Impacts of tree coring on indigenous trees

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Abstract

Advice is given on the impact to native trees of taking tree cores for research purposes.

Suggested guidelines for DoC decision making on issuing permits for tree coring are provided.

1. Introduction

Cores are extracted from trees in order to obtain information on tree ages, tree growth rates and on the physical and chemical properties of the wood. This information is in turn used to assess such things as population age structures, stand dynamics, site productivity, for dating of historical events (e.g., windthrows and landslides) and for reconstructing past climates (Norton & Ogden 1987). Tree coring has been undertaken extensively in New Zealand indigenous forests and has provided the basis for a large number of studies on forest ecology and palaeoclimatology (e.g., Veblen & Stewart 1982, Ahmed & Ogden 1987, Norton et al. 1989, Duncan 1993, Salinger et al. 1994).

Except for cutting trees clown, there is at present no alternative to coring trees in order to obtain this type of information, and coring is clearly preferable to felling. However, coring does involve directly injuring the tree, as a hole is created in the tree, and understandably there has been some concern over the potential impact coring may have on indigenous trees and other woody plants. The purpose of this note is to review what is known about the impacts of tree coring on trees and to suggest guidelines to assist Department of Conservation staff when they consider applications for permits to core trees.

2. Nature of core extraction

The normal increment borers used in New Zealand comprise a steel shaft with a tapered cutting thread at one end which draws the borer into the tree when turned, the borer holder which slots on the end of the shaft to allow it to be turned, and a shallow extraction spoon for removing the core. Borers typically extract cores of wood 5-7 mm in diameter and can be from 20-100 cm long (usually 30 cm). Cores are usually extracted at about breast height as this is the most convenient height for turning the borer, although in some studies cores are extracted from as close to the ground as possible (e.g., in order to more accurately age a tree). Depending on the nature of the study, one to four cores per tree are extracted; studies of tree population dynamics usually involve extracting one core per tree from as many trees as possible at a site, while dendroclimatic studies usually require a minimum of two cores per tree but from only a small number of trees at a site (usually 20-30 trees). The core is extracted using the shallow extraction spoon while the borer is still in the tree, and then the borer is removed. Following extraction, the holes may be left open or plugged with a variety of compounds including vaseline and various fungicide pastes. Most increment coring undertaken in New Zealand is done using hand-powered borers, although motorised borers (e.g., driven by a petrol engine) have been used elsewhere. Motorised borers are capable of extracting much larger diameter cores from trees.

3. Impacts on trees and tree responses

Extracting a core wounds the tree. Much of the concern about tree coring centres around the impacts this wounding has and is often based on misunderstandings about the way trees respond to wounds. Wounds damage trees, but trees have a coordinated system for limiting this damage called compartmentalisation (Shigo 1984, Smith 1988). A good understanding of the process of compartmentalisation is essential for making informed decisions about the effects of coring on tree health.

Compartmentalisation in trees is a defence process by which boundaries are formed to isolate injured tissues and thus resist the spread of pathogens (Shigo 1984). Compartmentalisation is a two-stage process. In the first stage, the effects of injury are confined by chemical changes in the tissues present at the time of injury. This may involve the production and accumulation of antimicrobial substances that retard the spread of pathogenic organisms that develop after wounding or it may involve the formation of tyloses and other plugs that limit water loss from damaged xylem cells. In the second stage, chemical and anatomical boundaries form after the infection, as the living cambium forms a barrier zone between the tissues that were present at the time of wounding and the new tissues formed after wounding. A barrier zone is a zone of protective tissue consisting of unique cells that serve to isolate or separate the infected wood on the inside from the healthy wood that continues to form on the outside after the barrier zone is complete.

The process of compartmentalisation provides a very efficient and effective means by which trees are able to isolate the effects of wounds (especially pathogens) from new tissues that are formed after wounding, thus allowing trees to continue growing despite the presence of wounds and pathogens.

Compartmentalisation is different from callus formation. While callus tissue can grow over a wound, a callus does not create the barrier that compartmentalisation does and is not able to isolate damaged tissue and associated pathogens.

While tree coring does have an effect on trees and can lead to discoloration of wood (Lorenz 1944, Toole & Gammage 1959, Schweingruber 1983), it appears that trees respond to the borer hole as they would to any other wound through compartmentalisation. In normal circumstances, this should not lead to more rapid tree death than would be expected from any wound the tree receives. Certainly, reports from scientists involved in tree coring suggest that tree death as a result of tree coring is very uncommon (FAQ 1997). In a preliminary assessment of c. 100 trees cored by Peter Dunwiddie in New Zealand in the 1970s (mainly species of *Agathis*, *Libocedrus* and *Phyllocladus*), only one tree has since died (Jonathan Palmer pers. comm. 1997), and the cause of death is at present unknown. However, when the borer breaks through into a zone of compartmentalised decay (e.g., heartrot), coring might break the boundary that was keeping the infection isolated in the tree centre. This may result in the infection spreading out into the sapwood and ultimately the accelerated death of the tree, although the active sapwood may again compartmentalise the infection.

The degree of sensitivity to tree coring appears to vary depending on the species being cored and the coring process. North American studies have suggested that some tree species are better able to compartmentalise coring damage than other species, but there is no objective information on the relative ability of New Zealand trees to compartmentalise such damage. North American studies do, however, suggest that resinous conifers may more quickly seal borer holes than many angiosperm trees, and this may also be the case for some New Zealand conifers (e.g., kauri).

The negative impact of tree coring is greatest when a blunt borer is used (Smith 1988). A blunt borer can, through ripping tissue as it is driven into the tree, lead to much greater cambial damage, thus delaying the formation of functional sapwood around the damaged area (the barrier zone) and thereby providing a longer time for microbial organisms to establish and spread through the sapwood.

4. Minimising impacts on trees from coring

A number of approaches have been suggested for minimising impacts of coring on trees. Traditionally, holes have been plugged in order to prevent infections entering the tree. However, the degree of infection appears to be independent of the presence of a plug, suggesting that pathogens can pass through the damaged tissue around the plug (Lorenz 1944). Dowels and other plugs in fact have the potential to increase the rate of cambial dieback and infection spread, as they cause further damage to the cambium and sapwood as they are forced into the borer hole. Although some studies have suggested that use of wound dressings can reduce fungal damage (Schweingruber 1983), more recent studies have suggested that these can also hinder the compartmentalisation process (Smith 1988), as boundary formation is forced further back from the wound site, resulting in an increase in the volume of infected tissue.

The best approach to mininlising damage as a result of tree coring is through the use of a clean sharp increment borer. Keeping increment borers clean would seem particularly important when sampling at different sites. While there are no documented cases of pathogen movement associated with tree coring, the spread of *Phytophthora* by vehicles and people through Western Australian forests is a salutary warning. Angling the borer slightly upwards ensures that water and dirt will not run into the hole. Coring during the growing season may also give the tree a better chance to react to the injury through active new growth, although Schweingruber (1983) has suggested that for European conifers, coring during summer causes considerably more damage than in winter. Finally, the fewer holes bored in a tree, then the greater the chance that unwanted infections will not occur.

5. Suggested guidelines for tree coring

Trees growing in natural forests are subject to a wide range of wounding events ranging from branch breakages during wind storms or under heavy snow loads to trunks being scarred by falling rocks or snow avalanches. In these circumstances, trees are able to successfully compartmentalise the damage and usually continue growing. The extraction of increment cores from trees is a further, although very minor, form of wounding that is likely to affect a very small percentage of trees within any area of forest. The response of the tree to wounding resulting with increment boring will be similar to the response of the tree to other types of wounding. The approach taken by Department of Conservation staff in dealing with applications for permits to extract increment cores from indigenous forest trees must be made within the context of the ongoing wounding and subsequent compartmentalisation of damage that occurs in all trees. As Shigo (1984) stated, the processes of compartmentalisation explain "the very longevity and capacity of perennial plants to survive countless wounds and subsequent development of even more countless pathogenic and parasitic microorganisms".

The following are some guidelines that Department of Conservation staff could use when evaluating permits for extracting increment cores from trees and other woody plants on lands managed for conservation purposes.

1. Increment cores should not be extracted from any species listed in the New Zealand threatened plant list (Cameron et al. 1995) unless there is an overriding conservation management reason for doing this. In this latter situation, cores should be restricted to one per tree and, if possible, not all trees in any one population should be cored.

2. If there are any long-term effects associated with tree coring (e.g., through breaking the barrier surrounding a central core of heartrot), then these effects are likely to be greatest in small, fragmented tree populations. It would therefore seem prudent to limit tree coring in small forest fragments to essential conservation management work only

3. All permits for coring should require that the researchers keep their increment corers clean and sharp, and that increment cores should be angled slightly upwards into trees. However, there should be no re quirement for plugging of holes, as such plugging may in fact hinder the process of compartmentalisation.

4. The number of increment cores extracted from a tree should normally be limited to one, except for dendroclimatic studies where a minimum of two cores per tree is usually required.

Much of the above discussion has been based on North American studies, as there are no New Zealand data on this topic. It might be useful if DoC, in granting future permits for tree coring, asked researchers to mark some or all of the cored trees as a basis for longer-term observations of tree health after coring.

6. Acknowledgements

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