Interpreting Flowering Graphs

Flowering is presented over 18 months from January to June. This allows easier comparison of both summer and winter peaks, in that the graph does not split one or the other.

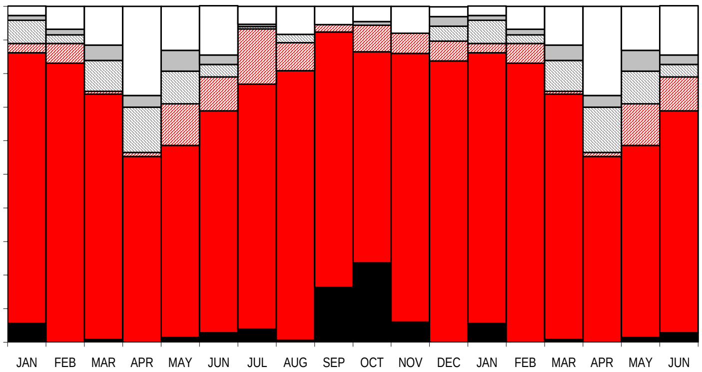
The unlabelled y-axis on the graph is a proportion (out of 1.0 or 100%, with tick marks at 0.2 intervals) of the total data (sample sizes are in the textual account). Data are the proportion for each month of the flowering categories (see definitions above) in ascending order:

Peak Flowering = Black;

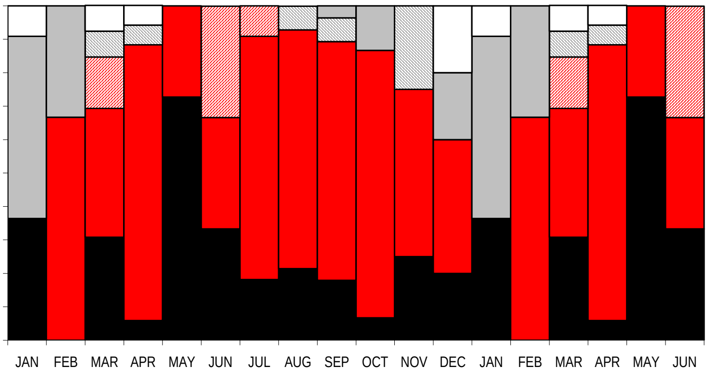
Flowering = Red; Bud = diagonal up red; Over = diagonal down grey;

Cone = Grey; and, Nothing <change throughout document to “No Flowers ?”>= White.

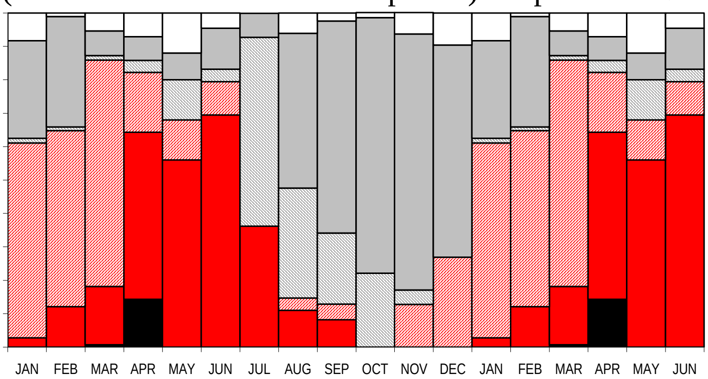
Note that data are for populations (or record localities), and not plants per population. No attempt has been made to restrict data to mature plants, so records for young veld are included. The following examples illustrate the most important patterns:



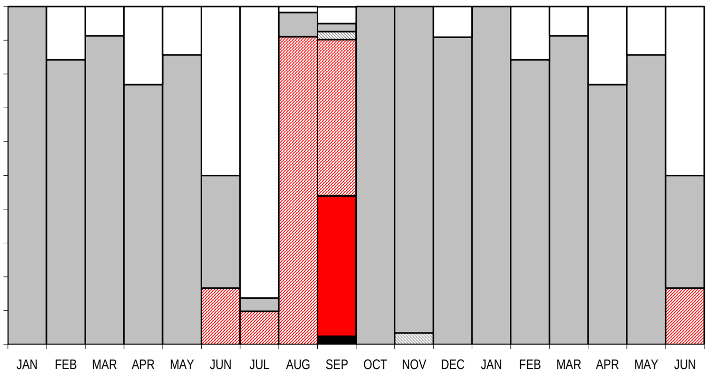
No season: *D. divaricata* has no proper flowering season, generally found in flower all year round. Peak Flowers occurs mainly in Sep to Oct, and Buds and Over occur at low levels all year round, as do Cones – in this non-serotinous species this means seeds. A low number of records have No Flowering.



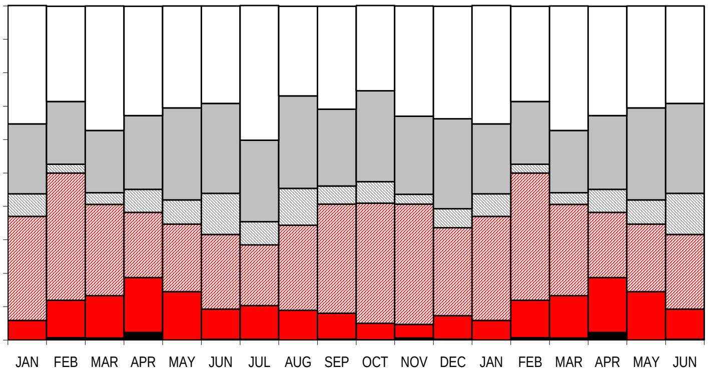
High Peak: *S. mollis* is unusual in having a high incidence of Peak Flowering. Flowers are found in most months, but lowest in Dec to Feb, when Cones (seeds in this non-serotinous species) are prominent.



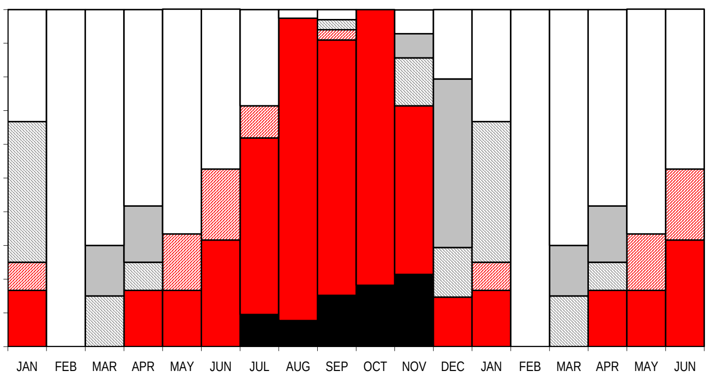
Broad season: *P. susannae* has a broad flowering season centred on Apr to Jul, but extending from Jan to Sep. Prior to Jun it is in Bud, and post Jun it is Over. During the non-flowering season the serotinous cones are prominent, with very few records of No Flowering (probably from young veld).



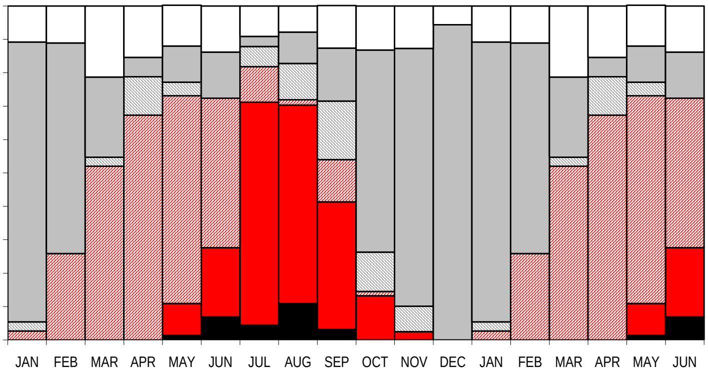
Narrow season: *L. laxum* has a very narrow flowering season (Sep), with Buds from Jun to Sep, and almost no detectable Over (Sep and Nov). Seeds (Cones) are stored on the plant until Jun, when they are dropped prior to the plants going into bud.



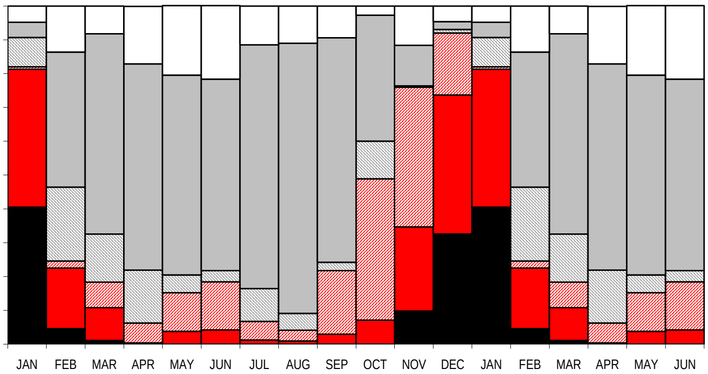
Low flowering: *P. cynaroides* does not produce much flowers, although there is a barely detectable autumn-winter peak. Note that the proportion of Buds is high all year round and that this exceeds the Flowers, suggesting that many buds produce new growth rather than flowerheads. Although serotinous, about an equal proportion have No Flowering, suggesting either a long period to flowering after a fire, or – more realistically – that flowers are not produced in older veld.



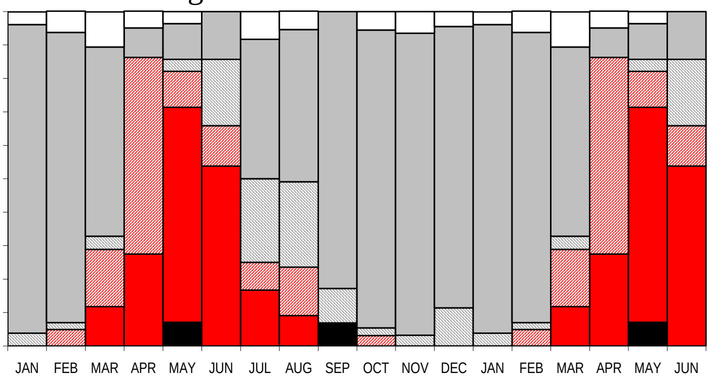
Skewed season: *M. pauciflorus* has a gradual increase in flowering from Apr to Jul, before reaching maximum levels (in both Flowering and Peak Flowering) from Jul to Nov. Post flowering there is a sudden decline with Over and Cone, with a lull prior to producing new flowers in Autumn.



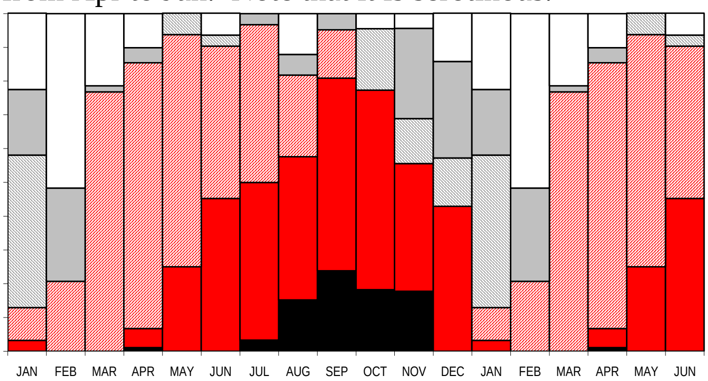
Winter Peak: *P. burchellii* has a winter peak, centred on Jul and Aug. Note that it is serotinous.



Summer Peak: *A. umbellata* has a summer peak, centred on Nov to Feb, with a strong component of Peak Flowering. Note that it is serotinous.

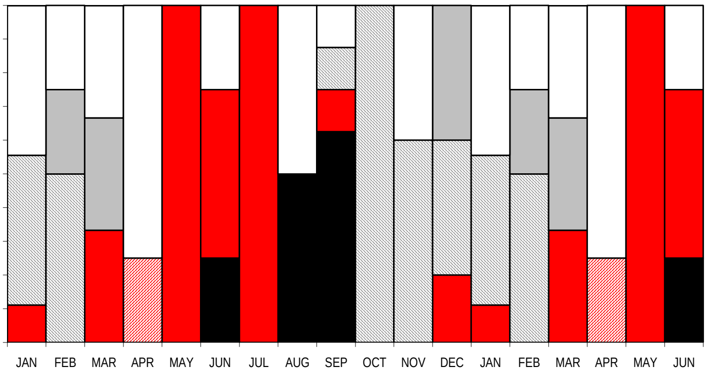


Autumn Peak: *P. canaliculata* has an autumn peak from Apr to Jun. Note that it is serotinous.

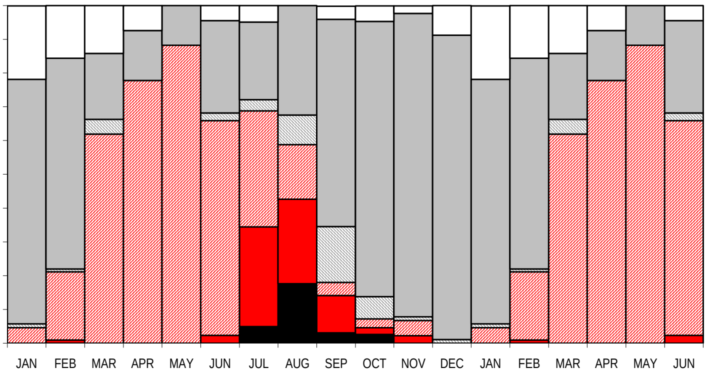


Spring Peak: *L. nitidum* has a broad spring peak, with most flowers in Sep to Oct. Note that it is not serotinous with Cones (seeds) on the plant from Nov to Jan (the "ant" season), and a brief spell of No Flowering before Buds start in Autumn.

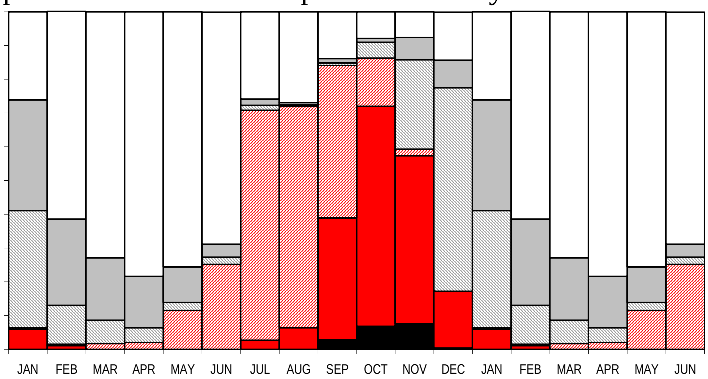
Bimodal Peaks: No examples of bimodal flowering (two peaks within a year) were found in our data.



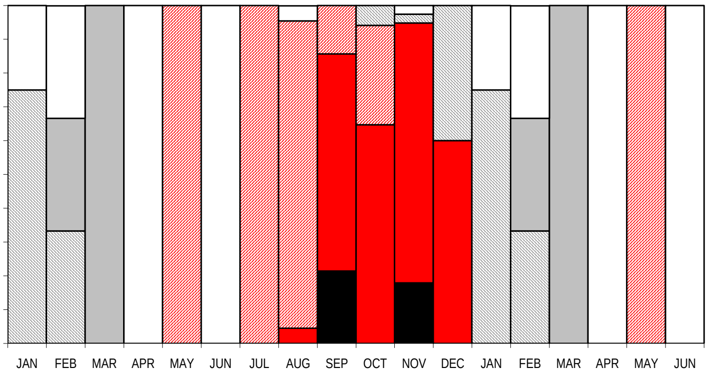
Short buds: *O. zeyherii* is unusual in only producing Buds for a very short period (Apr). By contrast plants are Over from Oct to Feb, with fruit (Cones) from Dec to Mar.



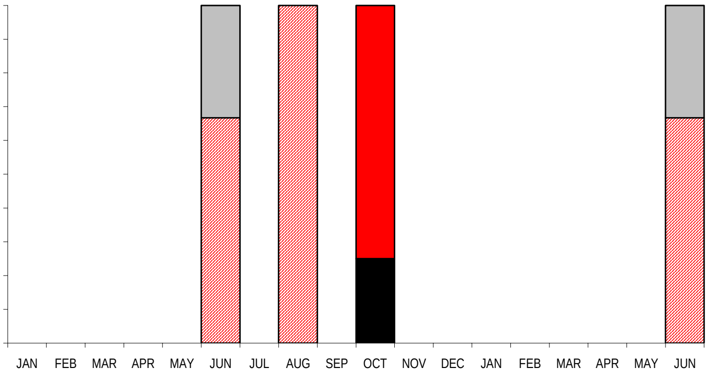
Long buds: *L. microcephalum* has buds from Feb to Jun, and flowers from Jul to Sep. Only Sep has prominent Over. The species is clearly serotinous.



Long cone: *L. conocarpodendron* is non-serotinous, and has an almost symmetrical Bud to Over pattern around the flowering period. Although fruit (Cone) peak in Jan to Feb, some can be found all year.



Short cone: *L. catherinae* flowers from Sep to Dec, with Over from Dec to Deb. However, fruit (Cones) are only found in Feb to Mar. The broad obvious steps in the bars suggest that data is limited and the graph should be interpreted cautiously.



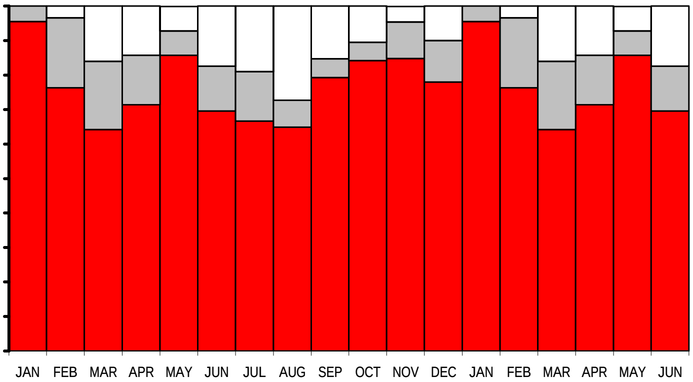
Insufficient data: *L. harpoganatum* is so rare that it was visited only infrequently – in four months. Although a pattern is evident, the sample sizes are too small to allow confidence in an Oct flowering peak, and do not allow the duration of the flowering season to be deduced, although the Cones from Jun suggest it might perhaps be as long as 6 months or more.

Interpreting Growth Graphs

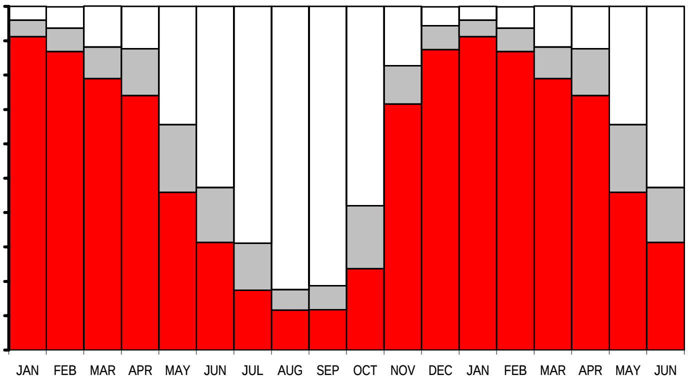
Like the flowering graphs, the growth graphs extend over 18 months from January to June. The unlabelled y-axis on the graph is a proportion (out of 1.0 or 100%). Data are summarized as the proportion for each month, in ascending order, of the growth categories:
"Much" in black; "Rare" in red; and, "None <change throughout in text to "No Growth"?>" as white.
Note that data are for populations (or record localities) and not plants per population.

Interpretation of the graphs is relatively simple, but for maximum benefit should be considered in tandem with the flowering data. Specifically, do species flower at, before, or after peak growth, or does growth cease for flowering? Do species with narrow flowering periods have narrow growth periods? There is a surprising wealth of strategies presented here for the first time.

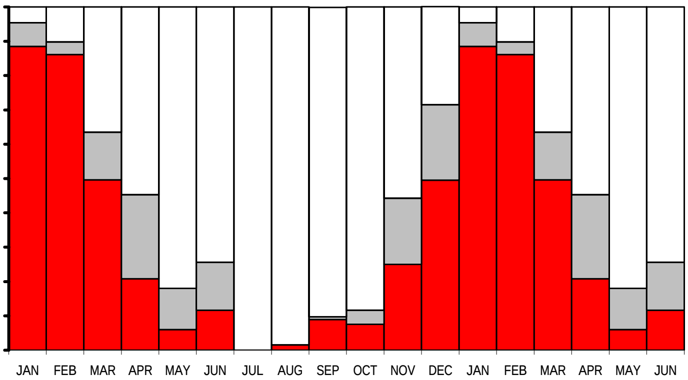
The following examples illustrate the most important growth patterns:



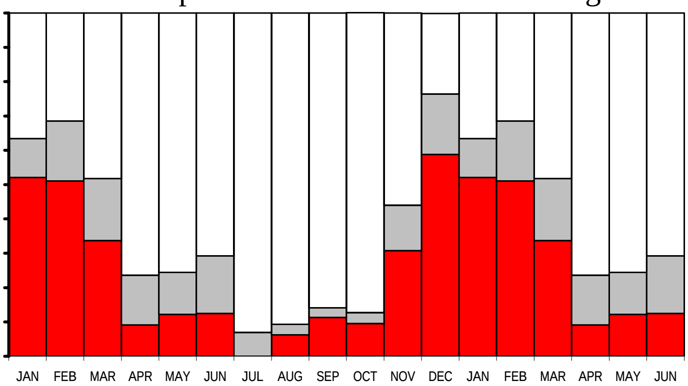
No season: *P. subulifolia* shows no seasonal pattern in new growth, producing growth throughout the year.



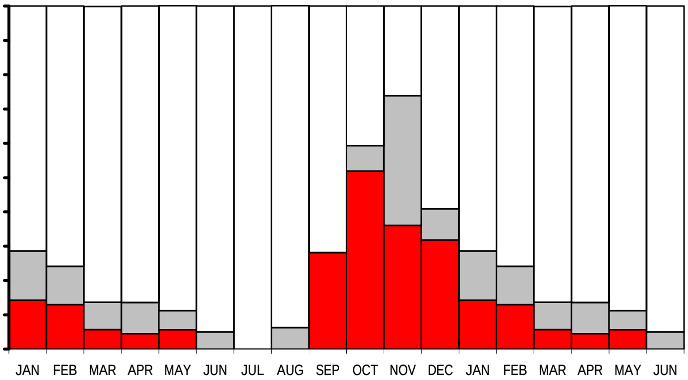
Broad season: *L. xanthoconus* produces growth from Nov to Apr, although there is some growth all year round.



Narrow season: *L. microcephalum* produces growth mainly from Dec to Mar, but peaks strongly in Jan to Feb. There is peak of No Growth in Jul to Aug.

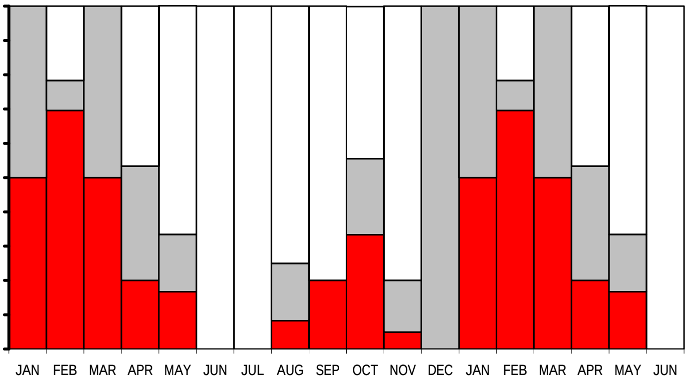


Low season: *A. pallasia* produces some new growth all year round, with a Dec to Feb peak, but even during this period only about 60% of populations are active.

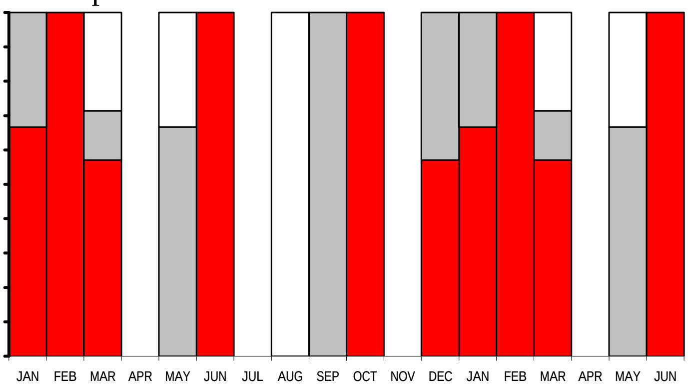


Skew season: *P. acuminata* has a sharp initial rise in growth from Aug to Oct, followed by a long decline from Oct to May. Although Much Growth peaks in Oct, most populations have growth in Nov.

Winter Peak: No examples of a winter peak were found in our data. Proteas don't grow in winther!



Bimodal Peak: *P. montana* appears to have two peak growth periods: a minor peak in Sep to Oct and a major peak in Jan to Mar. Not many species exhibit such a pattern.



No data: *D. myrtifolia* clearly grows from Dec to Mar, but the Jun and Oct peaks might be spurious based on too little data. Note the large column blocks, suggestive of few records per month, even though 9 of the 12 months have data.

Interpreting Age to Flowering Curves

The age to flowering curves have been calculated from data in which atlassers provided both the veld age and data on flowering. Veld coded as “Patchy” for fire age have been excluded, as have planted records. For each age class from 1 to 20 years old the proportion of records containing “None” for flowering *versus* the remaining categories for flowering has been calculated. These are presented as points on the graph with the vertical axis being the proportion of flowering records (from 0 to 1) per age class, and the horizontal axis the age of the veld (and by implication the age of the plants) from 1 to 12 years old (the data for 1-20 years are available electronically).

The error bars are calculated simply as $1/\sqrt{n}$: thus a big error bar of 1.0 implies a single record, an error bar of 0.5 above and 0.5 below would imply 4 records, and progressively smaller bars imply a greater and greater reliability of the data. Although not strictly accurate, it is useful to regard the data as being somewhere along the error bar and not necessarily at the shown point.

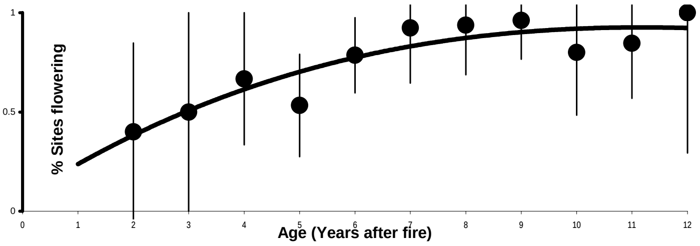
The curve connecting the points is calculated as a trinomial (ax^3+bx^2+dx+c). It is not constrained to pass through the axis (thus we do not assume that no plants can flower in year zero, i.e. that $c = 0$). The curves do not incorporate the sample sizes and consequently we have not presented estimates of accuracy (e.g. R^2) of the curves.

Note that these data are proportion of populations (or record localities) containing plants that have flowered, and are not proportion of plants within the population. No attempt has been made to check that these patterns are uniform across the species’ distributional range. Note that sample sizes are usually small.

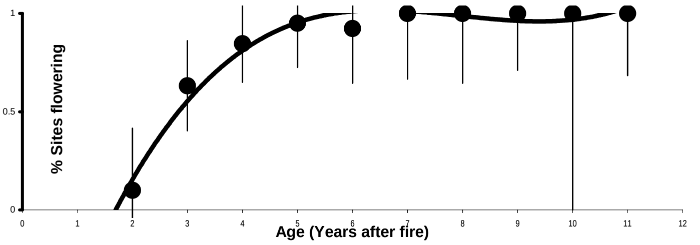
Strictly, age to flowering is only useful for serotinous species. These species store the fruit on the plant allowing plants that have flowered in the past to be coded as “In Cone” and not as “None”. For these species the age to 100% flowering is valid. For non-serotinous species, records from the non-flowering period will be coded as “No Flowering” so that values of 100% will rarely be achieved. Non-serotinous species flowering for long periods will attain higher values than those flowering briefly. However, species that are cryptic and overlooked when not flowering (e.g. some *Spatalla*) may have the proportions overestimated.

However, age to first flowering is useful for all species, and so curves are presented for all species. It must be noted though that only a single plant is required for the population to be coded as “Flowering” so that age to first flowering does not necessarily imply an ecological ability to cope with at this age, although it strongly suggests that some plants will survive.

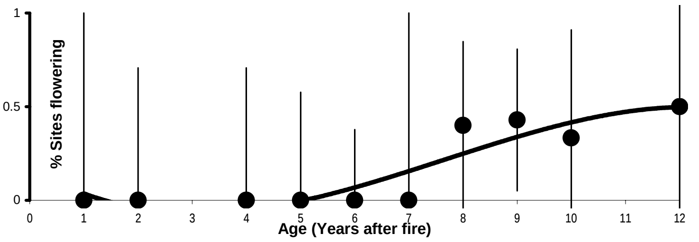
The assumption that the age of the plants is the same as the veld age does not apply to resprouters, which may be hundreds of years old. However, the utility of the graphs in determining post-fire flowering patterns is equally useful, and reflects a species ability to recover from the fire. Interestingly, many species exhibit the same patterns of recovery as species killed by fire.



Typical: *A. cancellata* produces its first flowers at 2 years, but note the high error bars for veld of 2 to 3 years age, and the lack of data for veld one-year old. Small error bars at years 6-9 indicate good estimates. About 50% flowering is reached in year 4-5 and 100% is approached, but not reached, in years 7-13.

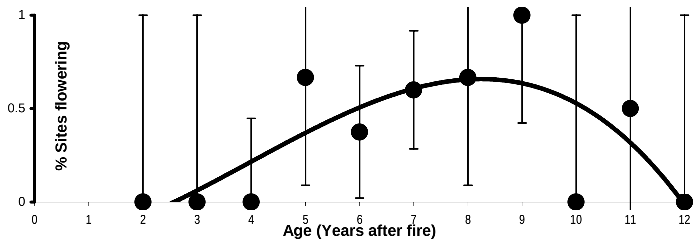


Early flowering: *A. pallasia* is a resprouter and flowers in the second year after fire, reaching 50% at 2-3 years and 100% by year 5, which is maintained thereafter.



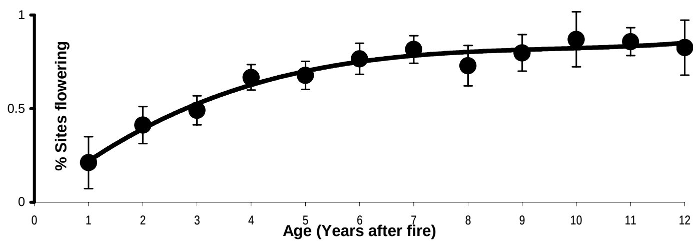
Late flowering: *P. stokoei* is a late flowerer, with the first data for flowering in 9-year old veld. Even at 13 years 50% flowering has not been attained.

Non-serotinous resembling serotinous: *O. zeyheri*, although myrmecochorous and thus expected to never peak flowering, in fact starts flowering in year 4, reaches 50% in year 7, and attains 100% from 8-9 years. The tails on the curve are extrapolation errors.

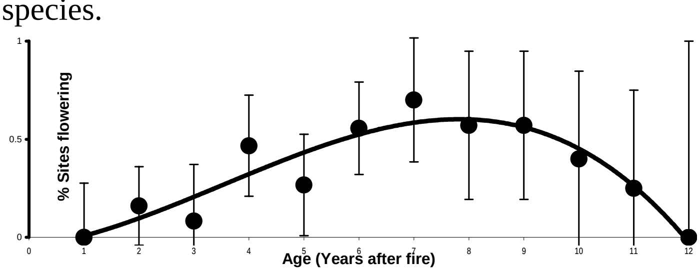


Non serotinous: *P. sceptrum-gustavianus* yields a curve expected for non-serotinous species, in that 100% flowering is not achieved because of records outside of the flowering season. Species with shorter flowering seasons will have lower peaks: in this case, flowering peaks at about 50% of populations, and suggests that after 9 years flower production declines. However, the error bars are too large to have much confidence in this interpretation.

Resprouter early flowering: *S. lineare* flowers at 100% after flowering. This is more likely to be a function of the populations not being detected when the plants are not in flower, than a true 100% flowering.



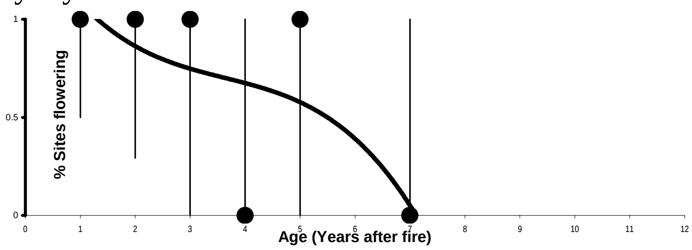
Resprouter resembling reseeder: *P. nitida* (note the nice short error bars indicative of plenty of data) appears to behave as a reseeder, except that in year 1 above 20% of the populations have flowered. However, the maximum attained is only 80% of populations – as we would expect for a non-serotinous species.



Resprouter with decline: *B. stellatifolium* displays the same pattern as *P. nitida* up until 7 years, but then declines to zero in year 13. The large error bars indicate the small sample sizes, and the last point is based on a single record which is thus of high uncertainty. Interpretaion of this curve is complicated by the flowers and fruit only being visible for a few months.

Resprouter with decline: *F. saligna* is a tree in grassland and should be largely immune to fire cycles. The data suggest though that most of the plants flower in the first 3 years following a fire, and then declines dramatically. Since most grasslands burn regularly, this might hint that keeping fires out of grasslands results in reduced flowering – however the high variance (error bars) suggests that such a hypothesis might be premature. On the other hand grasslands older than 3 years are relatively rare, and this may explain the lack of data for older veld.

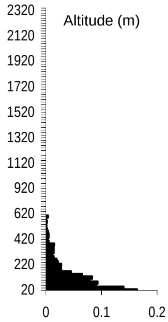
Poor data: *D. buekii* has only two records of veld age, both of which are supported by only a single data point. It is thus difficult to deduce anything from this data other than that some populations have flowered by 3 years.



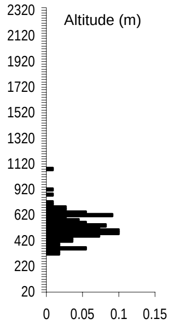
Poor data: *F. galpinii* has much more records, but most of these are based only on spurious data, as evidence by the large error bars. Little can be inferred other than that it can flower the year following a fire: perhaps not unexpected from a forest margin species.

Interpreting Altitude Graphs

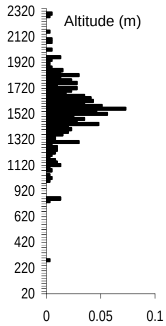
Altitude graphs are presented for all species. The vertical axis is the altitude range, which is resolved into 20 m intervals. The Fynbos altitude range of sea level up to 2400 m is used for all species – records from elsewhere higher than 2400 m are binned into the 2400 m class. The horizontal axis is the proportion of records from each altitude class – obviously species with many records from many altitudinal classes will have a low maximum value, whereas species that are poorly atlassed or with narrow altitudinal ranges will have a high maximum value. Planted records are excluded. Some patterns are:



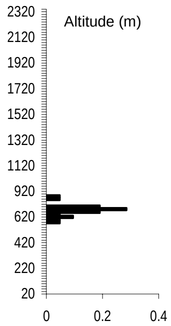
Low altitude: *L. coniferum* occurs mostly at very low altitudes from sea level to 100 m, but with outliers at higher altitudes.



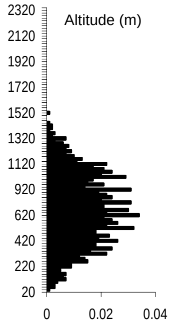
Medium altitude: *S. triternata* occurs mainly between 400 and 600 m



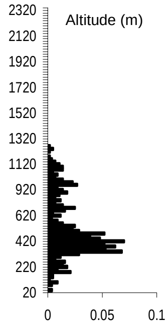
High altitude: *S. lanatus* is primarily a high altitude species, occurring above 1000 m, but with a peak at about 1500 m.



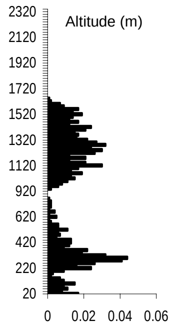
Narrow altitudinal range: *P. inopina* occurs over a very narrow altitudinal range, at about 600 m.



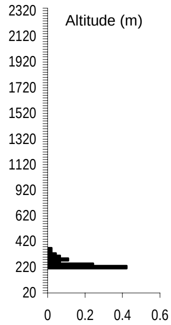
Broad altitudinal range: *P. nitida* occurs over a broad altitudinal range from sea level to 1300 m.



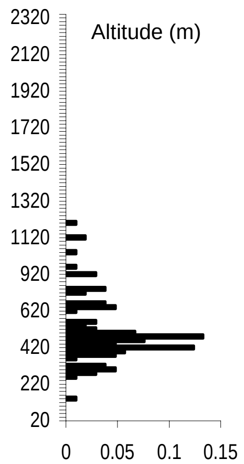
Double Peak: *L. procerum* shows two peaks: a sharp peak at about 400 m, and a lower, broader peak at about 800 m.



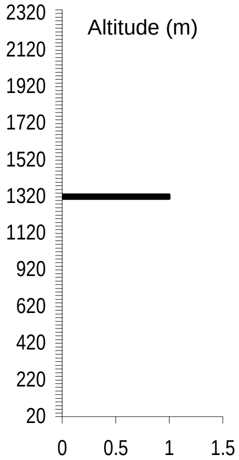
Triple Peak: *L. teretifolium* displays three peaks, corresponding to its three disjunct areas, viz. Agulhas Plain at 50 m, the Ruens with a sharp peak at 220 m, and the Little Karoo with a broad peak between 1000 and 1500 m.



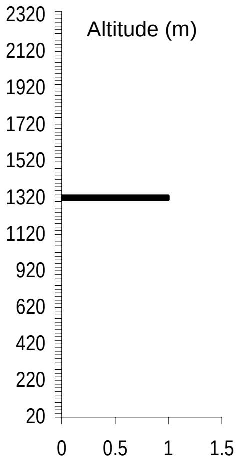
Poor data: *Di parile* has poor data, but this reflects its rarity rather than poor atlas data. Note though that the species is confined to a narrow altitudinal range.



Poor data: *D. thymaeloiodes* appears to have poor data, as the upper data is sparsely scattered over a wide 600 to 1200 m range. However, this is due to poor sampling of its habitat by this species, rather than lack of atlas data.



Profile of Cape Flora data: <dummy graph – data still to be compiled>



Profile of South African data: <dummy graph – data still to be compiled>

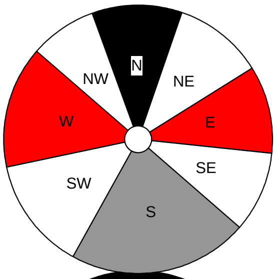
Interpreting Aspect Pies

Data were coded by Atlassers into 16 compass points. These are summarized as the four major compass points in the text summary. The Aspect Pies summarize these data in 8 compass points. The categories NNE, ENE, ESE, SSE, SSW, WSW, WNW and NNW were halved and the value added to the 8 principal compass points. These are coloured as black for North, grey for South, red for East and West, and white for the four intermediate compass points.

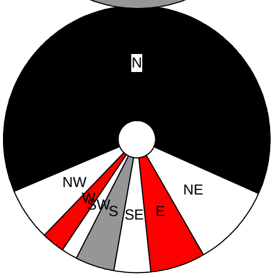
The proportions of records are coded as the angle of the pies. Thus a bigger slice implies a larger proportion. This has the disadvantage that the position of the compass points is lost, but is does have advantages. The North slice is constrained to be centred at 0^o.

However, aspect is not always relevant. Especially where the landscape is flat aspect may not a major environmental factor to the species. Consequently, the proportion of records from flat landscapes (Valley Bottom, Hill Top, Plateau) has been included as a doughnut. The size of the doughnut varies from < 10% for species that are confined to slopes, to 90% (the limit of legibility of the pie) for those that only occur in flat landscapes. The scale between 10 and 90% is linear and equal to the proportion of flat areas.

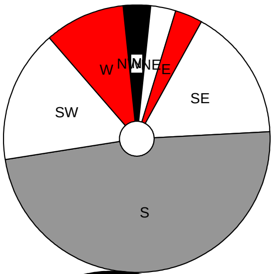
Even
Protea lepidocarpodendron has a fairly even distribution of aspect, with a very slight bias to the south and south-west. Almost all the records are from slopes.



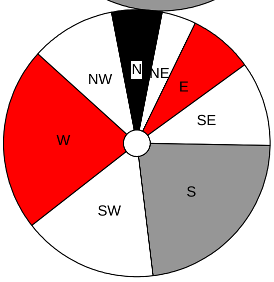
North bias
Leucospermum erubescens has a strong north bias, with over half of records from the north slope, and a good proportion of the rest from the NW and NE slopes.



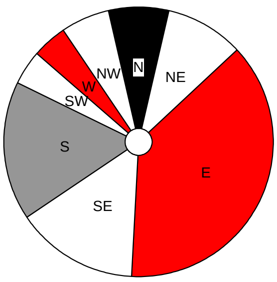
South bias
Leucospermum formosum has a strong south bias, with a good proportion from the SW and SE slopes as well. West slopes are slightly better represented than eastern slopes.



West bias
Leucadendron sessile has half of its records from the west, SW and NW sector. By contrast, only one quarter of its records are from the equivalent eastern sectors.

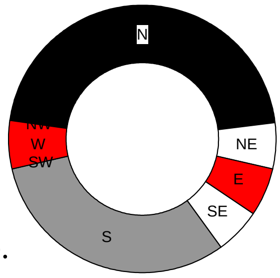


East bias
Leucadendron argenteum has a third of its records from the East, and over half from NE to SE.

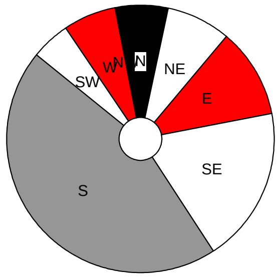


North-South bias

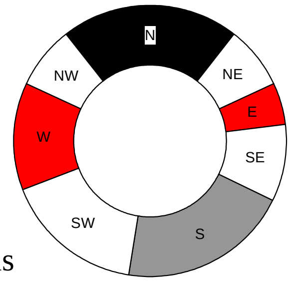
Mimetes saxatile has most of its records from the North and South slopes, and very few from any other aspect. About half of the records (57%) are from flat areas, as shown by the size of the doughnut in the centre.



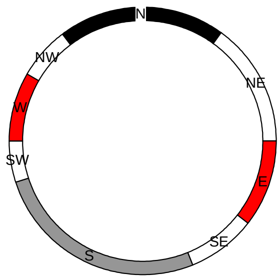
South and East bias
Protea stokoei occurs predominantly on south and SE slopes, but also on east and NE slopes. As a consequence the larger south wedge is displaced clockwise.



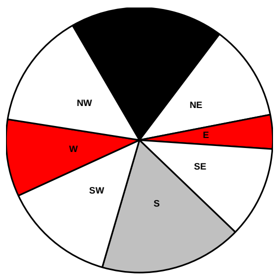
Largely flat landscapes
Leucospermum hypophyllocarpodendron occurs predominantly (56%) on flats and low-lying areas, with relatively few records from slopes. This is indicated by the relatively large doughnut.



Exclusively flat landscapes
Leucospermum heterophyllum occurs almost exclusively (> 90%) on low-lying areas and although aspect data give a good aspect distribution (slightly biased to S and NE), the size of the doughnut suggests that aspect is largely irrelevant for this species.



Sampling domain in the Cape.
The distribution of aspect types in the Cape Flora is not symmetrical and is shown opposite. Note the bias of north and south slopes (due to the Swartberg and Langeberg-Outeniqua- Tsitsikamma mountains ranges) compared to east and west. This is the pattern expected for species that are not affected by aspect. Flat areas are ignored in this summary.



Interpreting Distribution Maps

More to come here.