This turned out to be correct; there was a higher proportion of tree death of all tree species including *Banksia menziesii* compared to the site closer to the water table. *Banksia menziesii* trees rely on soil moisture during the dry summer months and during particularly hot, dry summers this soil moisture may be depleted if it is not replenished by rainfall and this may result in death. However, this did not happen this year.

The year in which the highest number of trees of all species died in the two sites in Kings Park was 2011. Most trees die during autumn, so the relevant rainfall is that of the previous spring and summer prior to death. In 2010 Perth had a record dry, hot year. There were three heat waves in 2010 and six in 2011. This, coupled with the hail storm of March 2010, is likely to have caused the high number of tree deaths, including *Banksia menziesii* observed in the Kings Park bushland in 2011.

Findings from my project revealed that the highest mortality of *Banksia menziesii* trees that was observed seems to have occurred following a particularly hot, dry summer and therefore widespread death may not occur every year.

With predictions of further warming and drying and an increased frequency of heat waves in the future in the south-west of Western Australia (IPCC 2007), we will likely see more *Banksia menziesii* trees dying.

Tree death is a complex process and there may be many contributing factors. There is a lot that we still don’t know about this iconic *Banksia* species and therefore more research is needed to understand the process of mortality.

Whether we can do anything about this problem at Kings Park is not clear, but a larger research project is just commencing, involving collaboration of scientists from the Botanic Gardens and Parks Authority and the University of Western Australia may provide more answers.

References


Seagrasses have evolved special traits to adapt to these difficulties. Seagrass pollen has been highly modified for dispersing underwater, with long, narrow (filiform) morphology (Figure 3), and are easily moved by currents. The flowers produce large amounts of pollen that is released as a fine cloud through August and September. The elongated shape of the pollen grains and complex water flow around the flowers and seagrass canopies slow water movement and increase the chance of trapping pollen. Successful pollination requires the transfer of pollen from the anther (where it is produced) to a receptive stigma for fertilisation. Approximately 40% of all seagrass species have male and female flowers present on the same plant. The term for this is monocious. Plants vary in size within a seagrass meadow, with some spreading their rhizomes many metres below the seafloor. Shoots extend upwards from the rhizomes and many of these shoots can produce flowers (or inflorescence spikes) in a single year. Therefore, lots of pollen from the same plant can mix locally and pollinate flowers from the same plant.

Three types of pollination systems are possible in monocious seagrasses (Figure 4): (1) Transfer of pollen from anther to stigma within a seagrass flower (self-pollination). This type of self-pollination can be prevented by delaying stigma receptivity until after the pollen is released. (2) Transfer of pollen from a flower on one inflorescence to the stigma of a flower on a different inflorescence (geitonogamous pollination, another form of self-pollination). (3) Transfer of pollen from the anther of a flower on one plant to the stigma of a flower on a different plant (outcrossed pollination).

If self-pollination is not tolerated, then plants must be able to recognise their own pollen when it lands on a stigma and prevent pollination (prezygotic) or seed development (postzygotic embryo abortion). When seeds are produced only by outcrossed pollination, then seeds are the result of genetic recombination (new combination of genetic information) and all new plants will be genetically unique.

Measuring the distance individual pollen grains move in the water is important for determining the extent of gene flow among local meadows. In reality, this is a seemingly impossible task! So rather than attempting to ‘track’ individual pollen grains in the water column, we use DNA markers to infer pollen movement. Individual shoots (from a mother plant) and their attached floral spikes containing up to 15 mature fruit (inflorescence), were collected as ‘families’, with the GPS location taken for all samples. By genetic fingerprinting (genotyping) each mother shoot and all the attached fruit, it is possible to determine the genetic pollen contribution for each fruit. The genotypes were used to assess overall levels of genetic diversity, size of individual parental plants, the mating system (inbreeding, outcrossing, or a combination), identify pollen donors (single or multiple pollen donors per ‘family’), and calculate the distance pollen has travelled between parental plants.

Two local seagrass meadows were chosen, one exposed site at Point Peron and one protected site within Cockburn Sound along the eastern shoreline of Garden Island, to see if the local conditions impacted on pollen dispersal distances and mixing of pollen.

Water movement at the time of pollen release may affect pollen mixing and dispersal distances; for example multidirectional wind and wave action could enhance mixing, while calm conditions with weak currents may reduce mixing across a meadow.

The average plant size was approximately 13 m in both meadows, but genetic diversity was higher in the sheltered meadow at Garden Island. Few plants were identified as pollen donors to specific fruit, likely because of the large and unknown number of plants in meadows and how far pollen can be carried.

For those fruits where a pollen donor was found, the mean distance a pollen grain travelled (calculated from the GPS points) was slightly higher at Point Peron (31 m) than Garden Island (27 m). The longest distance travelled by a pollen grain was 178 m in the Point Peron area. Water movement at the time of pollen release may affect pollen mixing and dispersal distances; for example multidirectional wind and wave action could enhance mixing, while calm conditions with weak currents may reduce mixing across a meadow.
Individual flowering spikes at Point Peron also had a higher number of pollen donors contributing to successful pollination of those families. Some plants are also more successful at spreading their pollen (or perhaps they produce more by having a larger number of floral spikes in a year).

One individual plant at Garden Island provided pollen to five different ‘families’. This may be explained by the mostly north to south direction of inshore water flow in a largely protected site at Garden Island, relative to the potentially higher amount of water mixing at the more exposed Point Peron meadow.

Seagrasses appear to be very good at reproducing sexually, with high seed production in many of the local meadows (Figure 5).

Pollin is travelling beyond the size of the average plant and thus successful outcrossing is occurring. Seed abortion rates were very low (<4%), unlike a close relative in the Mediterranean (Posidonia oceanica), which has in excess of 80% abortion rate in seeds.

Flowers are in high density at both our study sites and are generally positioned above the leaf canopy for better pollen mixing and dispersal. The different localised water conditions at each site (highly exposed conditions versus weak directional current) appear to have little influence on the outcrossed pollination rate, although pollen appears to be mixing better and dispersing further in the more exposed meadow at Point Peron.

Pollin is certainly able to move over hundreds of metres, but it is highly unlikely that pollen moves further than >5 km estimated for fruit (containing seeds, Kendrick et al. 2012; see also Sinclair 2012).

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Other reading:


FREE GUIDED WALKS

Please meet a friendly volunteer Kings Park Guide at the sign near the Visitor Information Centre, opposite Aspects of Kings Park Gallery Shop. All walks start there. For groups of 10 or more, please make booking.

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