The Fire Regime

- **fire frequency - how often**
- **fire severity - how hot (often fire intensity is used for this)**
- **fire season - what time of year**
- **fire spatial extent - how much area is burnt and how patchy this burnt area is**

In managing plants, animals and fires, it is important to remember that fires at a particular place can occur at different frequencies (**FIRE FREQUENCY**); will burn at different severities (**FIRE SEVERITY**); occur at different times of the year (**FIRE SEASON**); and will burn different sized areas from small patches to huge expanses (**FIRE SPATIAL EXTENT**). These four components make up what is known as the fire regime and they remind us that fires occur regularly in any fire-prone habitat. For the long term survival of plants and animals, we need to know how they are affected by the interaction between the above four components, i.e., the fire regime. How each of these four components of the fire regime affect plants and animals is shown below; remember though, that all four operate together in nature.

Post fire recovery in the Great Sandy Desert, WA (note dead shrubs, likely acacias, and small Triodias). Credit: Lucy Commander.

Fire frequency

The first thing we need to think about when an area is to be burnt, or when we hear that there has been a fire somewhere, is to ask **when was the area last burnt?** This is because fire frequency is the most important component of the fire regime in terms of the survival of plants. All fires burn areas of vegetation that have been burnt some time before. In the current 2019/2020 fires, this will range from areas burnt in the last 12 months to areas that have not had fire in living memory, and everything in between. For example, large parts of the fire in the Wollemi and Blue Mountains National Parks has burnt over areas where the previous fire was 3-7 years ago, while other areas were long unburnt.

Consequently, our bushland is a mosaic of fire histories, with some parts of the bush having had more fires than others, even though to the casual eye it may all appear the same.

Plants that are killed by fire, fire-sensitive plants, rely on seed germination after fires to survive at a particular location. For these plants, there must be sufficient time between successive fires for seedlings to mature and produce more seeds and hence, add seeds to the seed bank. This time will vary between species, with some species like flannel flowers (*Actinotus helianthi*) and sweet-scented wattle (*Acacia suaveolens*) flowering in the first two years after fire. Other species, such as the heath banksia (*Banksia ericifolia*) or *Persoonia pinifolia* may take 4-7 years to reach maturity. If another fire should occur before these plants have reached reproductive maturity, dramatic changes in the vegetation may occur.

Woody fruits of ti-trees, *Leptospermum* species open after fire and release their seeds

Fire-sensitive plants with woody capsules usually release all their seeds after a fire and no residual seeds remain in cones. These plants are the group which is most susceptible to two fires in short succession. Indeed, they can be eliminated locally if two fires occurring close enough in time to kill any seedlings that emerged after the first fire, before these seedlings had time to mature.

Plants that have seeds stored in the soil usually have some residual seed bank remaining in the soil following post-fire germination. For these species, a second fire before seedlings mature will severely reduce the size of the population, but it may not eliminate species locally. Ideally, land managers with concern for conservation of biodiversity should allow

the interval between fires to be long enough not only for new seedlings to mature, but at a minimum, several fruiting seasons beyond this so that a sufficiently large seed bank can be established before the next fire occurs. This should allow species to persist at a site.

Brunoniella australis flowering 2 weeks after fire.

The heath banksia (*Banksia ericifolia*), an example of how fire frequency can affect plants that are killed by fire.

This banksia grows to a large shrub of 5 m by 3 m and can dominate heaths and the understorey in woodland plant communities on sandstone and sandy soils from Jervis Bay in NSW to the Queensland border. Each autumn to winter the heath banksia produces large spectacular orange flower spikes. When these are pollinated, they produce woody cones which store seeds between fires in the canopy of the plant (**canopy seed bank strategy**). The heath banksia is killed by fire (**fire-sensitive)**, and after a fire the dead plants with lots of woody cones stand out as reminders of what the bush looked like before the fire. The heat from the fire helps to open the woody fruits and release lots of seeds onto the soil surface. These seeds germinate when there is sufficient rainfall, resulting in lots of new seedlings of heath banksia after fire.

Where a population of this species is burnt, it begins recovery via seedling germination, and it may take 4-5 years for these plant to mature and produce more woody fruits. If the population is burnt again before woody fruits can be produced, then it could become locally extinct or if only a few fruits are produced its abundance can be markedly reduced. We have seen this happen before and it may have happened to a range of species in the current 2019/2020 fires.

For those plant species that are capable of surviving a fire and regrowing after a fire (resprouters), it might initially appear that it does not matter how frequent fires are, since these plants survive fires. This is a very simplistic view and in reality not all these types of plants survive all fires. The level of plant mortality will vary between fires, but we expect that the more heat produced by a fire (fire severity), the more mortality there will be amongst resprouting species and the more new plants that need to be recruited to maintain the population into the future. The key for resprouting plants is that there must be sufficient time between some fires at any one place for seedlings to grow big enough to become fire-resistant. Becoming fire-resistant usually involves the development underground of a lignotuber, rootstock or bulb, or in the case of grasstrees, burial of the apical bud sufficiently deep in the soil. Now just how long does it take for the juveniles of resprouting plants to be large enough to survive the next fire? From what we currently know it would appear that it may take the seedlings of some slow growing resprouting species 8-12 years to become big enough to survive a fire, although other species are much quicker. This would mean that even for resprouting plants, we need to allow periods of a decade without fire in order to allow all species to persist at a site. This may not be necessary after all fires, but it is essential after at least some fires.

Reshoots on a branch of *Banksia serrata*.

Fire severity

How hot a fire is will depend on how much combustible fuel is available, how dry this fuel is, the topography of the area and the weather conditions, such as humidity and windspeed. When an area is burnt, the important thing for plants and animals is how much heat is produced. While fire severity can vary across the landscape, the 2019/2020 fires have

been recognised for being of high severity in many locations due to weather conditions and prolonged drought.

Where the fire is hottest, the flames reach the tree canopy and it is consumed. In other areas, where the fire is less severe, only the shrubs under the trees are actually burnt, and the leaves in the tree canopies are killed by the heat from the fire (scorched). These leaves turn brown and fall from the trees in the first few weeks after a fire. In still other areas, the tree canopies are not heated enough to kill the leaves and they remain green after a fire. In this case, the fire passes though the area at or near the ground and the shrubs may also not have their leaves burnt, but simply scorched. **So even though an area is burnt, the impact of the fire on plants and animals may be very different in different parts of the burnt areas depending on how hot the fire was.** In general, creek gullies, are moister, and so burn with less intensity than drier ridges and slopes. On the other hand, western facing slopes burn with the highest intensity in extreme weather conditions.

How much heat a fire produces can affect the survival of plants, as well as animals. Under severe fires, more resprouting plants are likely to be killed, and longer periods needed before the next fire for recovery, compared with milder fires. Greater soil heating, in severe fires, may kill seeds on or very near the soil surface. However, many plant species have seeds which lie dormant in the soil and for a number of these species the amount of soil heating that occurs during the passage of a fire will govern the amount of germination after the fire. This is particularly the case in wattles and peas (*Acacia*, *Bossiaea*, *Dillwynia*, *Pultenaea*), but it is also likely in a range of other plants, i.e. there can be prolific germination in wattles and peas after severe fires and these species are important in fixing soil nitrogen and making it available to other plants.

Fire season

For the survival of plants, does it matter when the vegetation is burnt? Recent studies have highlighted the importance of fire season on long-term plant persistence. The best known factor is the influence of season on germination after fire: less germination may occur after a cool season burn compared to after a wildfire in summer, in eastern Australia. Other factors that may be affected by fire season are plant survival in fire, flowering after fire, seed bank availability and plant growth (Miller et al. 2019).

Spectacular displays of Christmas bells, Blandfordia, in the second year after fire.

Fire spatial extent

What is the impact of the spatial extent of fires on plants? Fires come in all shapes and sizes. Some burn very extensive areas, while others may only burn a hectare or so. Within the boundaries of a burnt area, fires may be widespread and burn most of the vegetation, or leave large parts of the vegetation unburnt or only lightly scorched. All fires will be different, depending on: terrain, rate of fire spread, amount of fuel available and its moisture content, weather conditions and the presence of natural or man-made fire breaks. As well, fires burning at night will have different patterns to those burning during the day, as conditions at night are often milder. The result of all this: fires are patchy in area and severity.

For plants, the spatial extent of fires may be particularly important where burns occur on a scale or pattern that allows feral or native animals from surrounding unburnt vegetation to graze heavily on the new green shoots that appear after fire and hence, cause a decline in some plant species. The 2019/20 fires were very extensive, but there are a number of areas that are more patchy e.g., Kosiusczko National park, where regrowth after fire may be severely impacted by feral horses, deer, pigs and rabbits/hares. This will slow the rate of recovery of vegetation, and this is a particular problem for localised rare or threatened species as they recover.

Further Reading

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