundwater drawdown (lowering of the watertable).



A recently-dead banksia on the Swan Coastal Plain, all leaves brown
Photo: R. Froend

Through assessment of the natural abundance of the stable isotope of hydrogen within the available water sources and trees, recent research at Edith Cowan University has identified seasonal variability in the relative importance of groundwater as a water source to banksia species. During winter and spring (wetting phase of the year; see diagram), unsaturated soil horizons contain sufficient moisture to provide up to 80% of the total water use of a banksia tree. Only 20% of the water used by the tree is derived from the capillary fringe (groundwater rising 50 cm above the watertable due to capillary action). During the drying phase of the year (summer and early autumn), when rainfall recharge of the unsaturated zone ceases and soil moisture is depleted through evaporation and transpiration, the relative importance of groundwater as a water source increases significantly to 70%. This highlights the vulnerability of banksia to groundwater drawdown during the summer and early autumn months. Lowering of the watertable beyond the reach of the sinker roots removes the primary summer source of water to the trees. Moisture reserves remaining in the unsaturated zone then become the sole water source during summer but may be insufficient to meet tree

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Banksias and water

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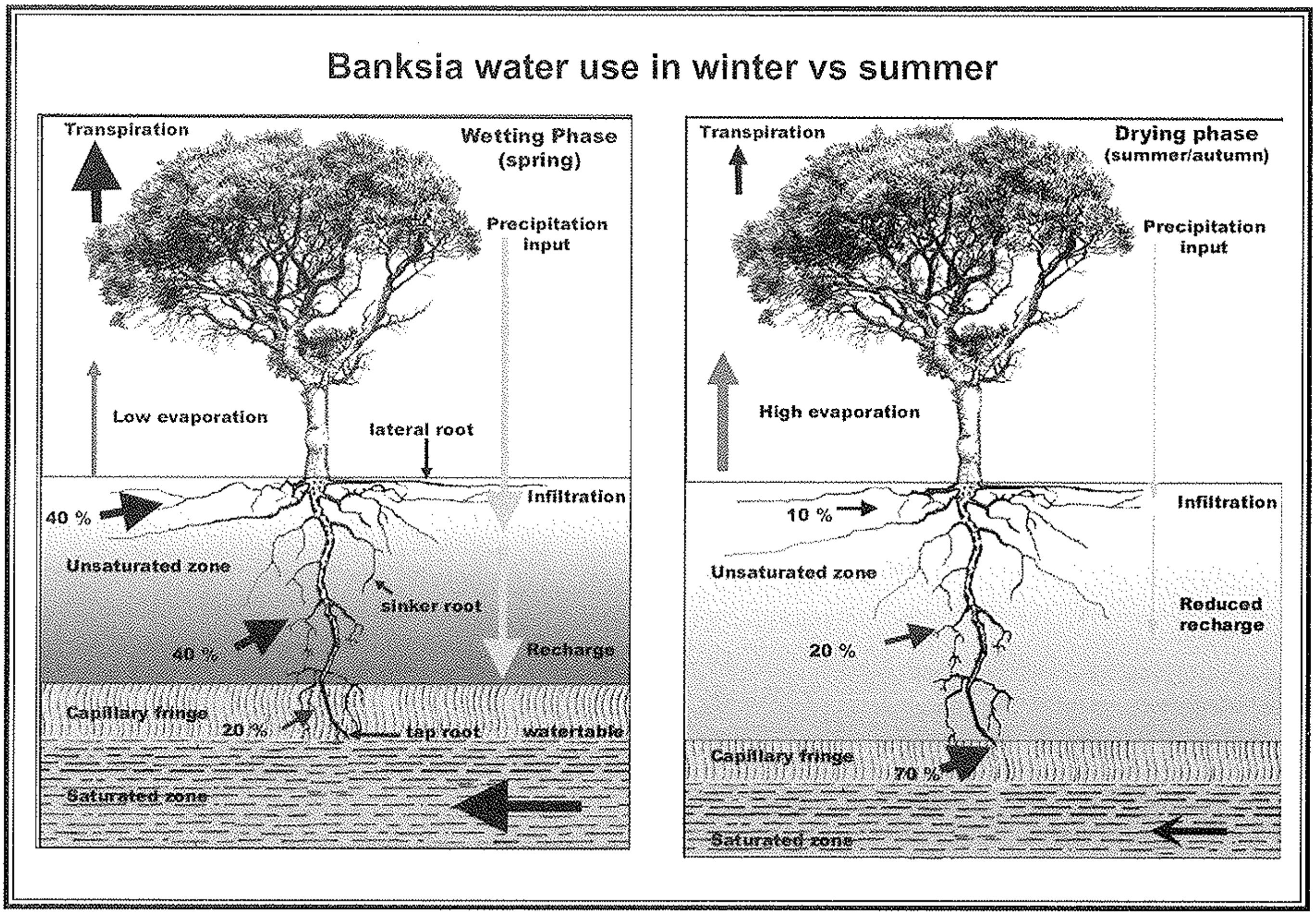

water requirements for a long period of time (1-2 months). However, by this time, autumn rainfall usually recharges the unsaturated zone and by late winter, groundwater is also recharged and the watertable rises again, resetting the plant water sources for another seasonal cycle. If insufficient recharge occurs due to reduced rainfall, or groundwater abstraction increases, watertables may not rise again, leaving the unsaturated zone as the only water source. In this case, the banksia trees will experience significant drought stress by the end of the following summer and may die as a result.

Recent increases in banksia death throughout the Swan Coastal Plain is predominately a reflection of record minimum winter (2006) rainfall recharge of soil moisture and groundwater levels. The most severe cases of banksia mortality have occurred where summer groundwater abstraction or land use changes have exacerbated poor winter recharge. Evidence of tree decline is typically seen in the first summer after a poor rainfall season. Further mortality is sometimes seen even during the second summer after a poor recharge year, therefore the full extend of banksia decline as a consequence of the poor 2006 rainfall (and cumulative influence of groundwater abstraction) did not become evident until the summer of 2007/08.

By identifying the seasonal variability in water source use by banksia, groundwater users are able to plan for abstraction to occur during times of the year when threats to the groundwater-dependent vegetation are minimal, and maintain abstraction rates at a level which ensures groundwater access by banksias during spring and early summer. However, even with improved groundwater use management, rainfall reduction due to climate change will continue to have a profound influence on the vegetation of the southwest, and in particular, the phreatophytic banksia of the Swan Coastal Plain.

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