



Forestry Commission

P R A C T I C E G U I D E

HAZARDS FROM TREES



A General Guide

APPENDIX 1

Tree Hazards: Recognition and Recommendations

1. Abrupt bends in branches

An abrupt or ‘dog-leg’ bend is likely to mark the point where a side shoot has replaced a pruned, broken or dead portion of the branch. A combination of localised stress and decay, associated with the old wound, can sometimes lead to failure.

Possible signs of significant hazard:

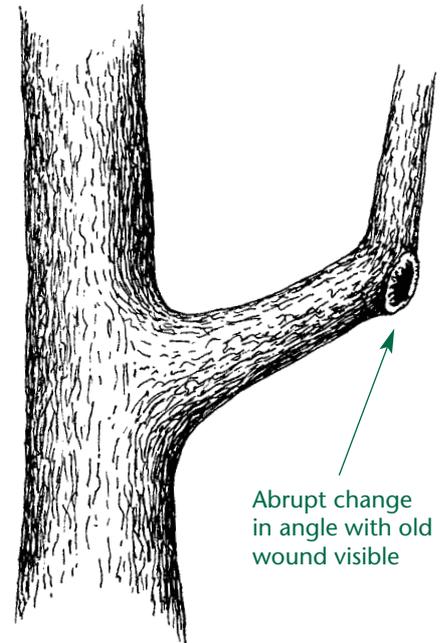
- Signs of decay at the ‘elbow’: this may need detailed assessment.

Options for remedial work on the tree, if needed

- Cable or belt and/or rod bracing of the branch.
- Branch reduction or removal.

Prevention

- Avoidance of cutting back branches.
- Avoidance of creating large wounds if branches do have to be cut back.



2. Brittle decay

The most dangerous form of decay is brittle decay, caused by fungi which degrade the rope-like cellulose content of wood (‘brown rot’). The tree retains its rigid strength (conferred by lignin) so that warning signs of increased flexure and cracking are usually absent. Snap can occur suddenly. Identification of fungal fruit bodies indicates the type of decay that is likely to be present.

Possible signs of significant hazard:

- **Fruit bodies of fungi associated with brittle decay.** Those commonest on woodland trees and most likely to be associated with brittle failure are:
 - *Laetiporus sulphureus* (on some broadleaved trees and yew)
 - *Sparassis crispa* (on conifers)
 - *Phaeolus schweinitzii* (on conifers)
 - *Ustulina deusta* (on many broadleaved trees)

Options for remedial work on the tree, if needed

- Cable or belt and/or rod bracing for affected branches.
- Crown reduction.
- Felling, if other options are not adequate or feasible.

3. 'Bottle-butt' ('Butt-swell')

Certain types of decay at the stem base, if extensive, may increase flexure sufficiently to stimulate extra growth of wood and create a bulge. In many cases, the extra growth is enough to maintain adequate support, but investigation is needed to ascertain this.

Possible signs of significant hazard:

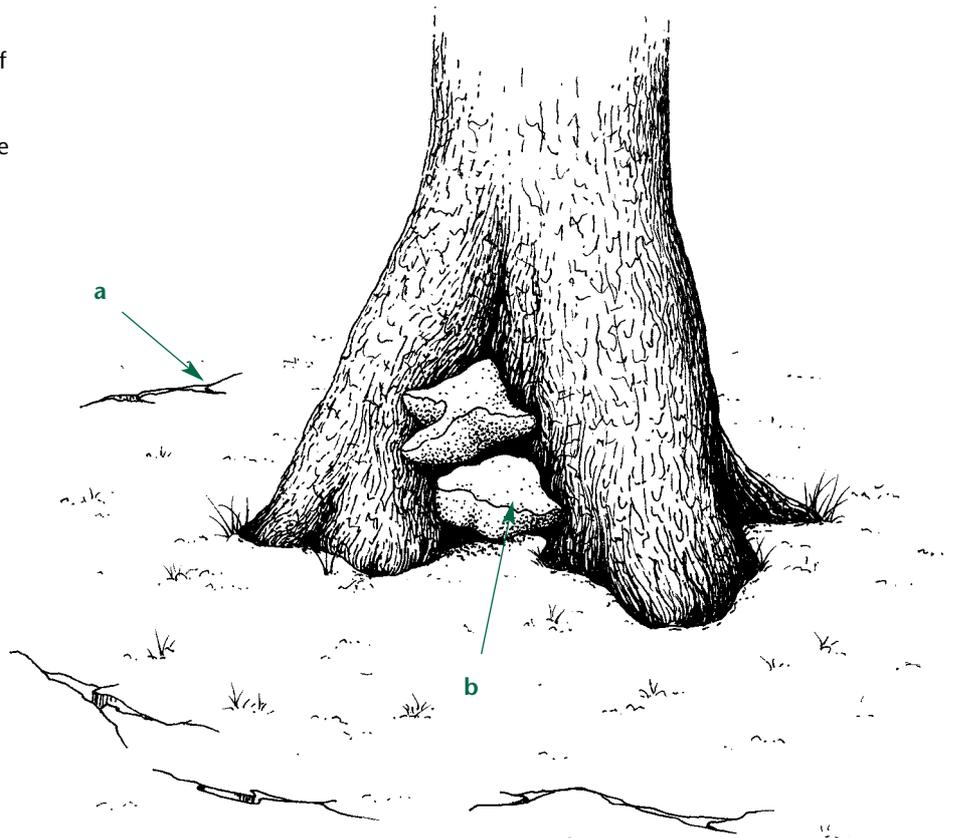
- **Cracking in the stem:** if more than two-thirds of the stem radius is hollow, cracks may develop as a warning of likely future collapse.
- **Cracking in the ground:** if roots are seriously decayed or otherwise lacking anchorage, cracks in the ground, around part of the edge of the root-plate area, may sometimes form due to wind-rock.
- **Insufficient sound wood:** detailed assessment is needed to determine this.

Options for remedial work on the tree, if needed

- Crown reduction.
- Felling, if other options are not adequate or feasible.

a. Cracks in the ground, around part of the root-plate area

b. Fungal fruit bodies sometimes visible



4. Excessive sinking down of branches

In many conifers, most of the branches tend to sink down progressively as growth increases their weight. In most broadleaves (and some conifers) most of the branches remain at their original angle or sink down only very slowly due to the formation of ‘reaction wood’ which has a natural bracing effect. However, in some cases the bracing may not be enough to support heavy limbs, especially those that start low down on the trunk, and they eventually snap. A big change of angle may be indicated by bark plates looking buckled on the under-side and stretched apart on the upper side of the branch.

Possible signs of significant hazard:

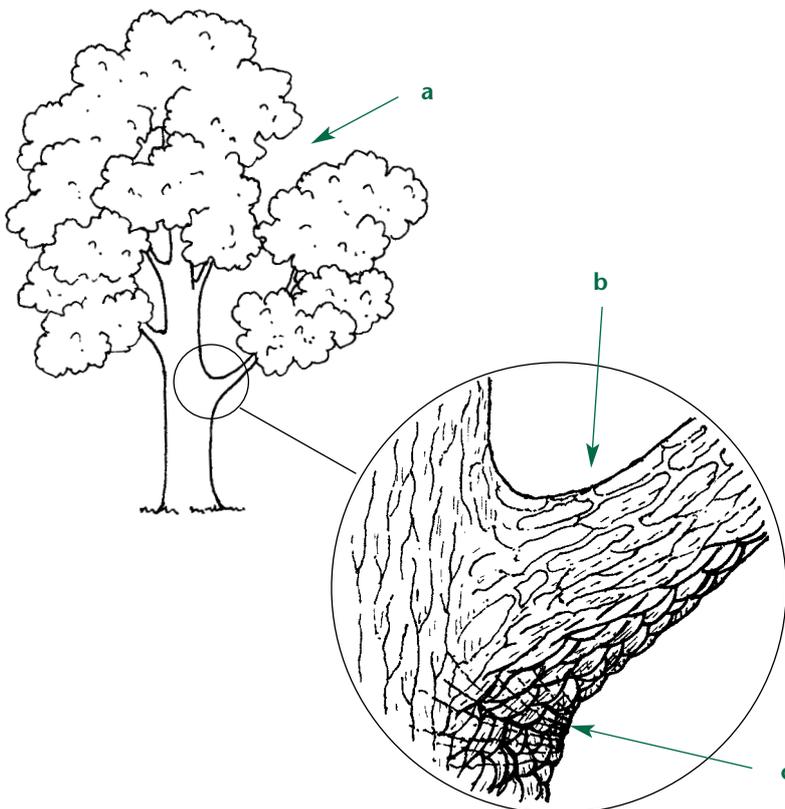
- **Cracking on the lower side of the branch:** this shows that partial failure has occurred, although it may be very localised and not necessarily serious.
- **A gap in the crown:** this may show that a major branch has sunk down so fast that the foliage has not had time to grow into the resulting gap.

Options for remedial work on the tree, if needed

- Cable or belt and/or rod bracing.
- Branch reduction.
- Felling, if other options are not adequate or feasible.

Prevention

- Formative pruning of lower branches in young trees in high risk situations.



- a. Gap in crown
- b. Bark plates stretching on upper side
- c. Bark plates buckling on underside

5. End-loading (top-heaviness) due to excessive pruning and multiple pruning wounds as source of a central decay column

The removal of many branches from a stem, or of many side branches from a main branch, alters the pattern of loading which may increase the amount of wind-sway and perhaps lead to an increased chance of snap. Moreover, decay associated with numerous wounds tends to coalesce to form a central decay column instead of small individual pockets of decay. If such a decay column occupies more than two-thirds of the stem cross-section, the stem could fail by buckling.

Possible signs of significant hazard:

- Excessive swaying in the wind.
- Cracks or other signs of partial failure.
- Signs of extensive decay, such as fungal fruit bodies in several places.

Options for remedial work on the tree, if needed

- Topping, if the tree is young and can be permanently managed as a pollarded specimen.
- Felling, in severe cases.

Prevention

- Better planning and site management to avoid the need for this undesirable treatment. In particular, trees should not be planted where they will eventually have to be heavily cut back to allow access; adequate space should be left between existing trees and new roads or buildings.

Features of a top-heavy tree (left):

- Relatively pronounced taper, indicating that the tree was open-grown, and that its bare lower stem is the result of excessive pruning; not of competition within a dense forest stand
- Numerous and perhaps large pruning wounds
- Broad, truncated crown, indicating removal of lower portion

Features of a tree previously in a more shaded and sheltered situation (right):

- Little taper
- Stem may be unusually free from algae and lichens
- Small branch scars, indicating natural pruning
- Suppressed lower branches
- Narrow crown

6. Exposure of previously sheltered trees

Trees that have grown in a closed-canopy stand are not mechanically adapted to strong wind exposure and can easily snap or blow over. The features shown in the illustration may aid identification of such trees when site history (e.g. nearby felling) is not known.

Possible signs of significant hazard:

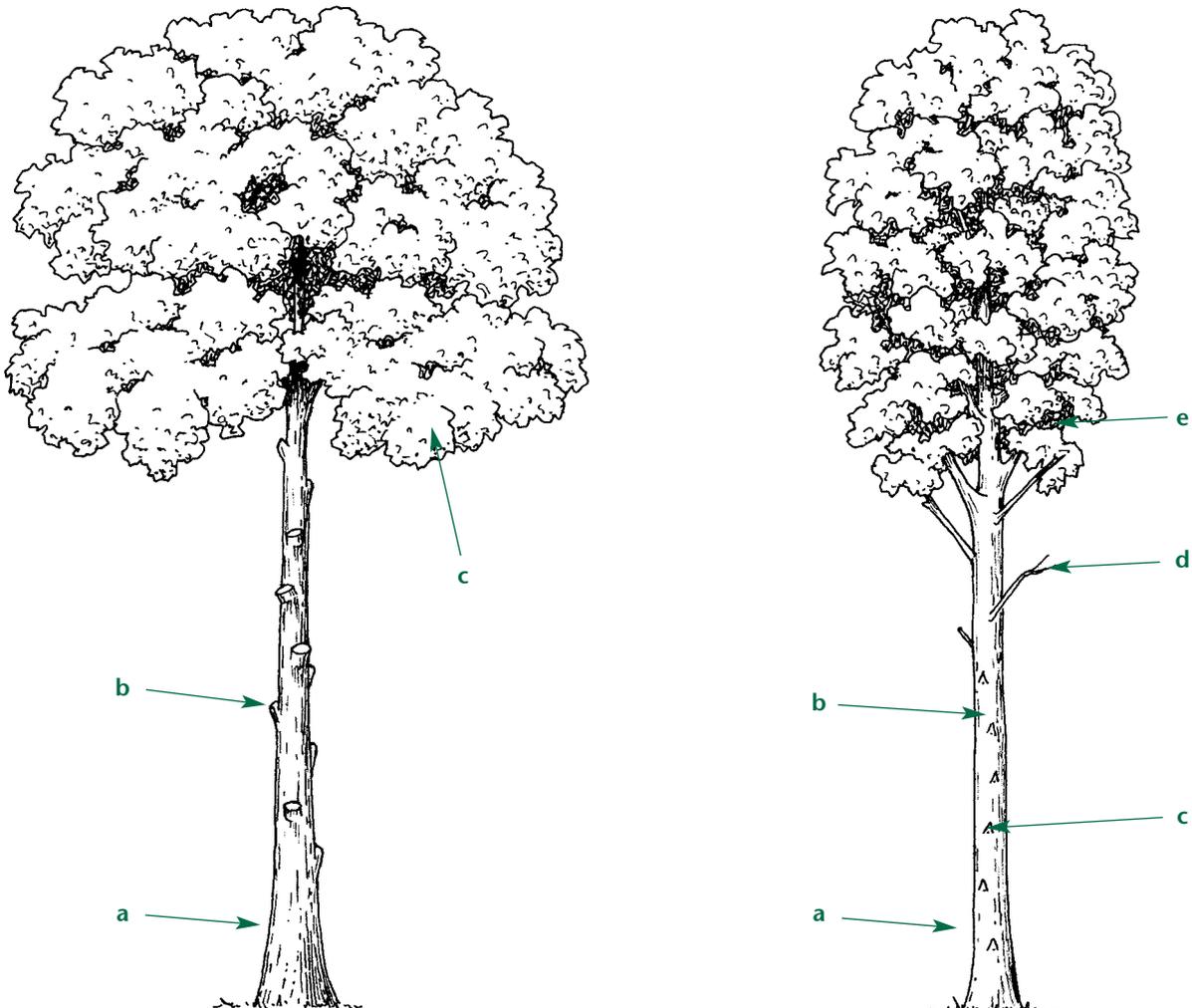
- High exposure to wind.
- Cracks or other signs of partial failure, including bending of stem.

Options for remedial work on the tree, if needed

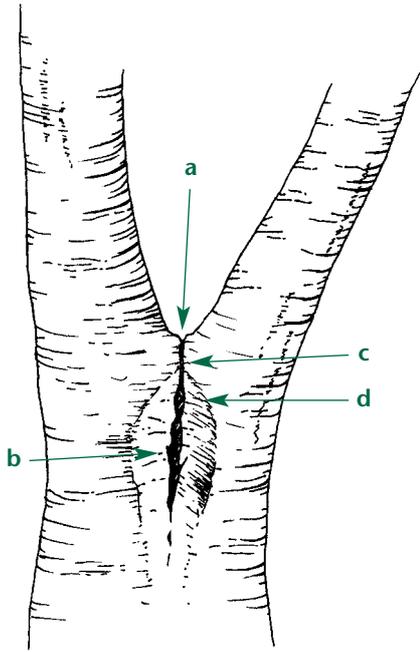
- Crown reduction.
- Felling, if other options are not adequate or feasible.

Prevention

- Maintenance of shelter, such as graded height of forest edge or avoidance of unnecessary removal of nearby trees.



7. Forks and other unions with included bark



A union with a very acute crotch angle is likely to contain a region of bark-to-bark contact, which contributes nothing to its strength. Such unions often occur at forks (i.e. between co-dominant stems). Even if there is no included bark between such stems, their internal structure usually allows them to be pulled apart rather more easily than a branch from a main stem. In many tree species, weak forks appear to be the most frequent contributory factor to major failure above ground level. They are thus probably more important than decay as a cause of hazard, although decay can be very dangerous when combined with a weak fork.

Possible signs of significant hazard:

- **Structure of the branch bark ridge:** the ridge which is a normal feature of a union, becomes a double ridge where there is a bark inclusion. It looks like two lips pressed together (c). The 'lips' usually gape apart at zone (b), where the bark inclusion is surrounded by wood. The longer the proportion occupied by the parallel 'lips', the weaker the union.
- **Angle above the union:** co-dominant stems often curve upwards to a near-vertical orientation just above the union. If, however, they diverge up to a considerable height, they may be bearing excessive leverage from the weight of the crown.
- **Species or cultivar of tree:** weak fork failures are more common in some species and cultivars of trees than in others. Examples of trees with a high risk of this type of failure include various species of willow and poplar, horse chestnut, beech, ash and true cedars. Examples of relatively low-risk trees include hornbeam, alder and many conifers, including most kinds of larch, spruce and redwood.
- **Splitting and decay:** if there is a crack below zone (c), the union has partially failed and could easily split completely apart, especially if decay has set in at this point.
- **Wind exposure:** unions with included bark are most likely to fail in trees on exposed sites (especially if exposure has increased, as when surrounding trees are removed), or in dominant trees whose height makes them rather exposed. Gusts blowing between the forks are most likely to cause failure.

Options for remedial work on the tree, if needed

- Cable or belt and/or rod bracing.
- Crown reduction.
- Felling, if other options are not adequate or feasible.

Prevention

- On high-risk sites, choose species or cultivars less liable to form these unions (see examples above and Lonsdale [1999] in reading list, page 13).
- Formative pruning.

8. Grafts, showing incompatibility

Grafted trees are less common in woodland than in other situations but are by no means rare in, for example, policy woodlands and arboreta. They may have a weak union between stock and scion due to genetic incompatibility or reaction to a virus infection. The stem may therefore break at the old graft line.

Possible signs of significant hazard:

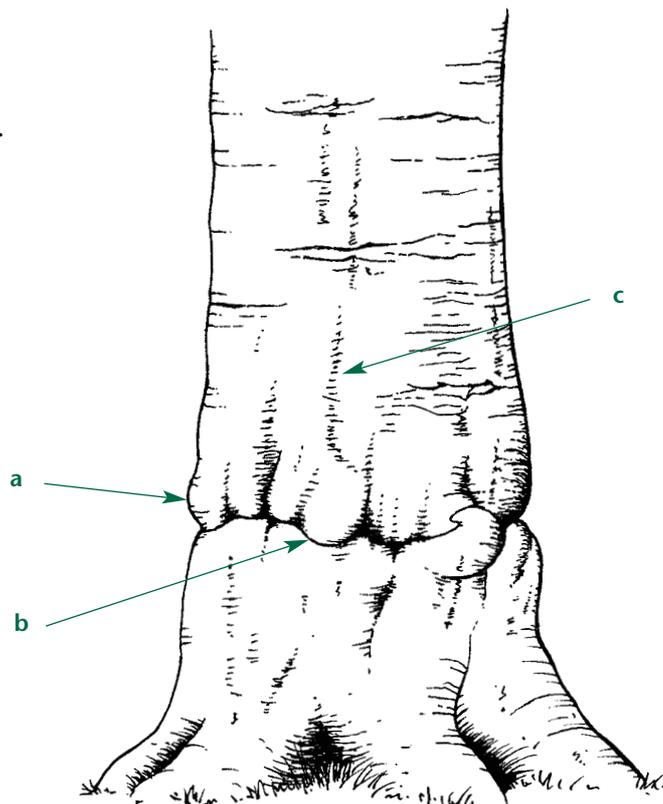
- **Irregular graft line**, associated with local bulging growth of the stock and scion.
- **Strong stem fluting** above and below the graft line: another sign of incompatibility.
- **Species or cultivar of tree**: some trees, especially species of *Sorbus*, fail more often at grafts than others.
- **Decay**: If decay is present in the graft zone, failure is more likely.
- **Wind exposure**: Weak grafts are most likely to fail in trees on exposed sites (especially if exposure has increased as when surrounding trees are removed), or in dominant trees which are more exposed than their neighbours.

Options for remedial work on the tree, if needed

- Crown reduction.
- Felling, if other options are not adequate or feasible.

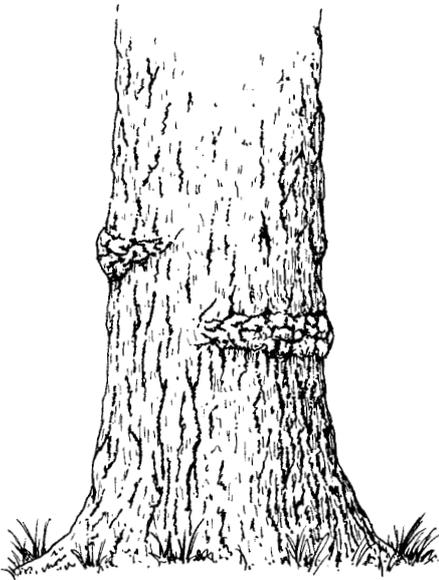
Prevention

- Use of non-grafted specimens if feasible.
- Choice of suitable stock and scion.



- Bulging growth near graft line
- Irregular graft line
- Stem fluting near graft

9. Incipient failure of the main stem



Tyre-like bulges, which may either occur on one side of the stem or completely surround it

Young trees may flex so much in the wind that the wood fibres buckle in places, even though the stems stay otherwise intact. Subsequent compensatory growth produces horizontal tyre-like bulges which may occur on one side of the stem or completely surround it, and which may continue enlarging indefinitely. In trees with dense wood, such as native oaks, these signs are no cause for concern, but snap can occur at old buckling points in poplars and other species with less dense wood.

Possible signs of significant hazard:

- **Tree species:** knowledge of tree species can aid an expert assessment of potential hazard.
- **Wind exposure:** for failure-prone species, wind exposure needs to be considered.

Options for remedial work on the tree, if needed

- Crown reduction.
- Felling, if other options are not adequate or feasible.

10. Instability due to restricted rooting

Tree species differ in their ability to root into poorly aerated soil. If the well-aerated zone of the soil is shallow, some species may become inherently unstable when they reach a certain height. They may to some extent compensate for this by producing wide, though flattened, root-plates but such lateral development is restricted by competition in forest stands. Thinning of the stand or exposure by partial clear-felling is then especially liable to lead to windthrow. (See also 'Exposure of previously sheltered trees', page 19.)

Possible signs of significant hazard:

- **A known history of windthrow** at the site, perhaps involving particular species, such as spruces, western hemlock or red oak.
- **Cracking in the ground:** if roots are lacking anchorage, cracks in the ground around part of the edge of the root-plate area may sometimes form due to wind-rock.

Options for remedial work on individual trees, if needed

- Crown reduction.
- Felling, if other options are not adequate or feasible.

11. Neglected pollards

Trees that are pollarded when young often live longer than is usual for the species concerned, but their branches can become excessively crowded and heavy if regular re-cutting lapses. Neglected pollards are common in urban streets and parks but they also occur in woodland and rural parkland, where ancient specimens usually have extremely high conservation value and younger trees are valuable for succession. Failure in pollards often involves snap of top-heavy new branches, rather than splitting at the pollard point. Crown removal in older trees (sometimes called topping, rather than pollarding) can cause problems as the new branches are likely to fail as soon as they grow heavy.

Possible signs of significant hazard:

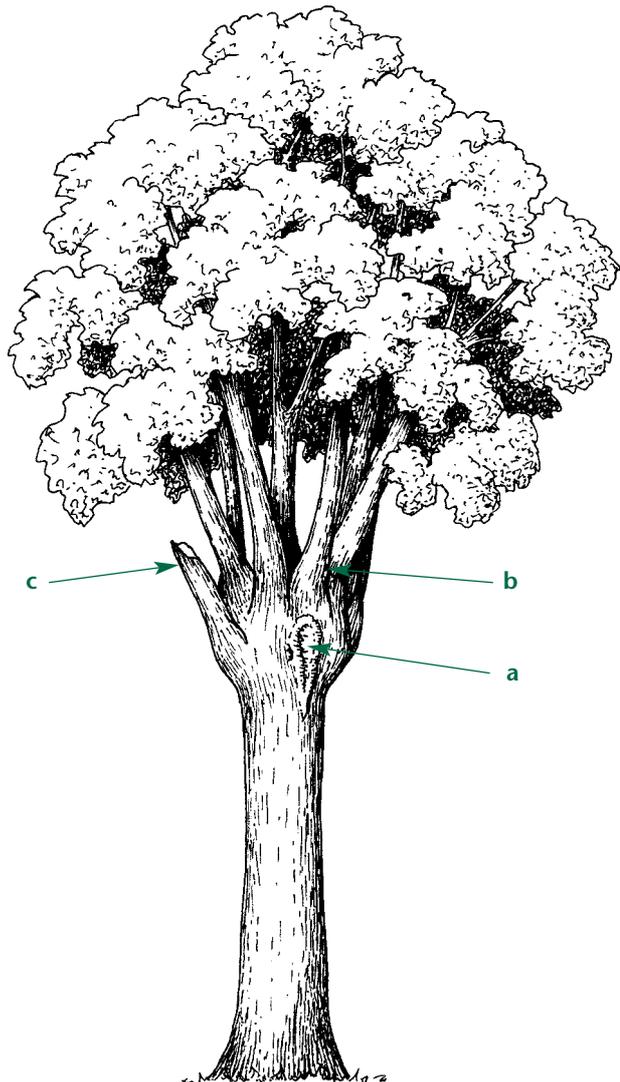
- **Branches with their bases pressing against a dead snag** left by topping an already mature tree: such branches are often poorly attached.
- **Species of tree:** fast-growing broadleaved species with relatively soft wood, especially poplars, willows and horse chestnut, are much more prone to fail when pollarded and then neglected than are many other species.
- **Wind exposure:** as with other types of weakness, the exposure of the site is a major consideration.

Options for remedial work on the tree, if needed

- Re-cutting above old pollard points.
- Felling, if other options are not adequate or feasible.

Prevention

- Avoidance of topping semi-mature or older trees.
- Regular re-cutting of pollards.



- a. Tear-out wound of weakly attached branch: a site of potential decay in the main stem
- b. Overcrowded and heavy branches
- c. Mechanically weak branch broken above pollard point

12. Poor crown condition

Small, dead, sparse or abnormally yellowish leaves or needles, especially when in the upper crown and associated with twig dieback, may indicate root-rot or other root injury which has weakened the tree's anchorage. A reduction in shoot extension growth often precedes obvious crown thinning or dieback. Expert assessment may be needed to confirm whether such signs indicate a root problem.

Possible signs of significant hazard:

- **Soil cracks:** these may indicate wind-rock due to poor anchorage.
- **Fungal fruit bodies at or near base of stem:** identification of fungi may be necessary to help decide whether decay is present and whether detailed assessment is required.

Options for remedial work on the tree, if needed

- Crown reduction.
- Felling, if other options are not adequate or feasible.



13. Ribs and open cracks on stems and major branches

Ribs are often a sign of cracking, being produced by the tree's attempts to seal over cracks with new wood. Although cracks represent partial failure, this is not necessarily a serious problem. Expert examination may be needed to evaluate the hazard associated with a particular crack.

Possible signs of significant hazard

- **Shape of the rib:** sharp-nosed ribs usually indicate that the crack has not been successfully occluded owing to continuing movement of the wood either side. Blunt-nosed ribs often indicate that the crack is overlain by a number of intact annual rings.
- **Position of ribs or of visible cracks:** major failure is most likely to be associated with ribs or visible cracks on opposite sides of a main stem. Other aspects of position are important in evaluating risk but require expert interpretation.
- **Species or cultivar of tree:** Some types of tree, such as native oaks, often form localised cracks which are seldom, if ever, associated with major failure. A similar crack on, for example, a horse chestnut, could be a more serious matter.

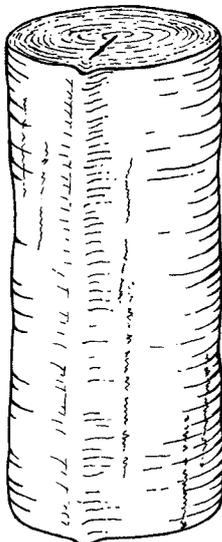
Options for remedial work on the tree, if needed

- Cable or belt and/or rod bracing.
- Crown reduction.
- Felling, if other options are not adequate or feasible.

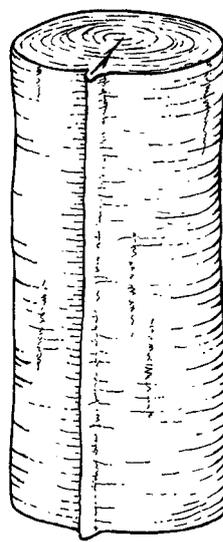
Prevention

- Avoidance of harsh pruning, which leads to the formation of localised stresses in subsequently formed wood.

a



b



a. Blunt-nosed rib showing occluded crack covered by intact annual rings

b. Sharp-nosed rib showing crack extending to the outside

14. Target canker

Some types of canker persist for years, with successive periods of healing growth and then killing of the new tissues. Mechanical stresses become concentrated around the canker, and this can cause snap. For further information on target cankers, caused by fungi such as *Nectria* spp. or *Stereum rugosum*, see Strouts & Winter (1994).

Possible signs of significant hazard:

- **A canker occupying a substantial part of the stem circumference:** there is not enough evidence to give an exact limit, but experience suggests that 25% or more should be regarded as suspect.
- **More than one canker present on a stem.**
- **Wind exposure:** cankered stems are most likely to fail in trees on exposed sites (especially if exposure has increased as when surrounding trees are removed), or in dominant trees which are more exposed than their neighbours.

Options for remedial work on the tree, if needed

- Crown reduction.
- Felling, if other options are not adequate or feasible.

Concentric rings of 'callus' growth



15. Wounds

If wood loses its protective cover of bark, it can become decayed. The decay may be apparent at the surface but it is not uncommon for there to be a 'case-hardened' layer of apparently sound wood over the decayed zone.

Possible signs of significant hazard:

- **Size of wound:** large wounds are more likely than small ones to lead to extensive decay.
- **Depth of wound:** wounds in which the wood is scored or splintered are more likely to lead to decay than skinning wounds.
- **Fungal fruit bodies:** on wounds indicate that decay is at least superficially present.

Options for remedial work on the tree, if needed

- Crown reduction if decay from wounds or dieback is extensive.
- Felling, if damage is extensive and other options are not adequate or feasible.

Prevention

- Use working practices that minimise stem and root wounding.
- Avoid unnecessary pruning.
- Protect high value trees.

