

URBAN GREEN SPACE MANAGEMENT

Manual for Local Municipalities

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INTRODUCTION

One of the goals of the project “GreenMan” (ELRI-177) is to develop a system for managing urban green areas in the border regions of Estonia, Latvia and Russia while enhancing the cooperation between specialists in urban green space planning and universities focusing on green space planning and management. One of the outcomes of the “Green Education” work package executed by the Estonian University of Life Sciences is this manual and the accompanying study course on green space management.

The manual gathers together and presents good practices for maintaining urban green spaces. All the issues are viewed in the context of the environmental, social and economic challenges of the new century such as better use of limited natural as well as economic resources, enhancing biodiversity and dealing with the pressures caused by increasing numbers of city dwellers, their lack of everyday contact with nature and their need for recreation. Traditional ornamental parks and gardens can only look their best and function well where there are sufficient financial resources, suitable equipment and well-trained staff to manage and maintain them. In their absence it may be a necessary to look at alternative and innovative practices that save money and require lower intensities of all types of inputs.

The manual is mainly intended to help the staff of local municipalities to focus their available resources in the most efficient way onto the most important maintenance activities and to nurture and care for the often sensitive plants under their care which, if incorrectly treated can be lost or their value diminished. The manual presents an overview of all the relevant topics of urban green space management and provides the most up to date information about what to focus on in preparing management plans, what maintenance works to order and how to make sure the tasks are properly fulfilled while securing a high quality end result.

The recommendations presented in this manual are based on expert reports made within the framework of the project as well as from a wide range of recent high quality and relevant literature on the topic. No references are given directly in the text but all base materials are listed at the end of the manual. All illustrations are provided by Labie Koki.

We hope that the manual will be used as the first point of reference and that as many of the recommendations as possible will be followed. Urban green space is as important a part of the infrastructure of an urban area as the roads, services and communications and should be given the same degree of protection and maintenance.

Liina Jürisoo, Anna-Liisa Unt, Simon Bell, Jekaterina Balicka,
Editors.

URBAN GREEN SPACE TYPES

INTRODUCTION

This chapter is intended to provide a brief overview of the various types of green and public spaces where vegetation which needs planning, designing and managing is likely to be found. These vary in their scale, in the intensity of likely use by people, in the complexity of their layout and vegetation contents and in the need for intensive management. Given that financial resources for public green spaces, either to develop new ones or to manage existing ones are under pressure it is important to:

- Invest in quality of design and in the use of materials, especially plant materials which are likely to grow well and require low inputs in order to establish them. Trees can often be expensive items, especially when planted at larger sizes and these need to be selected with care and looked after properly until well-established, then they will require much less ongoing management.
- Prepare designs and management regimes which can be simpler and cheaper to carry out while still looking attractive and providing the range of functions needed by people. If lower intensity management can be achieved it often improves the biodiversity values of the areas at the same time.

Taken together these spaces should form an integrated system of green infrastructure connected by pedestrian and cycle routes and also forming part of the urban ecosystem.

STREET, ALLEY, WALKWAY

Definition

Roads or paths surfaced with hard or more natural materials, intended for vehicular and/or pedestrian traffic, accompanied by single or multiple rows of trees, shrubs or hedges which may be planted in the surface, in tree pits, or alongside in an unpaved strip.

We usually spend at least a few hours daily in a street environment. In addition to simply moving along the streets, we also need the environment for communicating, taking time out and wandering about. In an urban environment it is important to enable vegetation to balance out paved surfaces. This is crucial for a comfortable feeling of tranquility and safety, but also for offering shade and cooling and cleaning the air and for sustainable surface water management.

Design / composition

A suitable choice of species and the correct spatial distribution of elements are necessary. It is necessary first to consider the functional aspects of street layout: the directions, type and intensity of traffic, the position and requirements of underground and above ground services, especially pipes and cables, and the needs for regular street maintenance (cleaning vehicles, mowing, snow storage etc.)

Rhythm is a feature that people relate to easily, it is bound with our existence – through our heartbeat, breathing and speech. It is therefore also something that we favour in our surroundings and notice when it is missing or out of balance. Alleys are one of the elements in landscape that carry their specific visual rhythm through the repetition of the same or similar elements at the same interval, the simpler and clearer it is, the better. When the clarity is disappearing – when a large proportion of trees in a row have disappeared or been removed – it is recommended to replace the entire row rather than replacing single items in the gaps. If the trees are the same species and cultivar all planted at the same time the unity of the design as well as the rhythm is strong and it adds a special quality to the street landscape. When double rows form a roof overhead the effect is even stronger.

Suggestions for management

Street trees are specially grown in nurseries to present a good form and branching structure suitable for later crown lifting. This is because crowns should be raised high enough so as not to disturb the traffic. Such tree crowns are usually lifted to 2–3 m above the surface, and other branches reaching up to the height of at least 4.5 m tend to be small in diameter – those are temporary branches that will be lifted or pruned one by one during later treatments. Such trees can be planted in alleys or as single trees and are also appropriate for parks and public areas where trees with lifted crowns are required (in public spaces where movement of big trucks, fire engines, etc. might be necessary). Damage from vehicles can be a problem and bark torn away lets fungal diseases into the tree so special protection against collision such as by the use of bollards may be recommended. De-icing salt is also a major problem in winter and causes problems to trees so a strategy of minimising its use should be considered.

URBAN FORESTS OR WOODED AREAS

Definition

Natural-looking green spaces, mainly designed by planting or by managing existing wooded areas close to or inside an urban environment. A rich layer of undergrowth may be characteristic to urban forests, clearly differentiating it from a park environment, although heavy use by people wandering about can cause this vegetation to be eroded.

Design / composition

Woodlands should generally exhibit naturalistic characteristics in their layout and spatial aspects, path alignments and edge structures so as to contrast with the formal aspects of the urban scene. They should contain a mix of densities, with open spaces to let light in contrasting with darker tunnels. In some places a more open character is desirable to avoid places seeming too dark and potentially dangerous.

Suggestions for management

No intensive management is needed or suggested for urban forests. A natural selection of species and habitats needs to be supported. Good connections with residential districts are recommended, by public and private transport as well as by bicycle or on foot. A supporting web of footpaths should suggest movement within the park to avoid excessive trampling. Rubbish bins need to be provided along the paths as well as at the entrances to the forest and also, if possible, at resting places.

Old and fallen trees do not need to be removed from a forest setting except where they might present a safety hazard within a tree length of busy paths: it adds special scenic values as well as necessary habitats. It is recommended to carry out thinning when the forest starts to be overgrown to avoid the disappearance of species and biotopes due to heavy shading. Forest edges along internal spaces or at the outside boundaries are important and therefore need to be maintained carefully. Fire may be a risk in some places and fuel accumulation may need to be reduced in vulnerable places. Unauthorised fires should be controlled in case of damage.

URBAN SQUARES, PLAZAS, POCKET PARKS

Definition

Paved open spaces with perceivable enclosing “walls” formed by buildings, rows of trees, park edges, hedges, fences, landform. Squares function best when a maximum number of people are drawn towards the space, for example via crossing streets, pedestrian zones and public and commercial functions along the edges of the square (galleries, meeting places, cafes, shops).

Design / composition

Trees make a good addition to small spaces by enclosing them, providing them with a “roof” and separating the space from hard reflective surfaces. Hedges are also a good addition to offer lower enclosure and shelter to sitting areas as long as they are dense. Owing to the scale and proportion of smaller spaces trees should not be selected from species which grow too big unless their architecture allows for a space beneath them and a high canopy. Large paved areas heat up in the sun, reflect glare and dry the air. Vegetation is therefore recommended whenever possible – trees provide shade and clean the air, shrubs divide large spaces into smaller pockets, flowers and grass add colour and prevent dust and sand from blowing around in the wind.

Suggestions for management

The function and context of the square sets some limits for vegetation. When underground structures exclude the possibilities for trees, containers can be used. As vegetation in urban squares uses minimal space and is exposed to intensive trampling, watering and fertilisation is highly recommended. Open grilles around the base of trees allows for water to percolate while protecting them from trampling. Larger open areas may need to be kept clear for public events and/or the access of vehicles.

CENTRAL OR INTENSIVELY USED PARKS

Definition

Intensively used green open spaces with carefully maintained elements of many types. Public parks need the most attention and therefore also most resources from their initial design and choice of materials up to daily maintenance and longer-term management.

Design / composition

Parks are one of the main subjects for landscape design and they come in all sorts of shapes, sizes and styles so that it is not appropriate to set down too strong guidelines. However, one particular aspect is the balance between formality and informality which can be emphasised by path layouts, tree layout and grouping, hedges and shrubs and special ornamental plants including perennials, bulbs and annuals. Naturalistic parks may be preferred for their lower maintenance requirements (see next section) while intensive and highly ornamental plantings may be used in key areas to make a statement. Trees can be used for shade, shelter, spatial enclosure, seasonal colour and spectacular form. Planting should relate to the form and layout of path circulation and the spaces needed for activities.

Suggestions for management

Sustainable methods should be used for maintenance. For instance, extensive lawns that are not used by people (for play, for picnicking) could be maintained as meadows, being cut less frequently and allowing for wild flowers of habitat value to be encouraged, cutting costs for lawn care and thus raising the richness of species. Native species, suitable for a certain setting (soil conditions, local water regime, sun and shade) could be used instead of annuals which need constant replacement and appear unnatural among the rest of the vegetation. Elements of undergrowth should not be avoided as they enrich the environment and support biodiversity. Trees can be grown in open conditions to allow a full crown to develop or in groups and clumps where the crowns fuse together. Older trees that may have safety issues and hazards of dead branches which may fall on visitors should be removed as needed.

LESS INTENSIVELY USED PARKS

Definition

Parks that are not used very intensively due to their size, location or conditions. These may be away from denser populations or may arise in peripheral areas and be deliberately kept simple and of low management and maintenance requirements. They may become intensively used if an urban area expands and housing is developed next to them in which case they may need redesign and investment in infrastructure.

Design / composition

As the intensity of use is not particularly high, a more informal approach could be used both in design and maintenance. Simple groupings of trees and shrubs to break up large spaces and subdivide the area for different uses within a matrix of grass and a network of simple paths with natural surfacing is the easiest approach to design for such places which could be developed if the need arose. These reflect the informal parks found in many areas and carry some connotations of a natural kind of landscape.

Suggestions for management

Such parks can be relatively self-regulatory, with local plants and minimal interfering. Low intensity mowing of grass or even haymaking or grazing by animals can be a very cost effective maintenance regime for such parks. Trees native to the area grown in open conditions look attractive and are simple to maintain as they require no pruning.

HERITAGE PARKS, MANOR PARKS

Definition

Old and noble green spaces with a specific history and archaic constructed park elements. They often reflect a single or more often multiple phases of development reflecting specific stylistic periods. Many are overgrown or undermanaged and need restoration.

Design / composition

As historical parks their rejuvenation needs special skills but when in poor condition they can also incorporate new elements and be brought up to date for contemporary use. Before any redesign they need to be carefully surveyed and researched in order to establish the essence of their value and to express the key historical aspects which make them unique. Fake historical-looking park equipment might be avoided – it does not support the original setting, but tells a different story. Instead, laconic and “invisibly” simple design could be used for park furniture that recedes into the background and highlights the original parts – park layout, heritage trees, old buildings.

Suggestions for management

Typical aspects of management involve treating old trees which have historical value or decay, removing vegetation which has taken over and is too dense, re-establishing grass under former heavy shade and rejuvenating or replacing hedges and shrubs which have become too overgrown to be treated by normal pruning. Once the improved conditions have been achieved the maintenance regime should be similar to the other types of park depending on the intensity of use.

NATURAL HERITAGE OBJECTS

Definition

Single trees or other natural elements under heritage protection.

Design / composition

Old veteran trees and other elements usually need space around them to set them off and should be treated simply in any composition where they are to be found.

Suggestions for management

Public access needs to be organised in a way that minimises a possible negative impact, e.g. excluding trampling around the tree, aerating the soil, adding fertiliser, propping up heavy branches or securing weak forks and branches from falling and breaking the tree. Nevertheless, the objects are of a high public relevance and should not be hidden or excluded from public access.

SCHOOL AND KINDERGARTEN YARDS, HOSPITAL GARDENS

Definition

Semi-private green spaces that encourage and support both active and passive outdoor activities. These types of gardens have clearly identifiable borders to provide a safe environment away from traffic and the active daily movement of other people. They may contain elements specifically designed and laid out for therapeutic or learning objectives.

Design / composition

These spaces frequently require specialist inputs into the design but generally benefit from being divided by vegetation or structures into a series of “rooms” suitable for different purposes, be they teaching play or therapy. Hedges are very valuable for this purpose as they take up less space. Trees are good for shelter and shade as well as linking e.g. children to nature and wildlife. Native plants may be preferred in some settings, more decoratively varied ones in other places.

Suggestions for management

The environment should support recreation and education in the choice of layout, materials and (local) vegetation. Resistant species should be used that withstand breaking of branches or picking of blossoms. The roots of plants should be protected from trampling. Quite intensive maintenance may be needed but these spaces are usually quite small.

PUBLIC SPORT PARKS, STADIUMS

Definition

Open spaces designated for active recreation. Sport parks can overlap with or be located within public parks – flat open areas can be used for team events and paths for jogging and skiing.

Design / composition

Sports fields usually have very specific requirements for size, proportion, surface type and associated elements such as changing rooms, seating areas etc. These different elements should be set within a framework of trees, hedges and shrubs to visually break up the area and also to provide shade and shelter.

Suggestions for management

Sports surfaces need to drain well. In case rain water does not infiltrate naturally, porous layers, accurate surface angles or ditches are necessary. When planning paths for cycling or especially rollerblading or skateboarding, smooth surfaces (e.g. asphalt) should be favoured over mosaic surfaces (e.g. concrete paving stones). Trees which do not cause too many problems with leaf litter in autumn may be favoured. Dense hedges are very good and so must be properly trimmed or maintain their shape and thickness.

BEACHES

Definition

Waterfronts with sand and grassy areas and associated recreational elements.

Design / composition

While the beach should be open sand with water access facilities the area behind should permit activities such as sunbathing, picnicking, informal play and allow for privacy. Subdividing the space by hedges shrubs and trees can help to ensure these features are successful.

Suggestions for management

Possibilities for shade should be provided by trees, as well as a servicing infrastructure such as benches, rubbish bins, changing cabins, restrooms and bicycle stands, all of which need maintenance and upkeep. Grass may need to be kept mown to allow for sunbathing and picnicking and rubbish and litter collection should take place frequently. Hedges dividing the space and providing enclosure should be kept properly trimmed and dense sand needs raking and rubbish removing. If necessary, the free movement of pets may be restricted.

CEMETERIES

Definition

Spiritual urban forest- or meadow-like green spaces, separated from the neighbouring environment. Layouts and elements may vary from one faith confession to another.

Design / composition

A logical layout should be provided, preferably with a general zoning and movement plan to enable users to orientate themselves. A supporting infrastructure is necessary, with maintained paths and benches, vehicular access and parking places in the vicinity, rubbish disposal and access to fresh water. The aesthetics and materials of the designs need to communicate safety, tranquillity and nobility. The trees are frequently a major element, especially in a forest cemetery but also in a more park-like one, with some species representing specific spiritual characteristics in some cultures.

Suggestions for management

Much of the cemetery space will be maintained by families owing graves but there may be abandoned areas and of course the central core areas and infrastructures. Trees may be very old and require special management. If their roots have been disturbed by grave-digging they may suffer from decay fungus. Grass areas may need to be mown close or kept as rough grass depending on their function e.g. as places for scattering ashes from cremations.

TRAFFIC ISLANDS

Definition

These are usually circular unpaved islands or roundabouts to assist traffic flows and may be found in many locations.

Design / composition

At town entrances sculptures can be used to enliven the space, but it is important to keep them simple – they should not attract the drivers' attention too much. Avoid high vegetation to maintain visibility. Higher vegetation is possible in the case of bigger roundabouts.

Suggestions for management

These areas should be simply maintained to keep them tidy and free from rubbish or distracting overgrowth. If used for flower displays these should also be simple and visible from cars at the natural driving speed. They may be replaced seasonally.

GREEN SPACES IN HOUSING COMPLEXES

Definition

Open public, semi-public or private spaces between and around multi-storied apartment buildings. These spaces service a high number of users, mostly of various ages and social and cultural backgrounds. The surroundings of older block houses are often contested spaces with a high pressure on both qualitative green space and parking places.

Design / composition

Closed and open spaces should be balanced in order to enable various spare time activities. Trees and shrubs are recommended to break the wind amplified by towering buildings. Good walkways and benches are essential. Trees should be selected which grow to heights to complement the scale of the housing blocks. Hedges can be used to screen car parking and to enclose smaller sitting or play areas and to provide local shelter.

Suggestions

Solutions with a low demand on maintenance could be favoured and grass-root initiatives should be supported. The surroundings of block houses tend to be anonymous, with a weak sense of ownership. Joint activities therefore stimulate the feeling of community and strengthen the control over one's home environment. The main structural plantings of trees, shrubs and hedges should be provided and maintained centrally but lots of spaces can be developed and maintained by residents.

PLAYGROUNDS

Definition

Play environments for all ages with an emphasis on creative interpretation of provided elements. They should offer a range of play opportunities and functions and meet the needs of different age groups.

Design / composition

Play areas work best when there is perceived or physical separation from surrounding areas and traffic. Zoning by function (physical play, social play or environmental play) using landform, water and elements such as vegetation or rocks is desirable. Hedges or shrubs can be used to divide spaces and control circulation and to prevent children running across moving structures. Safety regulations must be followed. Play equipment of a natural origin (topography, stones, trees for climbing, local flowers, varied ground covers, poly-functional architectonic forms) should be favoured over thematic commercial structures. A play environment needs to stimulate imagination, not clearly suggest types of play. Additionally, a playground should enable activities through all seasons.

Suggestions for management

Play areas require constant maintenance and safety checking with immediate repair of damaged or worn elements. Dogs should be excluded and rubbish and litter removed. Surfacing may need cleaning or raking, grass used for play surfaces should be closely mown in places and left long on others. Sand pits need to be refilled regularly. Maintenance and safety check records should be kept for inspection.

FORMAL SPACES

Definition

Small-scale green spaces with a decorative function, often connected with a building (entrance), a monument, sculpture or fountain.

Design / composition

The layout of these small spaces is formal, detailed and usually geometrical or axial. These decorative squares are mostly paved, enabling pedestrian traffic, while the recreational function may be secondary.

Suggestions for management

The solutions, materials and species should be resistant to intensive use and reflect the aesthetics of the bordering buildings and/or spaces. All surfaces, materials, furniture and vegetation must be well kept at all times. Trimming of plants, cleaning of sculptures and removal of graffiti etc. is necessary.

OTHER LINEAR SPACES ALONG RIVERS, ROADS OR OTHER ROUTES

Definition

Green corridors and linear green elements with grass, trees and shrubs which run alongside transport or stream corridors and which may contain cycle and footpaths and link other green spaces together as part of the urban green infrastructure. They may make use of old railway lines or canals, urban streams and even service corridors such as electricity lines.

Design / composition

These spaces should make connections with other elements and use continuous lines of trees with shrubs to enclose paths from nearby traffic. The design should be kept simple and uncomplicated with few if any ornamental flowers or shrubs, native species being preferred. Thus they are better for urban wildlife as well. Some benches at intervals and litter bins as well as surfaced paths are the main infrastructural elements needed.

Suggestions for management

The areas should only need low intensity management such as twice yearly mowing of grass and clearance of encroaching vegetation or branches growing across paths, maintenance of path surfaces and repair of damage to benches.

HARDINESS ZONES IN EUROPE

A hardiness zone is a geographically defined area in which a specific category of plant life is capable of growing, as defined by climatic conditions, including its ability to withstand the minimum temperatures of the zone. For example, a plant that is described as “hardy to zone 10” means that the plant can withstand a minimum temperature of -1°C . A more resilient plant that is “hardy to zone 9” can tolerate a minimum temperature of -7°C . These zones work but care must be taken when considering the average annual snow cover which insulates plants from deep frost. See plants recommended for our region’s climate zones in Appendix 1 at page 141.

Plants imported from many different countries can be used in urban areas, selected for their different aesthetic properties. While the urban heat island effect keeps cities 1–2 degrees above the average temperature of the surrounding countryside, species and cultivars should be chosen from similar hardiness zones, or from the next less-hardy zone on the hardiness spectrum, if they are to survive extreme winter conditions often found in the Baltic regions. When importing plants which are generally hardy, ensure that they have been grown in a suitable hardiness zone as they will acclimatise to the local conditions much better.



URBAN GREEN SPACE MANAGEMENT

This chapter considers the establishment and management requirements of all the types of plants likely to be grown in urban green areas; a list of species suitable for the urban environment is available in Appendix 2 at page 151. A concluding time table recommending management actions all through the year can be found in Appendix 9 at page 179.

LAWNS AND MEADOWS

LAWNS

Intensively managed or „ordinary“ lawns are mown grass surfaces used for activities, while extensively managed lawns have fewer practical uses and are more for aesthetic purposes.

A simple model of grass maintenance (example from Tallinn) has 3 different types of grass:

- Ornamental lawn (max height 5–7 cm, intensive maintenance),
- Ordinary lawn (max height 15 cm, weeding, aeration, feeding if needed),
- Natural grass (mowing 1–2 times per season, cut grass is removed).

Preparing the soil	<p>To establish a lawn the soil should be cultivated, stones and other materials larger than 1 cm diameter removed, levelled and graded (the biggest safe grade is 1:4) and then firmed up by treading or rolling. Where the soil is clayish, a drainage layer may be necessary. Establishing an irrigation system will increase the life and durability of a lawn.</p> <p>A lawn which is mowed regularly needs a minimum of 15–20 cm of topsoil, 10–15 cm is suitable for meadows, while parterre lawns must have 30 cm of rich topsoil.</p> <p>In order to provide sustainable rain water management (where no salt is used for de-icing) the surface level of lawns could be lower than that of paths. Where lawns need to be higher, they should not be raised more than 1 cm above path level.</p>
Sowing	<p>Grass seed sowing rates are chosen according to growth conditions. An average norm for seeds is 1,5–2,5 kg/100 m². The best time for sowing is either from May until the middle of June or from August until the middle of September.</p>
Using turf	<p>Specially grown lawn turf is used to establish a lawn quickly or to stabilise slopes. Both the soil and the turf should be watered before laying. The turf is delivered in rolls and can be stored for no more than 3 days in a shaded place before laying. The edges of the turf should be laid close together and fixed down on slopes. After the laying is finished, the lawn should be rolled and watered so that at least 5 cm of soil below the carpet is moist. The carpet becomes rooted after 2–4 weeks and the lawn is ready to walk on after 2–3 months. Lawn turf can be laid from the end of May until the beginning of October.</p>
Strengthened lawn	<p>Strengthened lawn should be used in places where treading is a problem. Strengthening options are:</p> <ul style="list-style-type: none"> • 50% of gravel in the soil • gravel underlay beneath the lawn • using special plastic cells • concrete lawn stones (“grasscrete” with holes) • artificial lawn (e.g. Astroturf)

SPECIAL MANAGEMENT AFTER CONSTRUCTION (FIRST SEASONS(S))

Watering	If there is a drought period after sowing the lawn, there is no need to water it. The seed will start to germinate eventually after the next heavy rain. After the seeds have started to germinate, regular watering is needed. Water should be sprayed as a fine jet and with a low pressure. Watering can be done at any time of the day if needed. After the grass has come up the plants need less watering, but more at a time.
Mowing	The first mowing is carried out during the sprouting period (5 weeks after sowing). The plants should be 7–10 cm high. The most suitable mowing height is not lower than 5 cm. The blades of the mower should be very sharp and clippings should be removed the following day. The last mowing of the season is done so that the lawn should stay 5–6 cm tall for winter.
Fixing sowing problems	Bare un-sprouted spots can be re-sown without raking the seeds into the soil, but covering them instead with additional peat or sand. Treading should be avoided the first year after sowing.
Weed control	Weeds usually germinate earlier than the lawn seeds. Weeds should not be pulled out. Annual weeds are only a problem for a lawn in the first year, they disappear afterwards.
Maintenance of carpet lawn	A lawn made of a carpet is watered regularly during the first two weeks after construction. The lawn is mowed after 2–3 days, after that every 7–10 days. The first mowing height is 5–8 cm.

REGULAR MAINTENANCE

The maintenance of lawns is a major cost for park authorities. The different kinds of maintenance works are shown in tables below (number of cuts per season)

Mowing	Type of grass	Height in cm	Species
	very low	< 1	<i>Agrostis stolonifera</i> <i>Agrostis capillaris</i> <i>Festuca rubra</i> <i>commutata</i> some varieties
	low	< 2	<i>Lolium perenne</i> <i>Poa trivialis</i> <i>Festuca rubra</i> <i>commutata</i>
	middle	< 3	<i>Festuca rubra rubra</i> <i>Festuca ovina</i> <i>Poa pratensis</i> some varieties
	high	3,5...4	<i>Poa pratensis</i> most varieties
Times per season:			
	Ornamental lawn		20...25
	Ordinary lawn		15...20
	Extensive lawn		17...20
	Sportsground		20...25
	Extensive grassland		2...10
	Meadow		1...2
	Natural grass		0...2
Trimming (cutting around obstacles)	Ornamental lawn		15...20
	Ordinary lawn		10...15
	Extensive lawn		12...17
	Sportsground		15...20

Gathering the clippings	Ornamental lawn	10
	Ordinary lawn	5
	Extensive lawn	5
	Sportsground	5
	Extensive grassland	1...2
	Meadow	1...2
Fertilizing	Ornamental lawn	3
	Ordinary lawn	3
	Extensive lawn	3
	Sportsground	5
Pest control	Ornamental lawn	1
	Ordinary lawn	1
	Extensive lawn	if needed
	Sportsground	1
Weed control	Ornamental lawn	1
	Ordinary lawn	1
	Extensive lawn	1
	Sportsground	1
	Extensive grassland	1
	Meadow	1
	Natural grass	1
Scarifying	Ornamental lawn	2
	Ordinary lawn	if needed
	Extensive lawn	1
	Sportsground	2
Top dressing	Ornamental lawn	1
	Sportsground	1

Watering	Ornamental lawn	if needed
	Ordinary lawn	1
	Sportsground	4
Aeration	Sportsground	1
Mulching fallen leaves	Fallen leaves can be kept and mulched as a natural nutrient source. To do this, lawn mowers need special mulching equipment, which consists of mower blades and decks. An added benefit with mulching is that the field staff will have more time to devote to other park maintenance priorities.	
	Ornamental lawn	1
	Ordinary lawn	1
Removing/replacing	Ornamental lawn	2
	Ordinary lawn	2
	Sportsground	10

LONG GRASS MANAGEMENT

Leaving long grass and cutting it only once or a few times per season can be a way to reduce costs and manage lawns more sustainably. This is especially effective for difficult places like roadside areas and places with many impediments.

FLOWER MEADOWS

Flower meadows are more-or-less natural or naturalistic plant communities that include both flowers and grasses. They usually flower best in spring and early summer but can also include some late flowerers.

Flower meadows can look very different from site to site and also from one year to another, depending on soil conditions, palette of species, management, climate, weather etc.

Meadows can be created by:

- sowing special seed mixtures on bare soil that lacks perennial weeds;
- spreading out hay made from a meadow which has seeded on bare soil;
- sowing and planting wildflower mixes on bare patches created in existing grassland;
- laying a ready grown 'meadow mat' on prepared soil;
- in cases of infertile or dry soils – just letting the existing herbaceous vegetation grow high.

SITE INVENTORY / CHOOSING THE RIGHT TYPE OF MEADOW

Meadows seed mixtures are prepared differently for different types of soil conditions. The correct time for sowing is from the end of August until the end of September.

Soil for meadows	Dry locations – underlayer 10 cm of sand or gravel, 4–10 cm of poor topsoil. Semi wet – ~5 cm of rich topsoil on the poor soil Wet soil – 30 cm of rich topsoil	
Seed mixture for dry locations – 250 g/100 m ² of grasses and 100 g/100 m ² of flowers	Grasses: 60g <i>Festuca ovina</i> 17% 160 g <i>Festuca rubra</i> 45% 30 g <i>Poa pratensis</i> 8%	Flowers: <i>Leucanthemum vulgare</i> 3% <i>Achillea millefolium</i> 3% <i>Centaurea cyanus</i> 3% <i>Cardaminopsis arenosa</i> 2% <i>Silene vulgaris</i> or <i>S. nutans</i> 3% <i>Campanula rotundifolia</i> or <i>C. patula</i> 1% <i>Dianthus deltooides</i> 3% <i>Solidago virgaurea</i> 3% <i>Rumex acetosella</i> 3% <i>Leontodon autumnalis</i> 3% <i>Crepis tectorum</i> 3%

Meadow plants for sandy dry locations (also calcareous):
Dianthus deltooides, *D. Arenarius*, *Armeria elongata*, *Pulsatilla*, *Helichrysum arenarium*, *Sedum*, *Scleranthus perennis*, *Senecio jacobaea*, *Linaria vulgaris*, *Campanula rapunculoides*, *C. rotundifolia*, *Achillea millefolium*, *Trifolium medium*, *Verbascum nigrum*, *Viscaria vulgaris*, *Tanacetum vulgare*, *Leucanthemum vulgare*, *Hieracium pilosella*, *Thymus serpyllum*, *Galium verum*, *Anthyllis vulneraria*, *Veronica spicata*, *Lotus corniculatus*, *Potentilla reptans*, *Plantago lanceolata*.

Normal moisture meadows:
Anemone sylvestris, *Campanula glomerata*, *C. patula*, *C. Persicifolia*, *Dianthus superbus*, *Filipendula vulgaris*, *Geranium sanguineum*, *G. sylvaticum*, *G. pratense*, *Leucanthemum vulgare*, *Thalictrum sp.*, *T. lucidum*, *Vicia cracca*, *Viscaria vulgaris*, *Galium verum*, *Helianthemum nummularium*, *Plantago media*, *Primula veris*, *Trifolium medium*, *Veronica spicata*.

Wet locations:
Potentilla anserina, *Geum rivale*, *Filipendula ulmaria*, *Lythrum salicaria*, *Polemonium caeruleum*, *Thalictrum aquilegifolium*, *T. lucidum*, *Myosotis palustris*, *Achillea ptarmica*, *Cirsium heterophyllum*, *Polygonum bistorta*, *Valeriana officinalis*, *Trollius europaeus*, *Inula salicina*, *Caltha palustris*, *Lysimachia vulgaris*.

TURNING AN EXISTING LAWN INTO A MEADOW

There are several options:

- The surface is milled and tuft is removed, sand is added to the soil and mixed, the surface is raked smooth before sowing;
- Holes are drilled into the lawn, which are filled with soil in which the meadow seeds are sown;
- Meadow flowers are planted into the lawn in the end of May or at the end of August.

MAINTENANCE DURING THE ESTABLISHING PHASE (1st year)

Meadow growth is usually dominated by annuals at first, either weeds or a nurse crop. These annuals must be mown before they set seed and the clippings must be removed. It is recommended to cut to a height of 5 cm up to four times during the year.

MAINTENANCE OF MEADOWS

Mowing	Mowing is carried out 1–2 times per season, grass is cut to 6–8 cm after flowering, clippings are removed after 2 weeks (to allow the seed to fall out).
Autumn cutting	After the main cut in summer (after flowering), it is recommended to remove the hay so that it does not excessively fertilise the soil. Mow with a rotary flail mower or other suitable mower to 4–7.5 cm. It is ideal to cut the meadow a few more times after the main cut in order to keep the grass short for winter.
Spring cutting	Removing the first flush of grass can produce a later flowering meadow that is shorter, more open and less prone to collapse. Spring cutting or grazing is particularly useful on more fertile soils and in the early years of newly sown grassland; on established infertile sites this is unnecessary. Mow with a rotary flail mower or other suitable mower to 4–7.5 cm.
Grazing	Most grazing animals can produce some benefits to sward structure and development through recycling nutrients and opening gaps with their hooves. Meadow and grassland can be maintained by grazing alone, but only in areas that are not too used by people. Either graze at a low stocking density through the season, or close the meadow to stock from spring to July / August to obtain more flowers.
Harrowing	In the absence of grazing the base of swards tend to become dense and matted. The accumulation of dead material (thatch) prevents the re-establishment of certain perennials, since the seed is unable to reach the soil surface, resulting in a progressive loss of flowering plants. Late autumn is the best time to harrow a meadow as it creates gaps which remain open to flower seed germination from autumn through to spring. There is an opportunity to add seed to grassland at this time.
Weed control	Perennial weeds can be an initial problem on most soils. Most grassland weeds such as docks and thistles are suppressed by the annual hay cut in July and will gradually decline with good management. Selective herbicides are only worth using as a last resort for serious infestations as they will result in the loss of many wild flower species. Dominant grasses can be reduced with earlier mowing.
Watering and feeding	A meadow does not require any additional watering or feeding, quite the opposite. This could alter the natural balance of plants in the area.

OTHER CUTTING REGIMES

Flowerly lawns	Flowerly lawns can be achieved when mowing meadow mixtures regularly to a height of 3–4 cm. Before and during flowering it is better to mow less. Regular cutting allows flowering to be richer and plants to flower at a reduced height.
Meadow with spring flowers and small bulbs	Grass is allowed to grow until the spring flowers have set seed and bulb leaves have withered. Then the grass is mown to around 4 cm (higher than a conventional lawn) and kept as low as this to the end of summer. In this way larger species and vigorous grasses cannot take over from spring flowers. Cuttings need to be removed in order not to fertilize the meadow.
Enhancing wildlife habitats with different mowing regimes	Mowing between April and October can have adverse effects on bird species breeding, nesting, rearing and feeding. It is best not to mow annually at all; a better option would be using a rotational mowing mosaic, leaving some patches untouched for several years.

HERBACEOUS PLANTS

Flowerbeds: main points to consider:

- do not screen the view;
- are eye catchers;
- are ornamental;
- make people to feel comfortable.

The best places for flowerbeds in public space are the most crowded points, where people can enjoy the beauty of decorative flowers. Flowerbeds should be big enough, too small scale patterns and small groups which appear out of proportion in a space should be avoided. Plants used on traffic islands should be from the same variety and kept simple.

Flowerbeds can be seen from one or several directions. The flowers for a border, which is visible from all sides are usually planted so that the taller ones are in the middle and maybe extend towards the edges in places. Some trees and shrubs could be planted in such borders as well. Some modern styles use planting arrangements in rows and the viewer can walk amongst them. Here tall and shorter plants may be mixed up to give a different feeling. Plants are selected for different colours and textures and to flower over the whole season, often in waves so that the colours change subtly over time.

Plants have to be planted far enough from the pavements or restricted, although overhanging edges make for more attractive and softer effects.

CHOICE OF LOCATION

Choosing the location of a flowerbed depends on many factors:

- Soil – excessive or adequate moisture or dry;
- Light-shade ratio – shady – sun is less than 3 hours per day, half shady – 3–6 hours per day, sunny – more than 6 hours per day
- Slope of the ground
- Wind exposure
- Light and warmth reflected from houses or street lights
- Roots of big trees
- Plant colours suitable for the background
- Representative or less representative location
- Observing while sitting on a bench, walking, from transport

CHOICE OF HERBACEOUS PLANTS

Flowers are divided into groups:

- Annuals
- Perennials
- Bulb plants
- Groundcovers
- Decorative grasses

ANNUALS

Annual or biennial plants are normally planted for one growing season. Groups of annuals are selected to give colour and variety to the surroundings. To have flowering plants throughout the vegetation period, annuals should be changed 3 times – spring, summer and autumn flowers, which are grown in greenhouses and then planted out in dense formations.

PERENNIALS

Perennials are herbaceous plants used as a surfacing plant or planted in groups because of their decorative flowers, leaves, colour, fragrance, etc. to vary the landscape.

Perennials are not demanding plants, but trimming them after flowering finishes in autumn helps improve their appearance and flowering, although the seed from the old flowers may be good for wildlife if left long enough. Flowering plants that grow and bloom over the spring and summer, die back every autumn and winter, and then return in the spring from their root-stock.

It is preferable to use such plants which are undemanding for soil and maintenance and which are lush, fully cover the ground and tolerate salty soil.

Since each species or variety usually bloom for a short time it is important to use different perennials, which bloom in different times in the same bed. It is also possible to use perennials, whose leaves are decorative all the season as structural elements.

Recommended perennials for different conditions:

Dry locations, full sun	<i>Achillea</i> , <i>Adonis</i> , <i>Antennaria</i> , <i>Anthemis</i> , <i>Aster alpinus</i> , <i>Campanula</i> , <i>Centaurea</i> , <i>Dianthus</i> , <i>Geranium macrorrhizum</i> , <i>Iberis</i> , <i>Nepeta</i> × <i>fassenii</i> , <i>Origanum vulgare</i> , <i>Papaver orietale</i> , <i>Pulsatilla</i> , <i>Sedum</i> , <i>Stachys</i> , <i>Thymus</i>
Dry locations, half-shade to full sun	<i>Delphinium</i> × <i>cultorum</i> , <i>Geranium</i> , <i>Heuchera</i> , <i>Leucanthemum</i> <i>maximum</i> , <i>Sedum spectabile</i>
Excessive or adequate moisture, half-shade to sun	<i>Alchemilla mollis</i> , <i>Aquilegia vulgaris</i> , <i>Aruncus aethusifolius</i> , <i>Aruncus dioicus</i> , <i>Astilbe</i> , <i>Bergenia cordifolia</i> , <i>Geranium</i> , <i>Hemerocallis</i> , <i>Iris sibirica</i> , <i>Ligularia</i> , <i>Lysimachia punctata</i> , <i>Pulmonaria</i> , <i>Rodgersia</i> , <i>Solidago</i>
Excessive or adequate moisture, half-shade to full shade	<i>Aegopodium podagraria</i> 'Variegatum', <i>Ajuga reptans</i> , <i>Alchemilla mollis</i> , <i>Anemone</i> × <i>hybrida</i> , <i>Anemone sylvestris</i> , <i>Aruncus</i> , <i>Asarum</i> , <i>Astilbe</i> , <i>Astrantia</i> , <i>Bergenia cordifolia</i> , <i>Brunnera</i> , <i>Dicentra</i> , <i>Eupatorium</i> , <i>Filipendula</i> , <i>Hosta</i> , <i>Peltiphyllum</i> , <i>Pulmonaria</i>
Wet location, sun to half-shade	<i>Butomus umbellatus</i> , <i>Caltha palustris</i> , <i>Eupatorium cannabinum</i> , <i>Eupatorium purpureum</i> , <i>Euphorbia palustris</i> , <i>Filipendula</i> , <i>Iris kaempferi</i> , <i>Iris pseudacorus</i> , <i>Iris sibirica</i> , <i>Lysimachia</i> , <i>Lythrum salicaria</i> , <i>Myosotis palustris</i> , <i>Polemonium coeruleum</i> , <i>Thalictrum aquilegifolium</i> , <i>Trollius</i>

GROUNDCOVERS

These are plants, which cover the ground thickly, forming sods or pads. Such plants do not tolerate treading but are usually hardy. Some of them can spread widely and they are good to use on slopes instead of lawn. They can be used in shady areas where grass does not grow and to discourage walking.

Recommended ground covers:

Ajuga reptans, *Asarum europaeum*, *Bergenia cordifolia*, *Brunnera macrophylla*,
Convallaria majalis, *Cornus Canadensis*, *Fragaria vesca*, *Geranium*, *Glechoma*
hederacea, *Houttuynia cordata*, *Inula ensifolia*, *Lamium galeobdolon*, *Omphalodes*
verna, *Polygonum*, *Pulmonaria*, *Sedum*, *Thymus*, *Tiarella cordifolia*, *Vinca minor*,
Viola odorata, *Waldsteinia ternata*.

DECORATIVE GRASSES

These are grasses which have seen a vogue in their use recently as ornamental materials with interesting textures and colours. Such grasses could be used as a mass of plants in their own right or used together with perennials, groundcovers and low shrubs.

Some of them form good shaped tufts.

It is better to use hardy vigorous species whose root system is deeper, demanding less irrigation. They are long-living and depending on the species can grow in direct sun or shady spaces. There are many species which are natural in our region and suited for ornamental use.

Recommended native grasses:

Dry location	<i>Calamagrostis epigejos</i> , <i>Calamagrostis x acutiflora</i> , <i>Deschampsia flexuosa</i> , <i>Festuca ovina</i> , <i>Leymus arenarius</i> , <i>Melicia nutans</i> , <i>Nardus stricta</i>
Shady location	<i>Bracypodium pinnatum</i> , <i>Luzula sylvatica</i> , <i>Milium effusum</i> , <i>Poa chaixii</i>
Wet location	<i>Carex acuta</i> , <i>Carex flava</i> , <i>Carex pendula</i> , <i>Carex pseudocyperus</i> , <i>Carex sylvatica</i> , <i>Juncus conglomeratus</i> , <i>Juncus effusus</i> , <i>Phalaris arundinacea</i> , <i>Schoenoplectrus lacustris</i> , <i>Schoenoplectrus tabernaemontanii</i> , <i>Scirpus sylvaticus</i>

Hardy grasses and their varieties:

Alopecurus pratensis 'Variegatus', 'Aureovariegatus' *Arrhenatherum elatius* ssp *bulbosum* 'Variegatum', *Briza media*, *Bromus sterilis*, *Calamagrostis x acutiflora* 'Overdam', 'Karl Foester', *Carex elata* 'Aurea', 'Bowles Golden', *Carex grayi*, *Carex oshimensis* 'Evergold', *Carex plantaginea*, *Carex siderosticha* 'Variegata', *Deschampsia caespitosa*, *Deschampsia flexuosa* 'Aurea', 'Bronzeschleier' *Festuca gautieri* (*F. scoparia*), *Festuca glauca*, *Glyceria maxima* 'Variegata', *Helictotrichon sempervirens*, *Holcus mollis* 'Variegatus', *Hystrix patula*, *Juncus effusus* 'Spiralis', *Juncus inflexus* 'Afro', *Luzula nivea*, *Melica altissima* 'Atropurpurea', *Melica ciliate*, *Milium effusum* 'Aureum', *Miscanthus* 'Purpurascens', 'Giganteus', *Miscanthus sacchariflorus*, *Miscanthus sinensis* 'Goliath', 'Gracillimus', 'Silberfeder', *Molinia cerulea* 'Variegata', *Molinia caerulea* subsp *arundinacea*, *Phalaris arundinacea* 'Picta', *Phragmites australis* 'Variegatus', *Sesleria hauffleriana*, *Sesleria nitida*

BULBS

Bulbs (and also rhizomes, tuber and corms) are frequently some of the earliest plants to flower in spring before the trees have come into leaf and they are attractive because they herald the onset of the growing season. Bulbs make a fine display planted in containers or borders, especially daffodils, snowdrops and tulips in spring. They are one of the easiest and most rewarding garden plants to grow.

Naturalised bulbs can also give interest to areas that otherwise might not bloom. Under deciduous trees, where the conditions are too dry and shady for most plants, you can use spring- or autumn-flowering bulbs because they are in growth when the trees have few leaves to cast shade. Suitable choices include anemones, crocuses and scillas.

Choice of self-sustaining bulbs

Spring-flowering	<i>Anemone, Chionodoxa, Crocus, Eranthis, Galanthus nivalis, Hyacinthus, Iris, Leucojum vernalis, Muscari, Narcissus, Fritillaria, Scilla and Tulipa</i>
Summer-flowering	<i>Allium, Galtonia, Lilium, Nectaroscordum</i>
Autumn-flowering	<i>Colchicum byzantinum</i> and <i>C. speciosum</i> . <i>Crocus goulimyi</i>
Bulbs for containers	<i>Anemone, Chionodoxa, Crocus, Hyacinthus, Iris, Muscari, Narcissus, Scilla and Tulipa; Agapanthus, Canna, Freesia, Lilium, Zantedeschia</i>
Bulbs for naturalising in grass	<i>Anemone nemorosa, Chionodoxa luciliae, Crocus chrysanthus</i> and its cultivars, <i>Crocus sieberi</i> and <i>C. tommasinianus</i> , <i>Narcissus asturiensis, Eranthis hyemalis, Galanthus nivalis, Scilla siberica</i>

MOVABLE FLOWERBOXES AND CONTAINERS

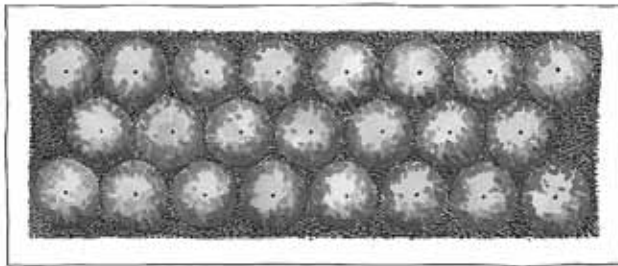
When there are no open beds in which to plant flowers then containers can be used. They are also used where streets and winter maintenance make impossible to grow flowers in soil. They need irrigation systems.

PLANTING FLOWERS

The soil should be prepared thoroughly so that the whole border or bed is without weed roots, suitable for the chosen plants 40 cm deep. Digging to remove weeds and addition of organic matter such as compost to improve soil structure and moisture retention is necessary. Mulches may be used after planting to prevent weed invasion and to help moisture retention.

PLANTING ANNUALS

- There are some species that could be planted early in spring (Viola), those stand night frost and are so called plants for the first round. Second round of annuals are planted after the spring frosts are over (end of May, beginning of June);
- Plants should be vigorous and without parasites or fungi;
- Plants should be watered some hours before planting;
- It is better to plant on cloudy days or later in the afternoon;
- Planting depth is the same as that at which the plants used to grow before in the nursery
- Watering after planting is very important even on the rainy days so ensure that soil air pockets are filled in.



A SUITABLE PATTERN FOR PLANTING ANNUALS (TOP VIEW)

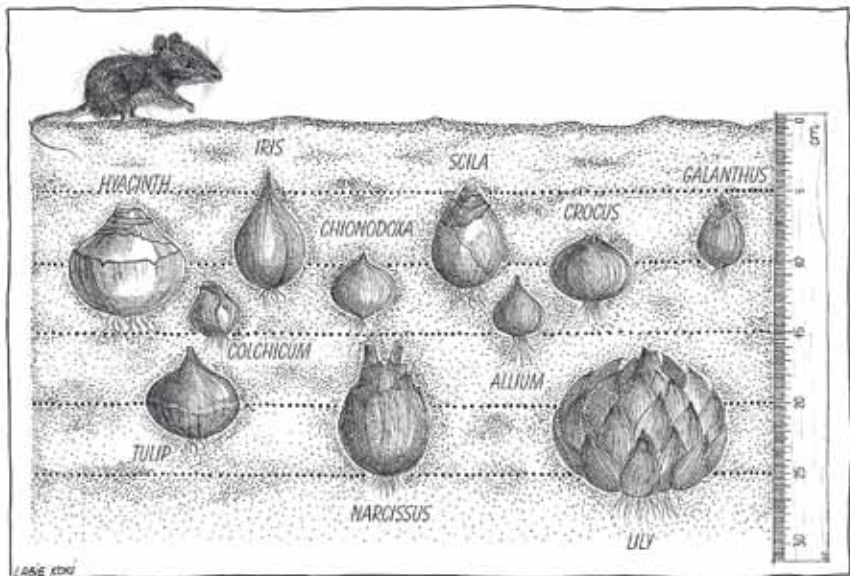
PLANTING PERENNIALS, GROWDCOVERS AND GRASSES

- The best time to plant is early in spring or in the autumn, but plants in containers can be planted throughout the growing season.
- Plants should not be planted too close to each other, the tall perennials can be planted 3...6, medium ones – 9...12 and low ones – 20...25 plants per m². More space should be left between the groups.

PLANTING BULBS

Spring-flowering bulbs should be planted in autumn. Hardy summer-flowering bulbs are planted in autumn.

Before planting, check that the bulbs are healthy and do not show signs of softness and rot.



PLANTING BULBS - EACH FLOWER NEEDS A DIFFERENT PLANTING DEPTH

Borders, lawns and wildflower areas

For a naturalised look, scatter bulbs randomly on the ground and plant them where they fall, but make sure they are not overly crowded together as they will grow in the same place for a long time.

The average planting depth for bulbs is three times their size. If they are too close to the ground they are exposed to draught. Use the same soil from the planting hole for filling it up later and replace the turf on top of the hole so that ground remains level. For planting small bulbs, it is possible to roll back sections of turf.

Planting in net containers

In order to have control over bulbs, it is possible to plant them in containers. This way it is easy to replant them whenever needed.

Planting time	Species	August	September	October
	<i>Narcissus</i>	•	•	
	<i>Hyacinthus</i>		•	•
	<i>Allium</i>		•	•
	<i>Tulipa</i>		•	•
	<i>Crocus</i>		•	•
	<i>Scilla</i>	•	•	•
	<i>Chionodoxa</i>	•	•	•
	<i>Muscari</i>	•	•	•
	<i>Eranthis</i>	•	•	
	<i>Galanthus nivalis</i>	•	•	
	<i>Leucojum vernum</i>	•	•	
	<i>Fritillaria</i>	•	•	
	<i>Puschkinia</i>	•	•	
	<i>Colchicum</i>	•	•	

MAINTENANCE

ANNUALS

- Equal blooming should be guaranteed
- Plants, which need bracing should not be used.

Aeration and/ or weed-killing	To be done as often as needed to assure clean soil surface;
Irrigation	Should be done at least every 10 days;
Fertilizing	Depends on the species, but long lasting fertilizers could be used at least twice during the growing period;
Disinfestations	Should be done if needed;
Preparing containers for the next season	Is carried out by moving the containers to storage or keeping them at their location but filling them with decorative material or planting evergreens (<i>Erica</i>).

PERENNIALS

Watering	It is necessary to water perennials regularly until they are well-established. Encourage roots to grow deep in the soil by watering for longer periods at a time, fewer times per week.
Mulch around the plants	To conserve soil moisture, but do not pile it up around the plant's stems. A ring of mulch around the plant – and about 5 cm deep throughout the beds – is best.
Dividing	Dividing is carried out when perennials have perished in the middle, have outgrown their space or do not seem to produce as much flowers as expected. Dividing is normally done every 3–4 years.
Aeration and/ or weed-killing	As often as needed to assure a clean soil surface
Deadheading and trimming back	As often as needed so that the borders are in perfect order

Fertilizing	Depends on the species and the soil analyses. Perennials need infrequent fertilization if they are planted in a well-prepared bed with average or better soil. One method is to apply topdressing of compost or a light application of an organic or chemical general-purpose fertilizer (NPK% 10-10-10, 12-12-12 or 5-10-5) in spring.
Disinfestations	Should be done if needed.
Cutting back in autumn and winter	Herbaceous perennials and ornamental grasses that die back to ground level need to be cut back, either in autumn or spring. Autumn cutting results in order and tidiness, however, this removes potential winter decoration and food and habitat sources for wildlife. Thus it is possible to carry out selective cutting that retains decorative flower-heads until spring but removes signs of decay or fungal growth. Separate and burn any diseased material (showing signs of leaf-spot, mildew and rusts, for example) and seed heads but use all other material for compost.
Cutting back in spring	More tender plants with woody stems, such as Lavandula and Oregano, are left uncut in autumn so that the old stems protect the crown from frost. Leave pruning until the risk of frost has passed – usually April or May. After cutting back, use the clippings for mulching the plants themselves. Using shears or secateurs, cut stems close dormant base of the plant. If there is any young growth, cut to just above it.
Cutting back after flowering	Early-flowering perennials such as geraniums and delphiniums are cut almost to ground level after flowering to encourage fresh foliage and late summer flowering. These are then cut back again in autumn or spring.

BULBS

Watering	All bulbs in locations likely to dry out, such as containers or boxes need adequate water throughout their growing period, and for six weeks after flowering until the leaves die back. When growing bulbs in containers, they need to be checked regularly. Keep the soil moist but not wet.
Fertilizing	Apply a general-purpose NPK fertiliser to flowerbeds in late April to encourage bulbs to flower well in the following season. Use liquid high-potassium feed for containers until six weeks after flowering.
Deadheading	After flowering, the stalks need to be cut back to the base of the plant in order not to spend energy on seed production. Do not cut if seeds are necessary for growing new plants.
Cutting back bulb foliage	At least six weeks needs to be given after flowering and before cutting the plants (and the surrounding grass) but it is ideal to wait until the entire plant goes yellow and straw-like.

SHRUBS, HEDGES AND CLIMBERS

SHRUBS

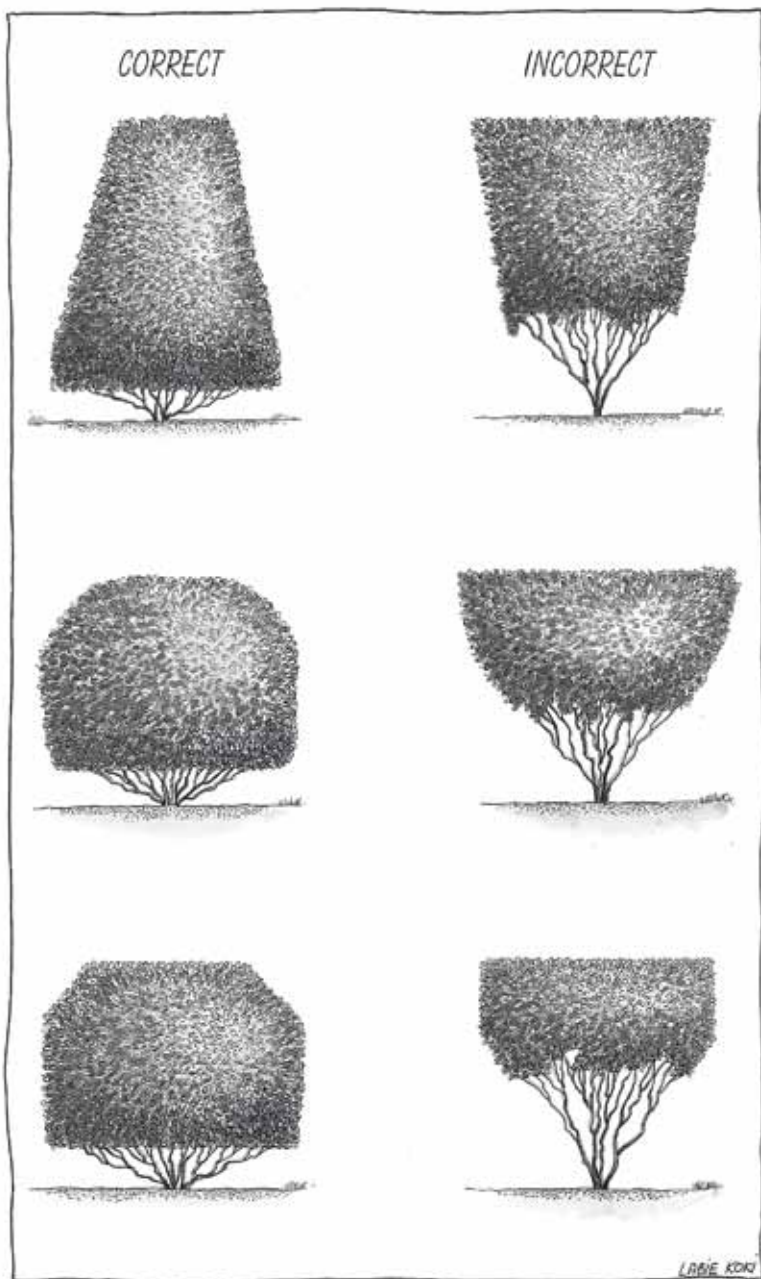
Plants of many species may grow up into shrubs or trees, depending on their growing condition. There are no distinct factors separating trees from shrubs – what is a small tree in one place can be called a shrub elsewhere. Typically, a shrub does not exceed 6 m in height and has several growing axes and no apical dominance, although many trees do not display apical dominance either.

Maintenance is usually simpler than that of the trees and professional arboriculturalist assistance is rarely necessary for shrubs.

HEDGES

A hedge is a line of closely spaced shrubs and tree species, planted and trained to form a single linear element where the crowns are fused and trimmed as one unit, at a variety of heights, with a purpose:

- To enclose or divide space;
- To separate several different zones;
- To form a barrier;
- To screen unattractive views;
- For wind protection;
- In cemeteries.
- To mark the boundary of an area;



CORRECT AND INCORRECT HEDGE SHAPE PROFILES

THE HEIGHT OF HEDGES

Dwarf hedges – height less than 0,5 m, boundary for a bed and for ornamental patterns in parterres	<i>Buxus sempervirens</i>	
Low hedges – 0,5–1 m, suitable for separating different areas	Trimmed hedges	Natural shaped hedges
	<i>Cotoneaster lucidus</i>	<i>Spiraea nipponica</i>
	<i>Cornus alba</i>	<i>Chaemamelis japonica</i>
	<i>Taxus</i>	<i>Potentilla fruticosa</i>
	<i>Thuja occidentalis</i>	<i>Berberis thunbergii</i>
Medium hedges – 1,5–2 m, suitable for boundaries or backgrounds for blooming plants.	Trimmed hedges	Natural shaped hedges
	<i>Cotoneaster lucidus</i>	<i>Aronia</i>
	<i>Cornus alba</i>	<i>Cornus alba</i>
	<i>Crataegus</i>	<i>Cotoneaster lucidus</i>
	<i>Berberis vulgaris</i> ‘Atropurpurea’	<i>Rosa rugosa</i>
	<i>Syringa josikaea</i>	<i>Symphoricarpos albus</i>
	<i>Picea abies</i>	<i>Pinus mugo</i>
	<i>Thuja occidentalis</i>	
	<i>Larix</i>	
A living wall, 2 m and higher	Trimmed hedges	Natural shaped hedges
	<i>Crataegus</i>	<i>Aronia</i>
	<i>Syringa josikea</i>	<i>Pinus mugo</i>
	<i>Picea abies</i>	<i>Juniperus communis</i>
	<i>Thuja occidentalis</i>	<i>Corylus avellana</i>
	<i>Larix</i>	

CLIMBERS

A climber is any plant with a growth habit of trailing or climbing. These might climb using tendrils which wrap around wires or branches, aerial roots which fix to masonry or thorns which hook onto other plants. They are planted close to a wall, fence or trellis and may require some initial support or tying back until established. Then they may need regular pruning to prevent them becoming overgrown.

Examples include:

Actinida kolomikta

Aristolochia macrophylla

Celastrus orbiculatus

Clematis alpina, *C tangutica*, *C × jackmanii*

Humulus lupulus

Hydrangea petiolaris

Lonicera caprifolium

Lonicera periclymenum

Parthenocissus quinquefolia

Schisandra chinensis

Vitis amurensis

CHOOSING A SHRUB, HEDGING AND CLIMBER PLANT MATERIAL IN THE NURSERY

While choosing the plant consider:

- The plant's suitability for the chosen location (e.g. whether the shrub has edible, decorative or poisonous features – see Appendix 4 at page 162 or whether a formal or informal shape is desired – see Appendix 5 at page 166). Sizes and shape properties of various shrub/hedge species are given in Appendices 6 and 7 at page 171 and 174.
- The plant's demand for light, whether the planting location is in open sun or in shade; light-requiring plants grow poorly or die in deep shade;
- Soil moisture:
 - » in wetter areas plant *Salix alba*, *Salix purpurea*, *Alnus glutinosa*, *Cornus alba*, *Cornus sericea*;
 - » in drier locations – *Pinus mugo*, *Juniperus communis*, *Rosa rugosa*, *Berberis*, *Crataegus*

Usually the plants grown for hedges are less than 2–3 years old, bare rooted or in containers.

Shrubs should have several stems from the ground – at least 3 strong axes. The branches should be proportionately displayed with no mutual interference.

TRANSPORTATION AND STORAGE OF WOODY PLANTS DURING PREPLANTING PERIOD

Plants should be transported in closed vehicles and not left standing in warm sun so that they get hot and dry. Plants should not be packed for long before being dispatched and should not take too long in transit.

When the seedlings arrive on site, the nursery packing should be opened and checked to see that the plants have not dried out, developed mould or are overheated. If they are satisfactory, they can be accepted to the site and then stored in a cool, shady place with the roots protected from sun and drying, and planting should be done in few days.

If the seedlings cannot be planted immediately they should be stored in a trench about 30 cm deep, covered with soil with the tops exposed. Soil should be packed firmly, watered thoroughly, and made certain that all the roots are covered. The seedlings may be stored in a cool place for as long as the plants are still dormant.

Evergreens require extreme care; their roots cannot be exposed to the air more than a few seconds.

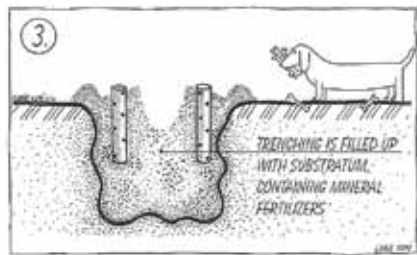
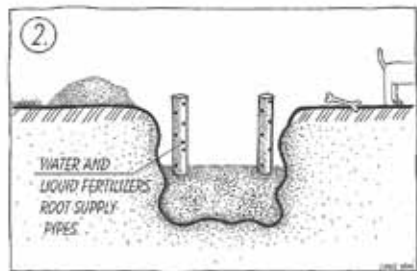
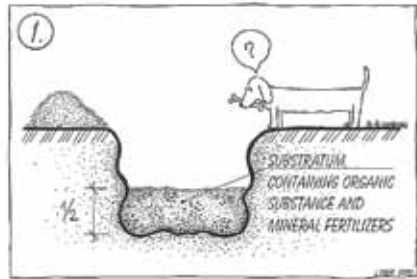
PLANTING

PREPARING THE SOIL

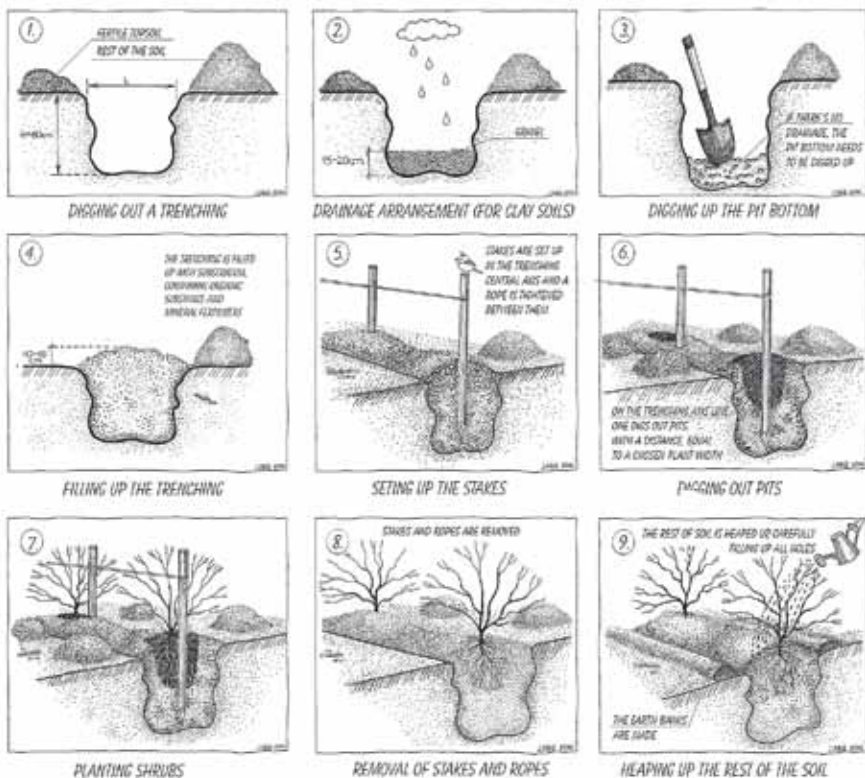
It is important to give shrubs and hedges a good start by preparing the planting area properly. An at least 50 × 50 × 50 cm bed needs to be dug for planting. Most shrubs need a slightly acidic soil, except *Rhododendron* and *Hydrangea*, which need a more acidic soil. If weeds have not been treated by herbicide beforehand, remove all weeds. If the soil is poor, adding some compost, well-rotted manure or other organic matter will improve the quality of the soil. Soils with a tendency to become waterlogged in winter may require a permanent drainage system.

After the soil is prepared, it should be watered well, and left for a week or so before planting to allow the soil to settle.

Hedges should be planted in a trench, 60–90 cm wide and one spade blade deep. If the sides or base of the planting hole are too compact, break the soil up with a fork before planting.



SETTING UP ROOT SUPPLY PIPES AND PLANTING HEDGE



PLANTING DISTANCE

Spacing of hedging plants should be close so as to form a dense mass at ground level. Planting distances vary from 30–60 cm, depending on the plants' final size, the size of hedge required and plant vigour. If hedges thicker than 90 cm are wanted, plant a staggered double row 45 cm apart, with plants 90 cm apart. Recommended distances between plants are listed in Appendix 3 at page 156.

Most climbers can be planted 1 m or even more from each other.

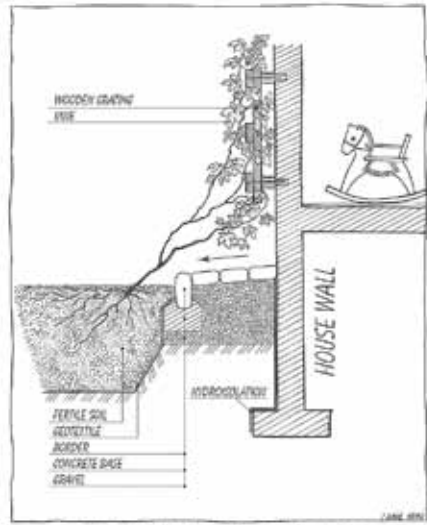
If shrubs are to be planted near a wall, they should be at least 50 cm from the base.

PLANTING TIME

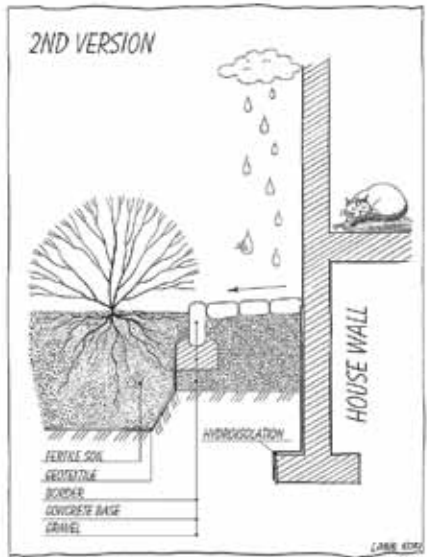
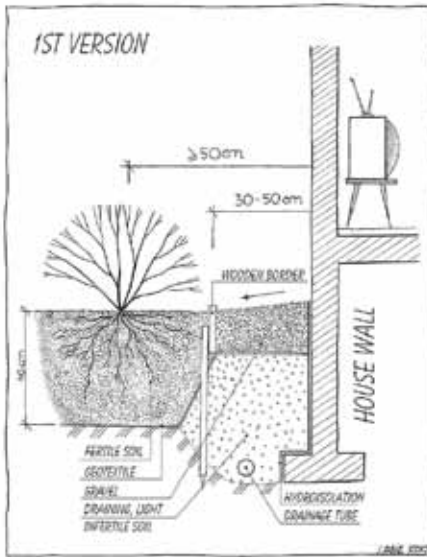
Container-grown plants can be planted any time of the year, but are easier to care for if planted in autumn or spring once the frost is out of the ground, although these need more watering.

Bare-root trees and shrubs are only available in nurseries in autumn and spring. They should be planted immediately on arrival from the nursery, but if this is not possible, then they can be temporarily planted in the soil to prevent the roots drying out until final planting is possible.

Vines could be planted the whole vegetation period, but it is better to plant more tender species in spring.



PLANTING VINES NEAR HOUSE WALL



PLANTING HEDGE NEAR HOUSE WALL

PLANTING DEPTH

Shrubs and vines can sometimes be planted deeper than the root collars. Roses and clematis should be planted 10–20 cm deeper for better wintering.

PLANTING WORKS

Bare root plants can be soaked in water for some hours before planting, although it is better to water them in once planted. The planting hole should be big enough to spread the roots widely and evenly around the stem and only as deep as to ensure that the plant sits on the bottom with the root collar at the correct level (the same as the undisturbed ground). Any damaged roots should be trimmed back to healthy growth.

The hole has to be filled $\frac{3}{4}$ full, then the soil firmed down carefully and watered before filling it completely and firming once more. If desired a soil ridge can be made around the hole to create a watering basin.

If the plants are grown in containers or wrapped in fabric, both should be removed before planting. Then plant them as described above.

Mulch to a depth of 7,5 cm after planting will prevent weeds and help to hold moisture.

Shrubs may need pruning after planting to reduce the shoot / root ratio. Trim back any broken or straggly branches to form a balanced plant. Further formative pruning may also be necessary.

REGULAR MAINTENANCE

WATERING

After planting, 10 litres of water per shrub is normally given. Watering should be repeated every week until the plant has become established unless the season is very rainy. As newly planted trees and shrubs often suffer from drought stress, they need to be watered well for the next two years, especially in dry conditions.

WEEDING, MULCHING AND FERTILISING

A circle at least 1,2 m in diameter around each shrub should be kept weed free for the first three years. Soil under a hedge should be kept weed free up to 45 cm on each side. This is because weeds, grass and other vegetation intercept water before it reaches the roots of newly planted shrubs. After planting, regularly feeding with NPK fertiliser is needed in the growing season, especially after the shrubs have been summer pruned or hedges have been clipped. Watering is important whenever necessary.

Mulching around the base of shrubs, with bark, peat, or well-rotted compost or manure, will help to retain moisture in the soil and keep down weed growth. A collar of 10 cm around woody stems should be left free of mulch, to prevent the risk of rotting the bark.

Because hedge plants are planted close together, special attention should be paid to regular watering and feeding.

PRUNING

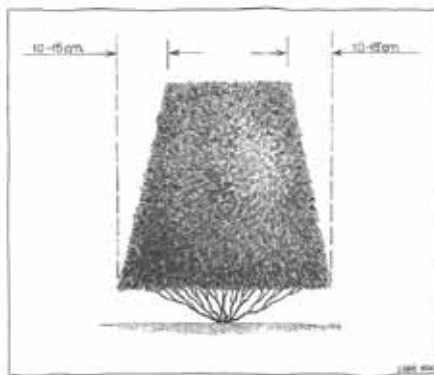
The basics of pruning of shrubs are significantly different than pruning of trees. Shrubs need more frequent pruning than trees, because shrubs are:

- short-lived and aging quicker – needing rejuvenating;
- usually have more than 1 stem;
- give a lot of shoots;
- cheap and easy to replace.

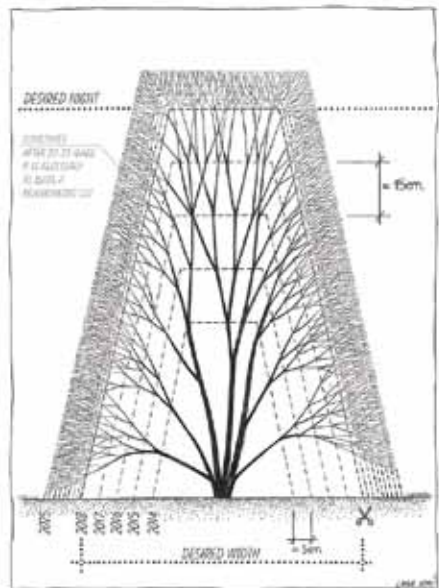
Skilled pruning of ornamental shrubs increases their blooming rate, attractiveness of foliage, gives young colourful shoots and postpones the aging of the shrubs. It also provides an economic benefit in that there is no need to replace the plants so often.

Before pruning one should know:

- how the specific shrub reacts on to it (are there enough shoots left after pruning);
- whether the shrub blooms in early spring or later (the time for pruning depends on it).



FOR A HEDGE WITH SQUARE PROFILE IT IS STILL RECOMMENDED TO MAKE A SLOPE OF VERTICAL AXES ON BOTH SIDES OF THE HEDGE

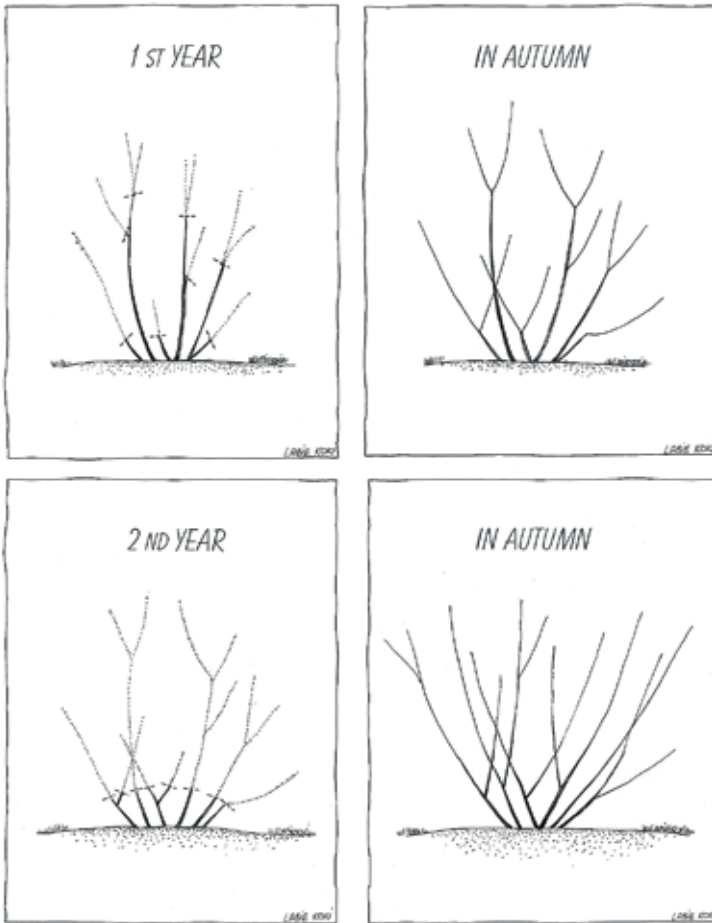


HOW TO GET THE SHAPE

Pruning methods

Pruning after planting

Many shrubs need pruning after planting, especially if they have only a few branches in order to stimulate new growth and multiple dense stems shooting from the base. A bare-rooted plant should be pruned back $2/3$ of each branch growth. The best time for this is late autumn or early spring.



PRUNING STAGES

Crown thinning and regular pruning

In order to keep a healthy well-shaped dense bush and to ensure good flowering or to repair winter snow damage shrubs should be pruned regularly once well established. Dead branches should be cut back to ground level, broken branches can be cut back to a side shoot or bud, weaker branches can be removed too. If some branches grow too tall they can be shortened.

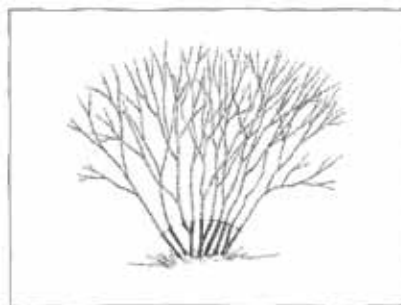
Rejuvenation pruning

Older shrubs often grow out of proportion with their surroundings, may appear top-heavy and open lower down and may have large amounts of unproductive wood. Two techniques are used to restore old shrubs, provided they still have sufficient vigour and are growing in a favourable location with sufficient light. Keep the following in mind with rejuvenation pruning:

- Species – see species groups below;
- Timing – the preferred time for rejuvenating pruning is just before bud break in early spring;
- Extra after-care is needed for heavily pruned shrubs – fertilization, watering, and pest control will be critical factors.

Gradual rejuvenation is a technique which gradually removes growth. In the first year, one-third of the oldest unproductive branches are removed. The next year, half of the remaining stems are removed. Finally, in the third year, the remainder of the old branches are pruned out. New, productive stems should quickly replace the old wood. This method takes longer to complete, but the shrub stays more attractive throughout the rejuvenation period. This method is suitable for shrubs which sprout strongly or have short-lived branches.

Extensive rejuvenation involves the complete cutting down of the entire plant to 15–25 cm above the ground. Heavy lopping shears and a pruning saw are used. The shrub will then sprout vigorously so that half of the new shoots that develop by mid-summer should be removed and some of the remaining shoots should be shortened. It is important to prune to outward-pointing buds so that the inner part of the shrub does not become too dense.



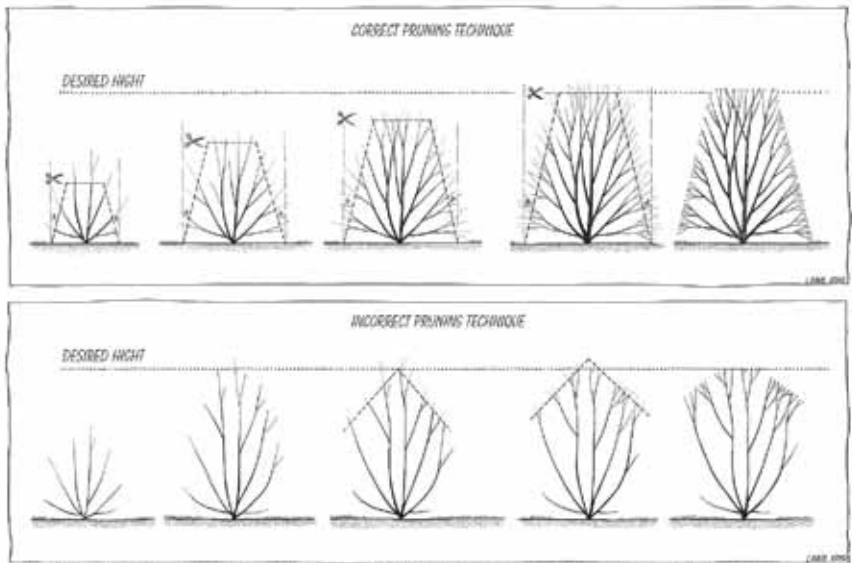
REJUVENATING PRUNING OF THE SHRUB

Shrubs that tolerate extensive rejuvenation include *Cornus*, *Lonicera*, *Hydrangea*, *Syringa* and *Spiraea*.

Reduction

Rejuvenation carried out too high can result in the shrub becoming too dense at the top with few branches on the lower section. Reduction helps to make the shape better and also makes shrubs flower better.

If the branches are cut step by step, some shrubs, like *Euonymus europaeus*, *Hydrangea*, *Syringa*, can be formed into small trees.



THE DIFFERENCE BETWEEN A HEDGE, FORMED FROM THE VERY BEGINNING AND ONE, THAT HAD BEEN GIVEN A CHANCE TO GROW BIG, AND ONLY AFTER WAS PRUNED TO GET THE DESIRED HEIGHT.

Pruning groups

Pruning of informal shrubs and formal hedges require different approaches. Shrubs belong to different pruning groups which require different approaches and timings of pruning according to growth habits and flowering characteristics such as:

- growing features;
- blooming time;
- character of blooming (flowers in the axils of leaves, on the top of the shoot, on the side shoots of annual shoots).

Some species can belong to several groups depending what kind of shrub is wanted.

I GROUP – shrubs which sucker or sprout on lower branches when the plants are grown. The main and lateral branches only grow longer, so they look like small trees. Only minor pruning is needed for cleaning purposes. Good formation pruning during first years ensures the optimal structure of main branches.

Acer ginnala, tataricum, mandchuricum
Syringa vulgaris (as a tree)
Euonymus europaeus
Cercidiphyllum
Hamamelis
Crataegus (as a tree)
Amelanchier
Hydrangea paniculata (as a stump)
Magnolia

II GROUP – is divided into subgroups – the main characteristic is that flowers form on the old wood (the wood from the last year or even older).

II GROUP a) – flowers in the axils of leaves, along (1–2 years old) shoots. Pruning can vary to some degree depending on the species. The main goal is to stimulate as many young strong shoots as possible which blossom in early spring. Old branches are cut down (or 3–5 buds left) after blooming to stimulate the growth of young shoot ready to bloom the next year.

Forsythia
Spiraea chamaedryfolia, media,
×vanhouttei, ×cinerea
Caragana arborescens
Berberis
Weigela
Ribes

II GROUP b) – flowers along the previous year shoots on leafed flower rachis, blooming somewhat later than the Group IIa types. Thinning should be in spring, before the growing season the braches which bloomed the previous year being cut back, leaving 3–5 buds.

Spiraea rosthorni
Spiraea nipponica

II GROUP c) – flowers occur on the top of lateral branches which grow from two year old branches. Pruning takes place in spring to remove the branches, which bloomed the previous year, leaving the strongest couple of buds.

Hydrangea

II GROUP d) – flowers on the top of the branches that are at least one year old. Needs only a small amount of pruning. Evergreen plants do not need pruning at all. Pruning every 5–10 years is sufficient. All the shoots from the last year should be kept.

Syringa
Cornus
Rhododendron
Rhus

II GROUP e) – flowers on the spurs of older branches. It is important give as much light as possible to those branches.

Amelanchier; Chaenomeles
Aronia; Crataegus
Laburnum

III GROUP – late blooming shrubs that form the flower buds on the top of the shoots from previous year. They are strongly pruned back in order to stimulate blooming. It is important to leave enough buds for starting growth.

Spiraea japonica, betulifolia, salicifolia, menziesii
Cytisus nigricans
Chamaecytisus supinus
Genista tinctoria; Sorbaria

IV GROUP – shrubs with coloured and decorative shoots. Pruned back in spring, leaving 3–5 buds.

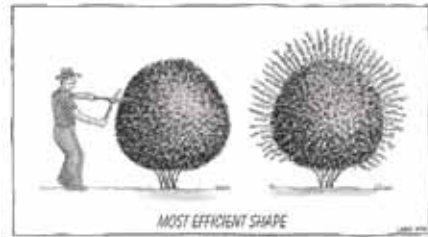
Cornus
Salix

Pruning of formal hedges

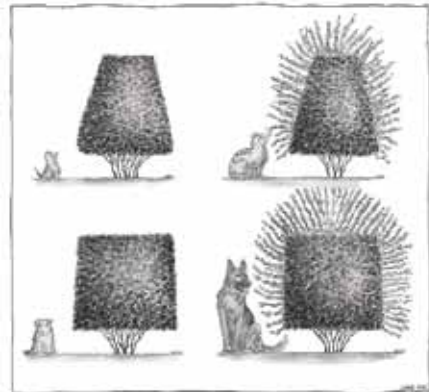
Formal hedges are trimmed to ensure a dense even texture from the ground up. Hedges should be trimmed to a broader base than the top with sloping sides and a flat top. Hedge trimmers are used to ensure a smooth even trimming. Depending on the species hedges should be trimmed one or twice per year. Initial forming of a dense hedge is achieved by pruning the leading shoots once they reach 20–30 cm below the eventual height and any side shoots once they reach the desired width.

If individual shrubs within the hedge die they can be removed and either replaced by a new one or else the hedge is allowed to grow into the empty space and over time to become as dense.

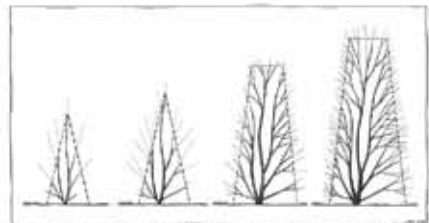
If a hedge has been neglected and grown out it can be rejuvenated in a similar way to other shrubs. The top can be removed to 20–30 cm below the desired height and side shoots cut back. Species which sprout from stems will respond and fill in but if there are wide gaps then new plants should be added.



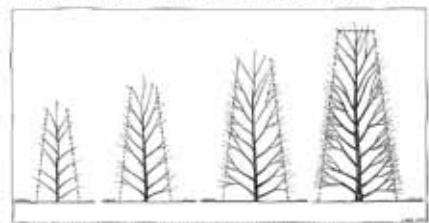
IF A HEDGE PRUNING IS STOPPED FOR A WHILE, THE SIMILARITY OF THE ORIGINALLY CHOSEN HEDGE PROFILE IS REMAINED



IF A HEDGE PRUNING IS STOPPED FOR A WHILE, THE SIMILARITY OF THE ORIGINALLY CHOSEN HEDGE PROFILE IS NOT RETAINED



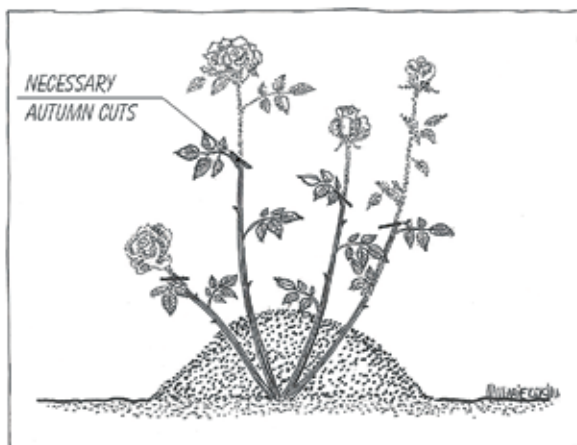
SHRUBS WITH MULTIPLE STEMS ALLOW PRUNING BOTH FROM TOP AND FROM THE SIDES



SHRUBS WITH ONE STEM ARE PRUNED FROM TOP, ONLY WHEN THE DESIRED HEIGHT IS REACHED

Maintenance of roses

Watering	Roses need a steady source of water during the growing season, about 30 mm a week from rain or by watering. It is better to use a soaker hose or install an in-ground system.
Fertilizing	Roses need regular fertilizing during the growing season. It is better to use specially formulated slow-release granular rose food and work it into the soil so it can feed the plant all season long.
Pruning	<p>Pruning is carried out in early spring once the plants start to show signs of new growth.</p> <p>Any obviously dead or damaged branches need to be cut first. A pruned plant should have four or five healthy stems, each ideally about as thick as a pencil while the rest should be cut out. Spindly and crossing stems should be favoured for removal. The remaining stems should all be well-spaced to allow free air flow.</p> <p>Cuts should be no more than 5 mm above a bud and should slope away from it. This applies to all cuts, whether removing dead wood, deadheading or annual pruning.</p> <p>Cutting to outward-facing buds should be favoured to encourage an open-centred shape. Some stems of roses with a spreading habit could be pruned to inward-facing buds to encourage more upright growth.</p> <p>If a dormant bud is not visible, it is possible to simply cut to an appropriate height.</p> <p>Only sharp secateurs make clean cuts! For larger stems, loppers or a pruning saw is used.</p> <p>Prune stems with dieback to healthy white pith.</p> <p>On established roses, poorly flowering old wood should be cut out and old stubs that have failed to produce new shoots need to be sawn out.</p> <p>With the exception of climbing roses, all newly planted roses need to be pruned hard to encourage vigorous shoots.</p> <p>Suckers, usually growth from the root stock upon which the ornamental plant has been grafted, should be traced back to their roots and torn away.</p>
Fall and Winter Rose Care	Fertilizing should stop in early autumn, at least one month before the first annual frost date of the region. Roses are protected as needed in late autumn, after the region's first hard freeze. Mound to about 30 cm about a month after the region's last average frost date; two weeks later the entire plant should be wrapped in burlap to protect the upper parts.



ROSES AFTER PILING UP THE SOIL

TREES

CHOOSING PLANT MATERIAL

The choice of tree species by qualified professionals plays a very important role in public space design. Selection depends on many factors, especially the eventual mature shape, size and proportion of the tree for the space it is designed to occupy.

Trees planted in urban areas should have a trunk diameter of at least \varnothing 14–16 cm or even larger in order to prevent excessive future costs for replacing unsuitable specimens: bigger trees are stronger and more resistant.

A list of the trees suitable for urban areas can be found in Appendix 2 at page 151.

Urban trees can be allowed to grow naturally shaped or be pruned to be more controlled.

Trees suitable for a street environment and for open landscapes and parks are different.

Trees chosen for planting should have:

- Healthy branches, twigs and foliage
- Small pruning wounds
- Foliage evenly distributed
- Single, well defined trunks
- Trunks with normal root flare
- Trunks without sprouts near the base
- Branches evenly distributed
- Appropriate sized root ball or container
- Appropriate height for size of trunk



TREES FOR PLANTING

The trees should not have:

- Unnaturally small leaves or dried shrivelled bark
- Large wounds with dead bark
- Foliage sparse or mostly at the top of the crown
- Forked trunks, especially low down
- Trunks without root flare
- Trunks with many sprouts at the base
- Many branches arising from the same point
- Pot-bound or with undersized root balls
- An overly slender shape – these trees need extra care and support.



THE RIGHT PLANT FOR THE RIGHT PLACE

It is a good idea to study the site and soil conditions carefully and to determine the acidity (pH), mechanical and chemical composition of the soil, especially if large and expensive planting is planned.

It is most important to select an appropriate plant for the particular place, paying attention not only to its visible parts but also its root system. The list of the main suitable street and landscape trees (according to our climate zones) is in Appendix 1 at page 141.

Factors that need consideration before planting:

- light availability, intensity and duration (full sun to deep shade)
- water availability, both quantity and quality
- exposure to wind and temperature extremes
- soil type, drainage, compaction
- hardiness zone (climate zones – see page 27)
- competition from existing vegetation
- below ground conditions in urban sites (soil, pipes, other past and future groundworks)
- above ground wires or obstructions

Aesthetic considerations for plant selection include:

- scale and proportion of the tree to the space
- growth habit, i.e. pyramidal, columnar, spreading, etc.
- foliage colour, texture and shape
- seasonal appearance (colour of blossom and foliage, winter appearance of bark, fruit or tree structure)
- benefits to wildlife
- longevity

QUALITY OF TREES IN NURSERIES

Plants selected should meet the local standards (e.g. the Estonian standard for decorative plants EVS 778:2001).

Crown size and structure

The crown of a street tree should have

- a lot of vigorous branches with many leaves,
- clearly identifiable main branches with side branches that are at least three years old (they have at least three identifiable branches of their own);
- had the last formation cutting in the previous growing period.

Upon choosing a suitable tree, attention should be paid to branch angles (no ingrown bark) and branch diameter (must not exceed $1/2$ of the trunk diameter). Branches should be evenly distributed (looking from the top and each side), they should not be rubbing, crossing or otherwise mechanically damaged. It is also very important that there should be no competitive co-dominants (separate excessively large branches).

The recommended fewest number of main branches of nursery stock, depending on the circumference of the trunk:

circumference of the trunk (cm)	The fewest number of main branches
12/14...14/16	10
16/18...18/20	11
20/25	12
25/30	13

Solitary tree with a single trunk:

- leader should be straight
- branches at least 30 cm long (except for column shaped trees).

Columnar trees:

- leader should be straight.
- Weeping and other grafted trees:
- should have at least two well-

developed main branches and a number of secondary branches;

- should have dense and homogeneous crowns.

Conifers:

- should have a clear or symmetrical crown;

- should have needles that look typical for the species, type or form of the tree.

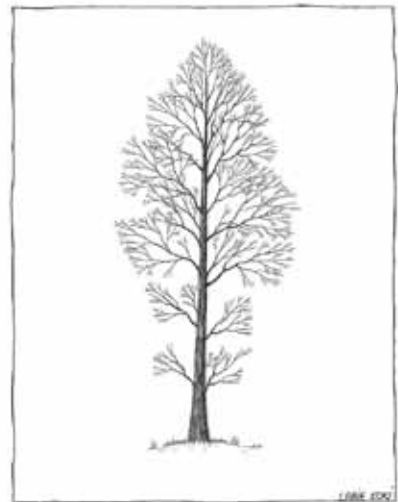
Trunk condition

The trunk should have no mechanical damage (from animal horns, rodent gnawing, woodpecker marks). Also check for frost cracks (due to extreme temperature fluctuations between day and night) and sunburn. This usually happens to trees with thin bark that have been suddenly exposed to the sun after strong pruning, crown lifting, replanting or the removal of a previous screen.

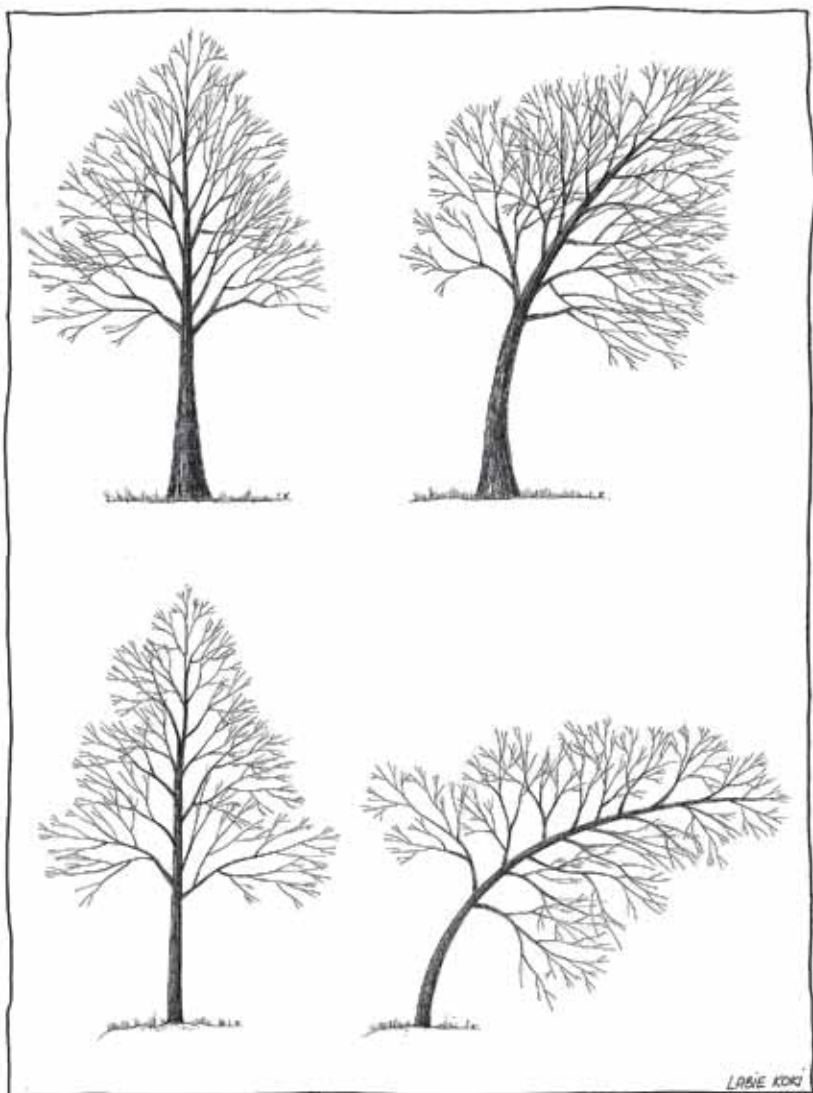
Wounds should not exceed 1,5 cm in diameter, so the last pruning should be done at least one growth season before selling the tree.

Trees with conical trunks are stronger.

Small lower branches produce nutrition necessary for normal tree growth. These branches also protect the tree from sunburn, animals and other damage. These twigs should be kept smaller than the main branches.



STRONG TRUNK

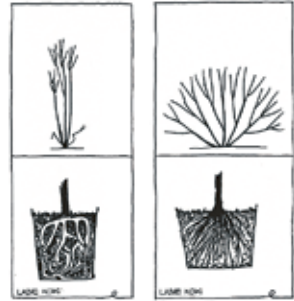


CONICAL TRUNKS ARE STRONGER

Root condition

The roots of nursery trees should be pruned regularly (at least once every 4 years) and information about the root pruning should be available when purchasing the plant. Correct roots are even more important than the trunk diameter.

Visible evidences of root pruning are: last year's growth of branches, leaf size and colour, foliage density.



Bare root plants should have regularly pruned roots with many small fibrous roots.

Large root balls should:

- have a strong, compact and branched root system;
- have the stem positioned in the middle of the root ball;
- be grown in substrates or light-textured soils that are supported by a wire cage.

Large root balls should not contain:

- perennial weeds;
- remains of previous wrapping.

Container plants should be replanted every 1–3 years and their roots should not be entangled.

Recommended size of the root ball depending on trunk circumference

Trunk circum-ference (cm)	Diameter of the root ball (cm)	The height of the root ball (cm)
12 / 14	50	40
14 / 16	60	40
16 / 18	70	40
18 / 20	75	50
20 / 25	80	60
> 25	100	60

PLANTING

- Trees should be planted only by a suitably qualified person; (early spring before new leaves and late autumn after leaf drop);
- good growing conditions for at least 20 years should be ensured for the tree;
- planting can be done throughout the year, except when the soil is frozen;
- in a four-season climate the dormant seasons are ideal for planting
- small container-grown plants (shrubs and small trees) may be planted throughout the growing season provided that they get proper care. Nowadays it is also possible to find large trees in specially prepared containers that allow for planting in the summertime.

When planning the planting of a larger number of trees, soil analysis should be carried out beforehand (before plant selection). The soil should be supplemented with any missing elements necessary for the particular species. The supplements should be added before planting, but are also recommended afterwards.

PREPARING THE PLANTING PLACE

Characteristics of the ideal growing soil (recommended at least for intensively used urban green spaces).

Figures and control methods	Unit of measure	Measure
Soil reaction pH(Kcl)		conifers 4,5...5,2; deciduous: 5,5...6,4
Electric conduction	10 × mSm/cm	(1,5) 2...4 (6)
Bulk density or unit weight	kg/l kg/m ³	0,7 (640) 800...950 (1200)
Humus by Tjurin's method	percentage balance%	2...15...20 (6) 10...12 (14)
N	mg/l	(10)...15...30...(60)
P	mg/kg mg/l	100...200 (5)...10...20...(30)
K	mg/kg mg/l	100...360 (75)...150...300...(450)
Ca	mg/l	(750)...1000...3000...(5500)
Mg	mg/kg mg/l	100...200 (50)...100...350...(500)
Cu	mg/kg mg/l	> 2,5 2...3...20
Mn	mg/kg	> 150
B	mg/kg	conifers (pH < 5,6) 1,4...2,1 deciduous (pH > 5,6) < 2,1
S	mg/kg	> 40
Zn	mg/kg	> 1,5
Mo	mg/kg	> 0,1
Chlorides (antiskid treatment)	mg/100 g	< 7

Space needed for a normal growth of plants (minimum distances between trunks) is given below. The distances are generalised and recommended and can differ if necessary, depending on the situation, the type and the function of the trees.

Columnar	Small trees	Medium trees	Large trees
3 m	5 m	6 m	8 m

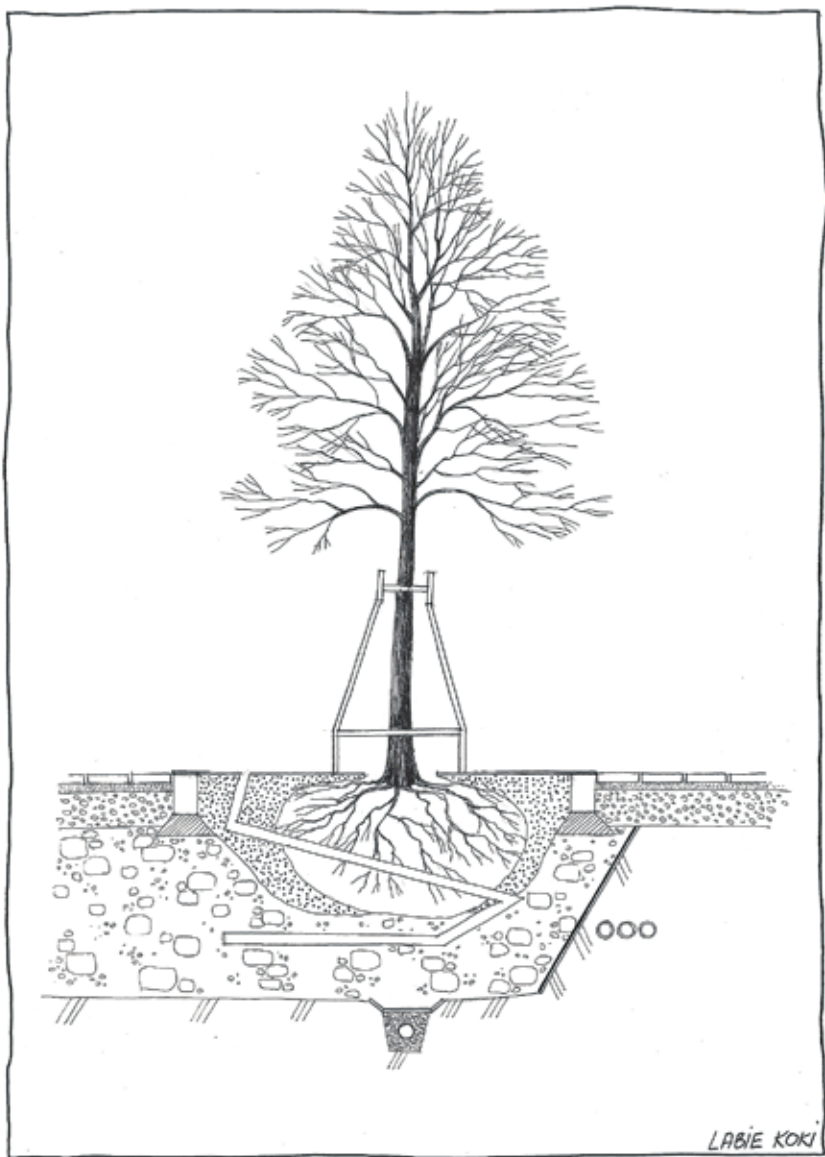
Amount of necessary growing soil:

Size of species	Minimum volume of growing soil (m ³)	Optimal volume of growing soil (m ³)	Minimum depth of growing soil (m)
Small trees	5	6	0,8
Medium trees	9	14	1,0
Large trees	18	26	1,0

SUPPORTED GROWING SOIL

Supported growing soil is recommended for all urban trees that are exposed to heavy trampling by both vehicles and pedestrians. It is prepared by adding a coarse fraction of supporting material to at least 1 m layer of soil beneath the pavement. The supporting material (gravel) carries weight; the growing medium (soil) fills the holes in between and enables the growth of roots.

Component	Rate	Specification	Approximate volume
Coarse fraction	70% of volume	stones, ø 60...120 (150) mm	
Fines	30% of volume	clay fraction	7% of weight
		sand fraction	40% of weight
		Organic matter (compost; added a little bit of decomposed material – bark crumbs, peat etc.)	10% of weight
		Other mineral material (gravel, natural soil to enrich the soil with mycorrhiza fungus)	43% of weight



SUPPORTED SOIL: STREET SITUATION

The bottom of the hole should lead water away from the tree; if not then drainage should be installed.

Surfaces with vegetation should preferably be higher than street level, especially when de-icing salt is used on the streets. In the case of clean surface water, it can also be directed into the soil instead of being drained away.

The size of the planting hole depends on the root ball and the type and location of the tree.

The depth of the hole for street trees is the same as the root ball height and 20% wider than the root ball. The depth of the hole for landscape trees is the same as the root ball height and 2 times wider than the root ball.

The growing medium should not contain weed roots. If necessary mycelia and microorganisms are missing from the medium, then bio stimulators should be added to the medium.

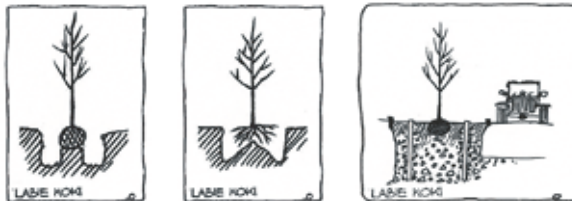
TRANSPORT AND STORAGE OF TREES DURING THE PRE-PLANTING PERIOD

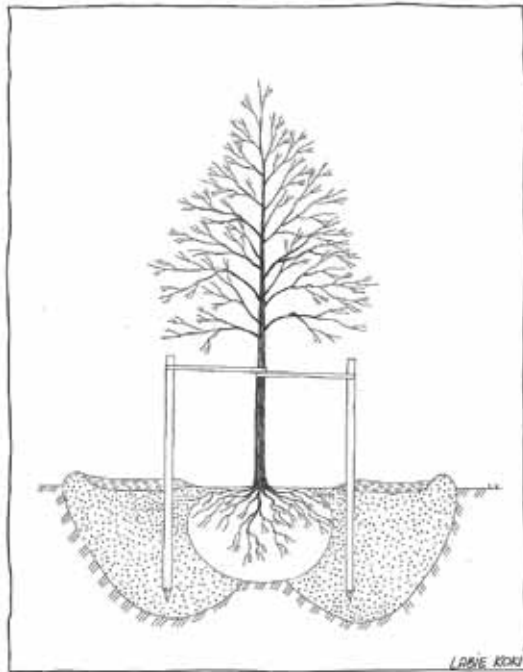
- The plant should be tied up with soft material;
- The plant with a root ball or container must be lifted and moved only by the root ball and not the stem;
- The plant must be protected from wind and drying.

If planting is not possible at once, the plant should be stored in a vertical position and unwrapped, protected from wind and sun, but for no longer than 2 weeks.

PLANTING WORKS

- The hole should be dug one day before planting and filled with at least 50 l of water;
- The root ball should also be watered before planting;
- Wire net and wrapping fabric should be opened from the top and the sides, the root ball remaining in one piece. If the wrapping material is natural, it can stay at the bottom of the hole. Containers and other non-organic materials must be removed;
- Damaged roots should be cut back and it is important to make sure that the roots do not point upwards;
- Soil is back-filled step by step and compressed towards the roots. One of the most common mistakes is planting too deep. The root flare of the tree must not be buried; otherwise the growth processes will decline severely and the tree can wither and die;
- Watering pipes may be inserted during the planting;
- Aeration pipes may also be inserted where there is heavy soil or restricted space. Usually they are laid deeper than watering pipes (up to 2 m deep). It is also possible to insert them later by drilling special holes. Such pipes are perforated and they provide gaseous exchange and oxygen access deeper into the soil. This promotes root growth in depth, not only in width.
- Before backfilling make sure that the tree is placed straight. Small trees can be straightened while backfilling the hole and by staking them afterwards. If large trees are planted and special machinery is used for it, the straightness is usually checked with a spirit level or plumb line.
- Since leaves are the producers of oxygen and roots are the consumers, it is important to choose friable soil and avoid excessive soil compaction. Meanwhile, the soil should be packed firmly during backfilling, in order to eliminate air pockets that can prevent root growth. Watering can be done during the backfilling or after it and this also eliminates air pockets.





PLANTING INTO NORMAL PARK SOIL

WATERING AFTER PLANTING

After planting it is necessary to water container trees at least a few times a week if the weather is hot and dry until the roots have stabilized in the ground. The soil should be moist but not waterlogged.

In the case of bare root trees a well prepared root ball loses 10–30% of the root area during transplantation, while a poorly prepared tree might lose up to 90%. Regular watering can relieve crown reduction – if the tree can take up enough water then the crown does not need to be pruned during trans-



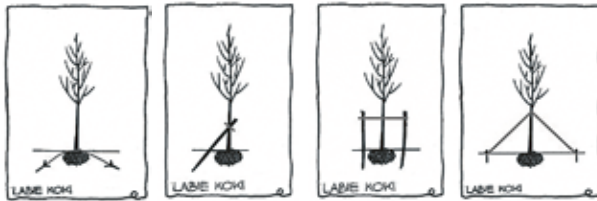
WATERING AFTER PLANTING

plantation. In this case arborists suggest pruning 1–3 years later (provided the transplanted plant gets regular watering).

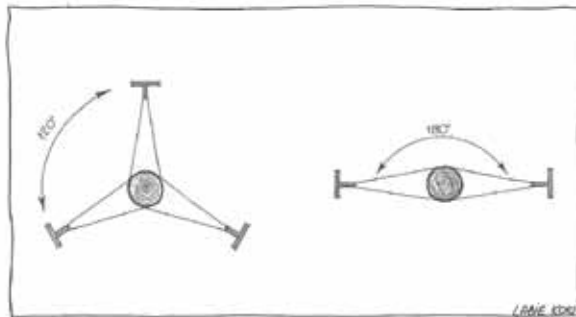
Trees should be watered straight after planting with 50–100 litres of water, depending on the plant dimensions. If a watering system is used, additional watering could also be done from the top, as normal.

FIXING THE PLANTS

An urban tree should be securely fixed either by special underground anchors during planting or with stakes straight after planting to ensure that the tree does not lean. Otherwise new roots might be harmed and the tree might not root. 1–3 years later the tree should be released so that it can get used to winds, but the stakes can be left for further trunk protection.



Stakes have to be strong and about 5 cm in diameter. The height of the stakes should be $\frac{1}{3}$ of the height of the tree for deciduous trees and $\frac{2}{3}$ for conifers. Conifers are fixed only if they are more than 100 cm high.



FIXING TRUNKS WITH 2 AND 3 STAKES

It is possible to fix trees either above the ground using one or multiple stakes or below the ground.

Similar fixing materials should be used continuously throughout the same planting area.

MULCHING

When special materials are not used for protecting trees against trampling, the surface should be mulched after planting. Mulch not only reduces weed growth, but also holds moisture and provides some protection during temperature extremes. Natural mulching material is better as in a few years it rots down to become an organic fertilizer.

The mulch layer should be even, 5–10 cm thick. The best materials for mulching in public areas are:

- bark or timber chips (about 5 cm pieces);
- crushed granite or light gravel on geotextile;
- paper mulch or coconut matting (has to be fixed well).

The material should be kept at least 10 cm away from the root flare.

The mulch layer should be maintained at least until the tree has rooted, but it is also good later on:

- There is no need to mow and trim under mulched trees and it protects roots as well as the trunk from mechanical damage;
- Organic mulches raise the biological activity of the microorganisms while composting.

Mulched spaces need careful fertilizing as the microorganisms that decompose the mulch need nitrogen.



COVERING GROUND UNDER THE
CROWN WITH MULCH

REGULAR MAINTENANCE

WATERING

Trees growing in places with limited space or intensive trampling (especially street trees) need regular watering. It can be done with water from natural water sources or from water treatment works.

To decide on the need for watering it is important to check the humidity or the root ball.

Even if a watering system is installed, it is important to water from the top as well.



Urban trees need regular watering during the first three years after planting; street trees appreciate watering throughout, when the weather is dry. Watering before the plants have rooted should take place regularly at least once a week during the growing period, even if it rains. The amount of water needed depends on the size of the tree, ranging between 50 and 100 litres of water per tree. It is better to do the watering infrequently but using large amounts of water at a time. Watering should take place in the evening or night-time, while in cloudy weather it can be done during the daytime. Water should infiltrate into the soil in 10–15 minutes – if it does not, the soil is too compact and measures should be taken to deal with the problem.

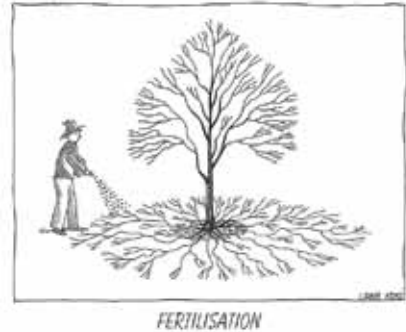
Fully grown trees and shrubs in public areas are usually not watered. Longer drought periods are an exception that can harm the plants.

FERTILIZATION

For better development, plants should be fertilized regularly – at least a few times a year.

Fertilization depends on the overall condition of the plant and also on the results of soil analyses. By using fertilizers it is possible to adjust the pH (acidity) of the soil and to compensate for the lack of micronutrients to increase the fertility, water and oxygen permeability.

Fertilization can be done both with organic and mineral fertilizers.



Fertilisers should be distributed over the entire root system extent.

Organic fertilizers (mostly compost)

Are almost always used during planting, but it is strongly recommended to apply them on top of the soil (a layer of a few cm) at least every few years, especially if fallen leaves are removed from the root area.

Mineral fertilization

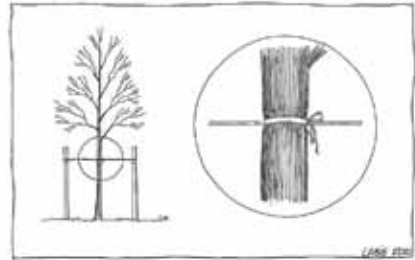
This is also sometimes carried out during planting (blending fertilizer with the substrate).

There are different fertilizer blends, such as spring, summer and autumn fertilizers, or ones with quicker or slower effect, etc. They can be either applied to the soil during planting or later as a top dressing, covering the entire root area. In public space, fertilization is usually combined with watering by adding soluble fertilizers to the water – this is a fast and effective method.

STAKE CONTROL

Supporting stakes should be checked at least twice during the growing period, starting in spring. The stakes should be unbroken, tightly fastened and straight in the ground. Trunk and root protection stakes and binding material should not injure the tree.

The stakes are removed after the plant is entirely rooted, not later than three years after planting.



CHEMICAL PROTECTION

The chemical protection of trees is mainly carried out by specialists, but many of the chemicals can be bought without any special permits. However, inappropriate usage (such as wrong amounts and timing – usually overdosing) can harm the plant as well as the surrounding environment. Chemicals used for disease control:

- Herbicides – to kill individual groups of plants; these can be systemic, when they enter the plant and kill (good for tough perennial weeds) it or else burn off the foliage (suitable for annual weeds). Since some types also kill woody vegetation they must be used with care;
- Fungicides – against fungi, usually moulds and mildews on leaves but sometimes against root or stem attacking types;
- Insecticides – against insects which mainly affect foliage, flowers or buds.

Application:

Spraying – used for shrubs and smaller size trees – protection of lower-level green parts of plants is needed if the herbicide also kills woody plants

Injections in the trunk – not so popular in Europe at the moment. However, more research has been done in this field recently.

PRUNING

Pruning is the most common means of crown maintenance for trees and shrubs. While nature is working well in forest conditions, it is usually not enough for plants in public and private spaces.

Pruning must be done by a specialist with professional education (arboriculturist).

Crown shaping should be started early and carried out regularly – a properly pruned juvenile tree will need less corrective pruning, cabling and bracing as it matures. Some species can grow also a good structure by themselves in an urban environment, while others require more attention and training. Such training begins in the nursery and depends on the particular species and the purpose of the tree (such as a street tree, park tree, etc.).

There are two kinds of crown management:

- naturally shaped tree and shrub crowns and
- artificially shaped crowns.

THE RULES OF PRUNING

- It is important to know the goals of pruning a specific tree.
- Long lasting and safe trees are formed during the first 25 years.
- The roots and the crown have to be in balance, this is why no more than 30% of foliage should ever be removed at a time.
- Cut less (moderately) and frequently.
- Keep cuts as small and smooth as possible, never leave a stub.
- Use good quality, sharp, clean tools.
- Remove shoots which grow from wild rootstock and roots. They can start to dominate over the cultivated part if the plant is grafted, because the wild shoots grow faster. Cutting back suckers does not help (except for roses) – they should be torn off instead.

GOALS OF PRUNING

No branch or twig should be removed without a reason. The most common goals of pruning are:

- corrective measures and aesthetics – dead branch removal, changing / improving the shape of the plant, increasing the amount of flowers or fruit, etc.,
 - compatibility measures – to establish a friendly co-existence
 - preventative (safety) – risk and hazard reduction.
- with other landscape components as well as with humans and their property (in dense urban areas we sometimes have to choose – no tree or pruned tree),

WHEN TO PRUNE?

The best time for pruning from the point of view of plant health is the active growing period, when the leaves are full size and mature (dark green in colour).

Possible problems with pruning in summer are e.g. bird nests and poor visibility of the crown structure due to thick foliage. The most suitable time for pruning is therefore April-March just before the growing period – the whole crown is clearly visible. The period in spring right after budbreak should be avoided for pruning, since lots of the tree's energy has gone into producing early shoots and new foliage. Light pruning can be safely performed on small-diameter branches on most species at any time. Pruning during summer results in less decay than dormant season pruning.

Low winter temperatures can cause cambium damage, which often shows up as cracks near pruning cuts.

Pruning should be avoided before (from the middle of August) and during leaf drop in autumn (as the tree is saving energy then) and in wintertime if the temperature drops below -5 to -8 °C (-15 in Finland).

“Bleeding” trees are those which tend to “bleed” sap if pruned early in the spring (before budbreak). Pruning at this time does not harm the tree – only the amount of sap dedicated for the particular branch or twig flows out, and this hinders pathogen penetration into the wound. Deep drilling in the base of the trunk (in order to collect the sap of birch or maple) is rather harmful, since decay tends to spread in these wounds. It is nevertheless better to cut bleeding trees during the summertime.

Most strongly bleeding trees:

- *Vitis*
- *Acer*
- *Betula*

Strongly bleeding trees:

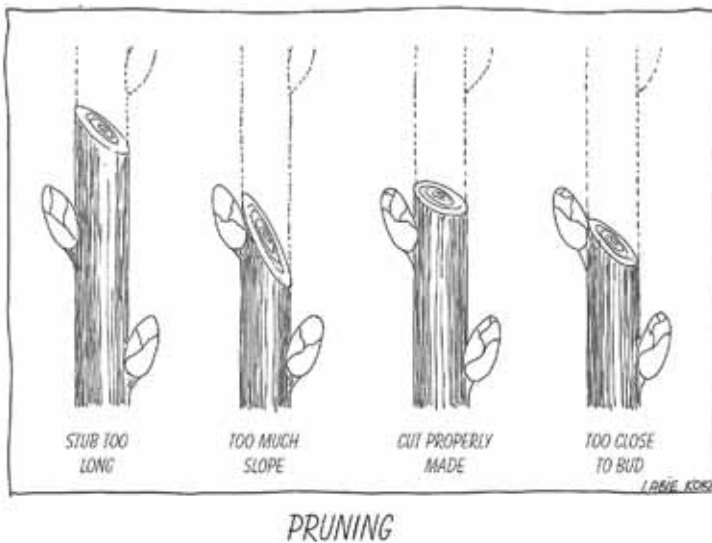
- *Juglans*
- *Prunus*

Medium bleeding trees:

- *Ulmus*
- *Carpinus*
- *Fagus*
- *Sorbus*
- *Populus*
- *Aesculus*

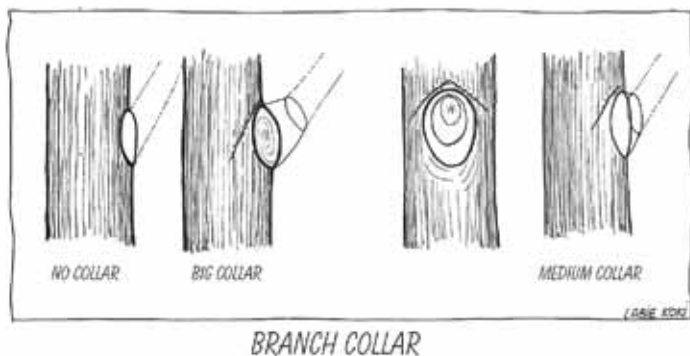
HOW TO PRUNE?

The basic principles of pruning apply to trees (shrubs, hedges and vines need a different approach – see earlier sections). Branches are cut back until a bud or a branch without leaving a stub. The cut is slanting.



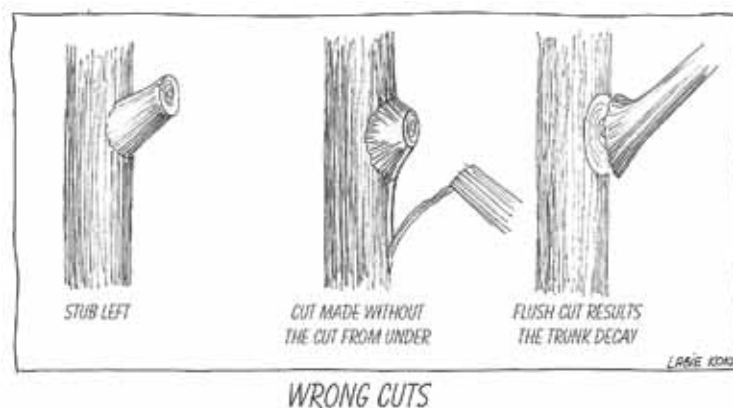
PRUNING

If the collar of the branch is removed during pruning, the chances of the trunk becoming infected by decay and canker-causing microorganisms are greatly increased.



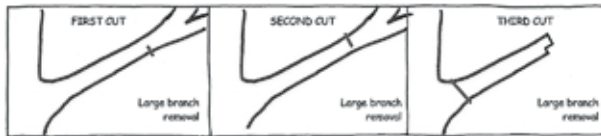
Flush cuts should not be made; instead, cuts should be made just outside the branch collar. A branch collar is the swollen area at the base of the branch that sometimes has a bark ridge.

Improper cuts:

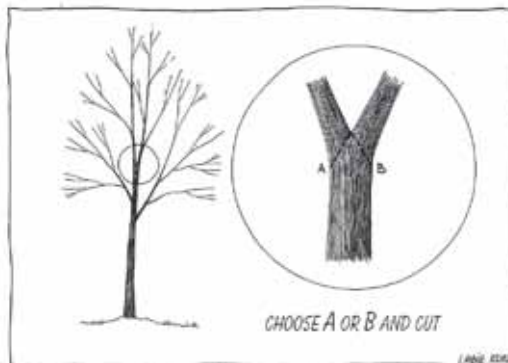


In case the branch is heavy, three cuts are necessary. The first cut should be made 30–50 cm from the trunk, starting from below the branch and cutting upwards to prevent tearing when the branch is removed. The second cut is made about 5 cm from the first, away from the trunk, to remove the main part of the branch, cutting

from the top. The third cut is made at the branch collar and enables a good final cut to be made with no risk of tearing the bark.

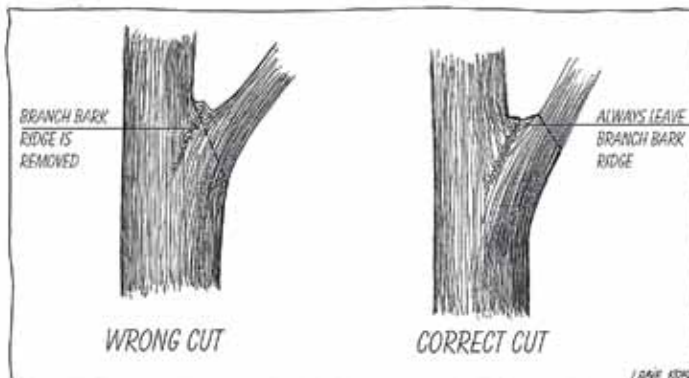


Co-dominant branches should be removed as soon as possible.



*CUT SHOULD BE MADE IN THE SAME DIRECTION AS
BRANCH DIRECTION*

A healthy, durable connection of branches (the scar reaches upwards).



BRANCH BARK RIDGE

Branches may crack apart (ingrown bark).

PRUNING CUTS

Pruning cuts are crucial for guiding the further growth of the tree. There are three types of pruning cuts, only two of which are suitable and often practiced: the reduction cut and the removal cut. The third type is the heading cut, which is not desirable at all and is rarely practiced professionals, but very often by amateurs and ignorant people.

A reduction cut is used for reducing a larger branch to a smaller lateral branch, where the diameter of the small branch is at least 1/3 of the larger one. When reducing a tree branch by branch, it becomes a more compact form from one or all of its sides.



As a result of such pruning the size of the tree is reduced, and the growth energy is thus transformed to the smaller branches. If there is a branch bark ridge, it must not be removed or touched, the cut must be done next to it.

A removal cut is the reduction of a smaller branch to a larger lateral branch or trunk. The pruned branch should not exceed \varnothing 5–7 cm. There usually is a clearly visible bark ridge that should not be touched. The cut is made next to it. The removal cut is applied in the cases of crown lifting, crown thinning, and other maintenance.



Heading / topping cuts are unacceptable for trees. It can be justified only in hedge trimming (for topping the plants to establish the hedge height and to trim annual growth) and very rarely in order to save a hazardous situation in the case of a heritage or an otherwise outstanding tree that should not be removed and when no other methods are applicable. Such treatment must be followed by further procedures, for instance maintaining a rather low artificial crown.

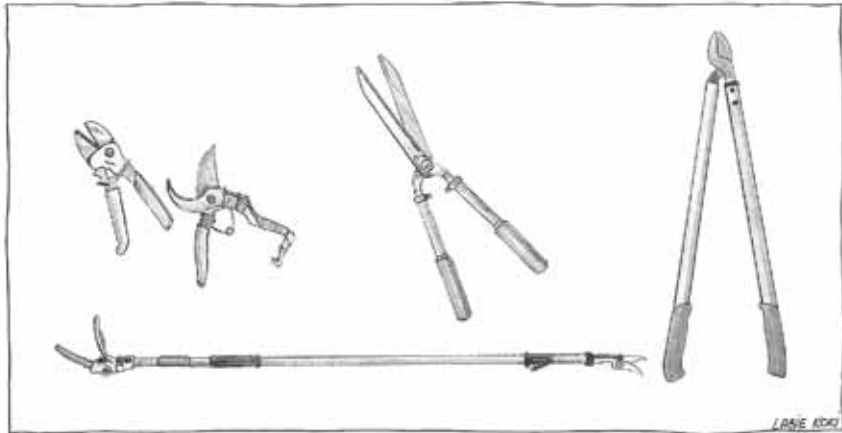


INSTRUMENTS FOR PRUNING

Specific tools and strong working gloves are required for shaping and trimming a tree. Tools require oiling and regular sharpening so that all cuts on the tree are clean. Cleaning tools after each cut on the tree prevents the spread of diseases.

Pruning shears:

Bypass pruning shears; Loppers; Telescopic pruning shears; Hedge shears

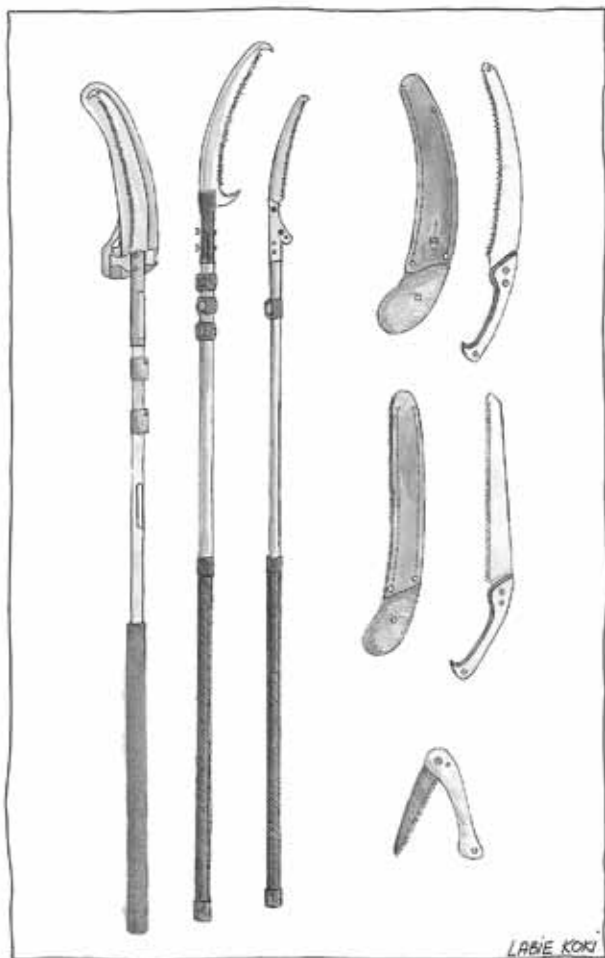


PRUNING SHEARS

Bypass or scissors type pruning shears (not the anvil pruner) should be used for young trees.

Hand saws:

Saw with a curved blade; Saw with a straight blade; Extension saw

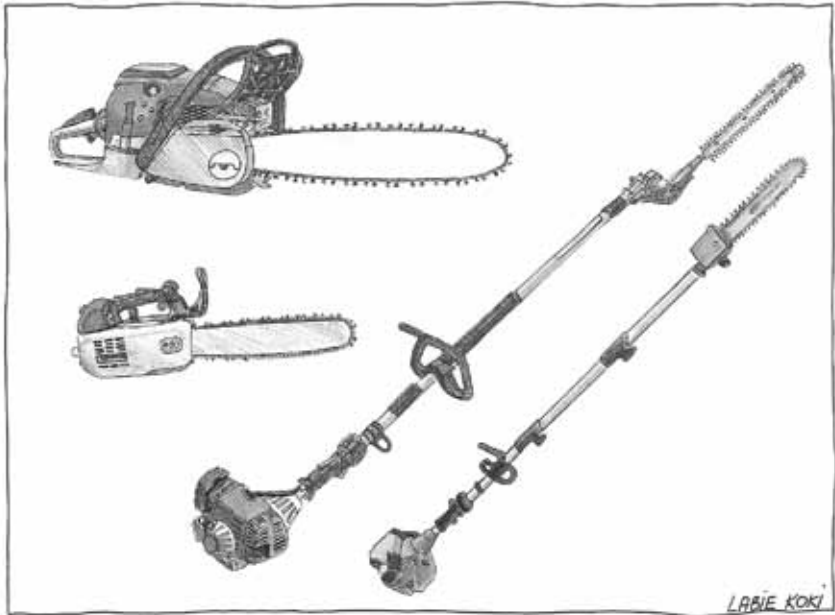


HAND SAWS

For larger trees with larger branches a sharp hand saw should be used.

Power saws:

Arboriculturalist's single-hand power saw; Regular chain saw (used mainly for tree removal, not for maintenance); Telescopic power saw.



POWER SAWS

WOUND DRESSING

Despite common practice, it has been demonstrated that wound dressing does not help with wound closure nor does it prevent disease infestation. In fact it either provides no effect or may even promote the development of decay – some dressings block the air flow (decay prefers anaerobic conditions).

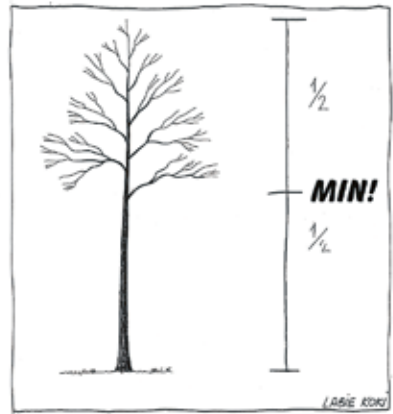
PRUNING METHODS

- Formation pruning
- Rejuvenation pruning
- Cleaning the crown
- Pruning newly planted trees
- Thinning
- Stimulating the sprouts
- Reduction
- Shaping (pollarding)

Formation pruning

This is used for young trees (up to 20–25 years). With minimal effort it is possible to create a beautiful and safe tree that requires little maintenance in the future. Pruning such trees is carried out only with pruning shears or hand saw. It should be done regularly, preferably once a year or at least every three years. With such treatment the wounds will be small ($\varnothing \sim 2$ cm) and recover quickly (pruning wounds in nurseries should be no larger than $\varnothing 1.5$ cm). 5–10 minutes of work is usually enough for young tree pruning.

- Branches should be far enough from each other. An ideal tree has its main branches in a rising spiral.
- The radial spacing is 3–5 branches in one circle around the trunk.
- The vertical distance between branches is recommended to be 3% of the intended height of the tree. If the height is 15–20 metres, the distance should be 45–60 cm.
- If branches are too close to each other, the lower branch takes food and water away from the upper one and the upper branch prevents the lower one getting sufficient light.



THE PROPORTION CROWN AND TRUNK SIZE

- If branches protrude from the trunk at the same height, located like a node, the crown will be too dense and dominate the leader.

The crown should be big enough to feed the whole plant. Thinning the crown too much and disbranching the trunk should be avoided. No more than 25% of leaves

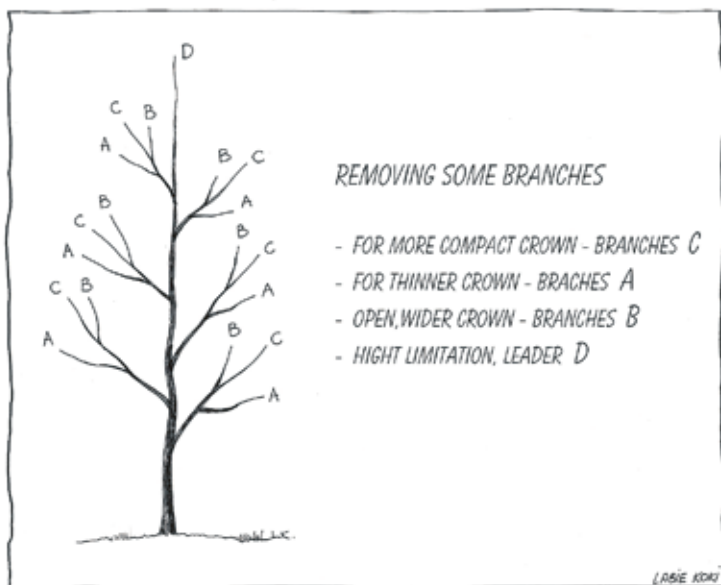
and buds should be removed from a young tree at any one time. Every branch has to feed itself with its own leaves and also give food to the trunk and roots. Half of a tree's height has to be the crown.

Formation pruning is used for:

- keeping a specific crown shape for the species;
- producing alley trees;
- producing trees with vigorous crowns.

It is best if the angle of the branch is more than 45°, so it does not break so easily.

Half of the foliage should be located on the lower 2/3 of the tree. Removing certain types of branches is used to obtain:

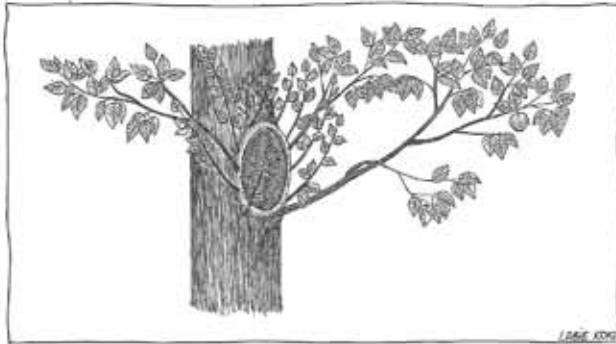


REMOVING BRANCHES

a more compact crown – branches C; a thinner crown – branches A;
an open, wider crown – branches B; height limitation, leader D

Rejuvenating pruning

Rejuvenating pruning means cutting back most of the branches to stimulate the growth of new sprouts in order to achieve a balance between the crown and the roots. A few years after rejuvenating, trees may have several brush-looking branches. These need to be thinned every year to lighten them. This technique is used very rarely for trees (mostly fruit trees). It is better not to cut but tear off young water sprouts.



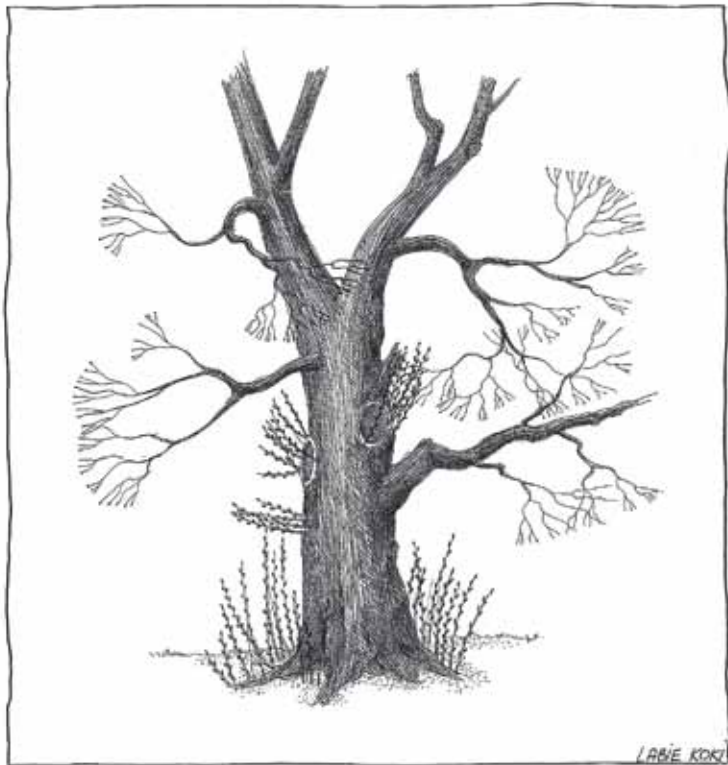
REJUVENATING PRUNING

It is necessary to prune young shoots away from the base of the tree, especially below grafts. These can spoil the shape of the tree and use resources excessively.



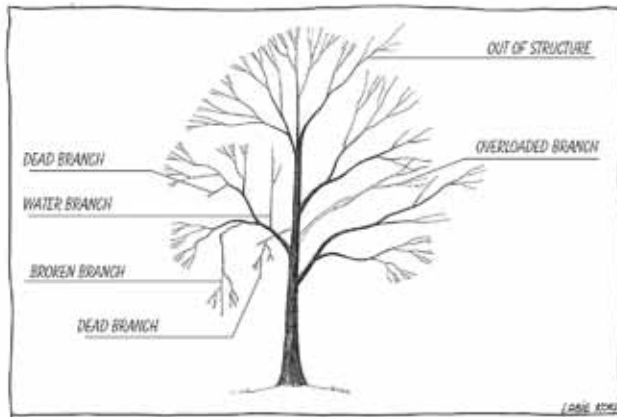
SPROUTS GROWN FROM THE YOUNG TREE BASE

Sprouts grow out from the sleeping buds after some serious damage or over-pruning. Elimination of sprouts may or may not benefit the tree. Sprouts left on the trunk and branches in trees that have been over-pruned, injured by root damage or soil compaction, struck by lightning, or stressed in other ways will help the tree defend itself and rebuild its energy reserves.



*SPROUTS GROWN FROM OLD TREE BASE AND SLEEPING/
ADVENTIVE BUDS*

Cut out:

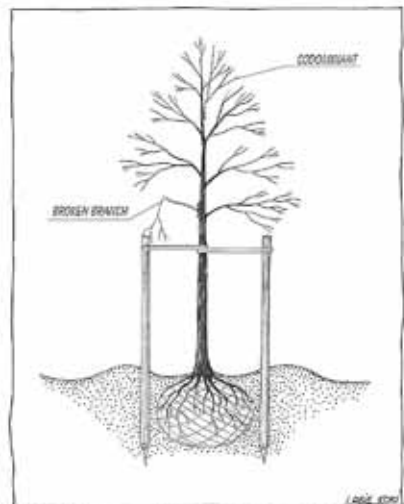


CUT OUT BRANCHES WHICH CAUSE PROBLEMS

- dead and wounded branches;
- branches that can cause problems;
- branches that mismatch the structure.

Pruning newly planted trees

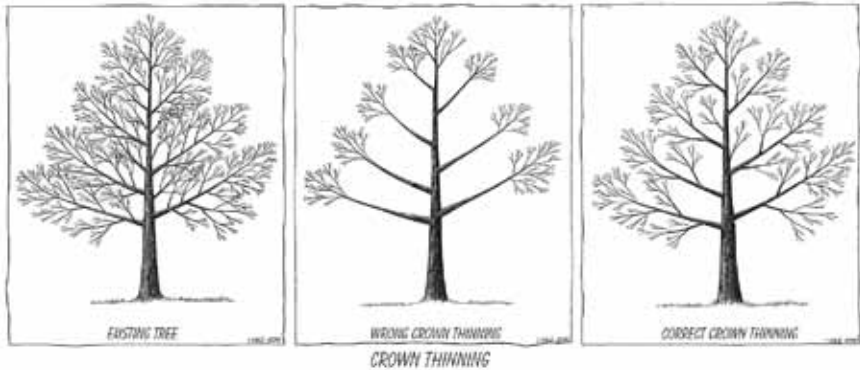
Pruning for formation of the crown starts once the tree becomes rooted. Before that only broken and co-dominant branches growing in the wrong direction should be removed.



PRUNING NEWLY PLANTED TREES: DO AS LITTLE AS POSSIBLE, ONLY BROKEN BRANCHES AND ROOTS, AND CODOMINANTS

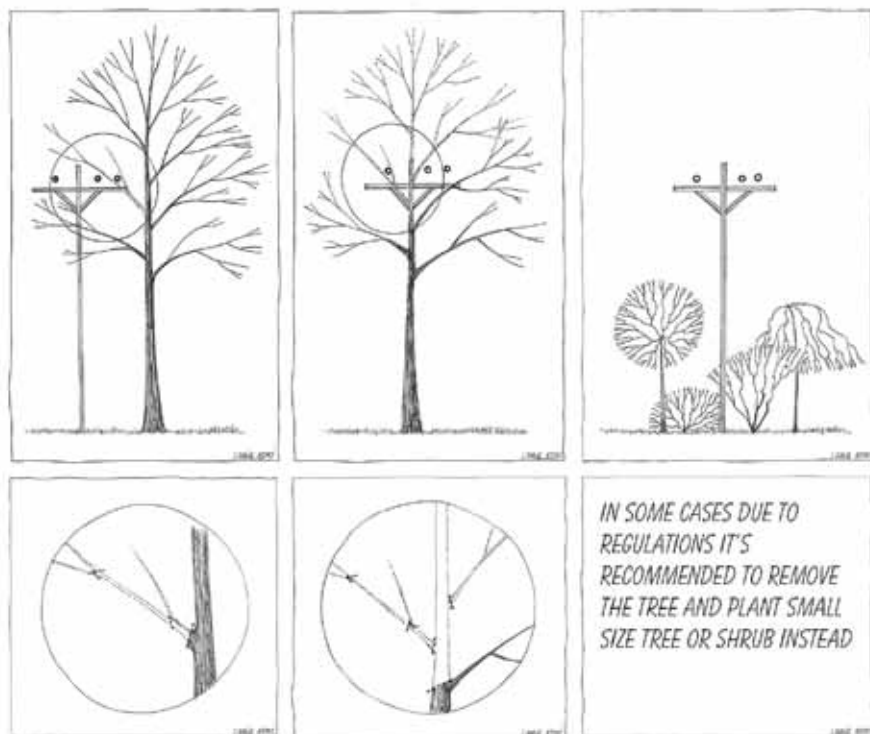
Thinning

- Thinning starts from the outer layers of the crown.
- It increases light and air inside the crown and raises the vitality of the tree.
- Thinning from inside the crown makes the top of the branches heavier, which can cause breaking.
- Competent thinning shows the beauty of the whole tree, improves the conditions for plants growing under the tree and avoids future damage.



Reduction

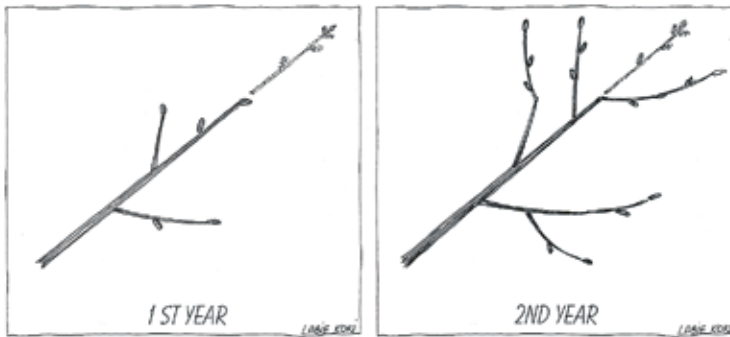
Reduction pruning means reducing the crown while forming the tree as close as possible to its natural shape. This method helps maintain the form of the tree, e.g. for trees growing under power lines.



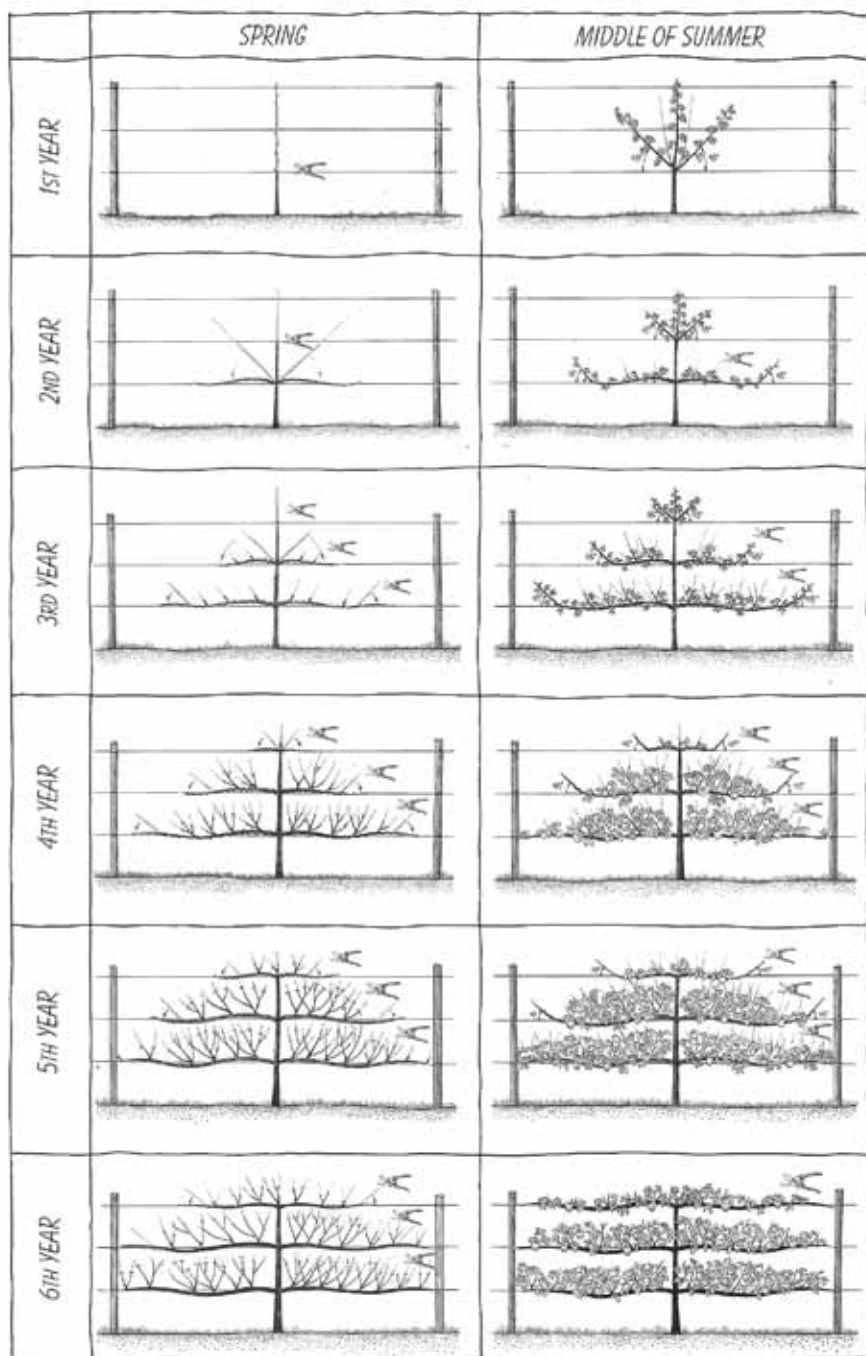
REDUCTION UNDER POWER LINES

Crown reduction is used in order to adapt trees to poor growing conditions (e.g. sudden loss of light). A tree with smaller proportions is able to handle changes more easily. Crown reduction should not be carried out on branches bigger than 10 cm in diameter.

- Reduction to the side bud - reducing first year branches to stimulate branching and strengthen lower branches.
- Reduction to the side branch – used for shaping young trees and rejuvenating old trees.
- Removing cut: branches (not bigger than \varnothing 5–7 m) are cut down to the trunk or larger limb.
 - » Shortening cut: branches are shortened to a smaller lateral branch with \varnothing no smaller than $\frac{1}{3}$ of the \varnothing of the branch to be cut.



REDUCING THE **ONE YEAR OLD** BRANCH WILL CAUSE BRANCHING AND STIMULATE THE LOWER BRANCHES TO LAUNCH OUT



Shaping

An artificially shaped crown does not usually comply with the typical features of the species. Shaping is used to give an artificial shape to the trees – topiary, palmet, pollarding, etc. Both trees and shrubs can be shaped this way, but this practice is more widely applied to shrubs. Shaped trees take up less space and can become an effective boundary (hedge). There are several reasons why we choose to shape the plants artificially, and various methods can be applied.

Crown shaping pros:

- desired size, perfect shape;
- very decorative;
- health and longevity.

Crown shaping cons:

- much more work required;
- formation cannot be stopped;
- not all species are suitable for shaping.

Bending













A preferable tree shape can be made by bending one-year branches (yearlings) and securing them to a frame so that once they stiffen they retain the form. Espalier means tying branches horizontally (into a flat plane) and it was originally practiced in orchards. Nowadays this method is also used for various tree species in private and public spaces.

Pros of Espalier:

- no harm to the tree;
- interesting shape of the tree;
- trees use exactly as much space as we let them.

POLLARDING OF PREVIOUSLY TOPPED TREES

IF YOU OWN A LARGE TREE THAT HAS BEEN PREVIOUSLY CRIPPLED - TOPPED, AND THAT HAS A FAIRLY GOOD ADVENTITIOUS GROWTH, YOU CAN EITHER REMOVE THE TREE OR CREATE A RATHER SMALL, SAFE AND BEAUTIFUL TREE BY POLLARDING IT. IT IS A WORK CONSUMING METHOD THAT WILL INDEED TAKE TIME AND PERSISTENCE BUT IF YOU WOULD RATHER PRESERVE THE TREE THIS IS ALSO A COST SAVING METHOD, SINCE THERE IS NO TREE FELLING, BUYING AND PLANTING OF A NEW TREE INVOLVED.
 IN THE BEST CASE SCENARIO POLLARDING SHOULD BE STARTED AT THE JUVENILE AGE OF A TREE. A TREE MUST NEVER BE PURPOSELY TOPPED IN ORDER TO POLLARD IT!
 POLLARDING SHOULD BE DONE PROPERLY, AS INCORRECT PRUNING WILL DO NO GOOD.

WRONG 1st YEAR	WRONG ~5th YEAR	WRONG ~10th YEAR	WRONG ~15th YEAR
			
<p>QUITE OFTEN WE SEE THAT NOTHING IS BEING DONE WITH THE CRIPPLED TREE AFTER TOPPING. IT GROWS FOR A FEW YEARS, AND THEN THEY USUALLY TOP IT AGAIN A BIT HIGHER THAN BEFORE.</p>	<p>IN 3-7 YEARS TIME LARGE BRANCHING APPEARS ON THE LIMB-TOPS, AND THEN IT IS AGAIN TOPPED, HIGHER AND HIGHER THAN BEFORE.</p>	<p>AS TIME MOVES ON, THE TREE SEEMS TO BIG AGAIN, AND IT IS TOPPED AGAIN - HIGHER THAN BEFORE.</p>	<p>IN 10-20-30 YEARS TIME THE TREE GROWS BIGGER AND DISTURBS, SO THE DECISION IS MADE TO TOP IT LOWER THAN PREVIOUSLY, CREATING UNACCEPTABLY HUGE WOUNDS AGAIN!</p>
			
<p>IF YOUR TREE HAS BEEN MISTREATED AND TOPPED, DON'T WAIT LONG - ALREADY AFTER 1 GROWTH SEASON THE IDEAL SHAPE SHOULD BE CHOSEN AND THE FIRST STEPS OF POLLARDING STARTED. (SHOULD BE DONE BY PROFESSIONALS)</p>	<p>ONCE A YEAR WHEN THE TREE IS DORMANT IT SHOULD BE PRUNED, LEAVING STRONGEST TWIGS GROWING IN THE PREFERRED DIRECTION. SPACING BETWEEN BRANCHES SHOULD BE AT LEAST 20 CM (OPTIMAL - 50CM)</p>	<p>EACH-YEAR BRANCHES SHOULD BE SHORTENED. THE NEW GROWTH CAN REACH 1 M EACH SEASON, BUT IT SHOULD BE KEPT UNDER 0.5 M. PRUNING TILL THE BUD ON THE DESIRABLE DIRECTION FOR THE NEXT YEAR'S GROWTH.</p>	<p>EVENTUALLY, THERE WILL BE A BEAUTIFUL AND SAFE TREE WITH A CONSTANT SIZE, SMALL WOUNDS, AND RATHER EASY MAINTENANCE WHEN THE SHAPE IS CREATED. WE ONLY NEED TO PRUNE THE ANNUAL GROWTH (PROFESSIONAL ASSISTANCE IS NOT REQUIRED)</p>
			
<p>IT IS POSSIBLE TO CREATE VERY LOW POLLARDED TREES, BUT NEVER LOWER THAN PREVIOUSLY TOPPED! OTHERWISE, WE WOULD BREAK THE CODED WALLS AND HARM THE TREE.</p>	<p>ONCE A YEAR BY THINNING AND SHORTENING THE NEW GROWTH A PHOTOSYNTHESIS - FRIENDLY SHAPE IS CREATED (MUSHROOM - SHAPE, UMBRELLA, TABLET, ETC)</p>	<p>IN FEW YEARS TIME, THE STRONGEST SHOOTS CAN BE LEFT ON THE SIDES. ALL POLLARD HEADS SHOULD BE AT THE SAME HEIGHT SO NONE OF THEM WOULD PERISH.</p>	<p>THE BASIC SHAPE SHOULD BE CREATED BY A PROFESSIONAL, WHILE FURTHER ANNUAL PRUNING CAN BE DONE BY ONESELF - IN THE DORMANT SEASON USING BYPASS SHEARS AND STABLE LADDER.</p>

Pollarding

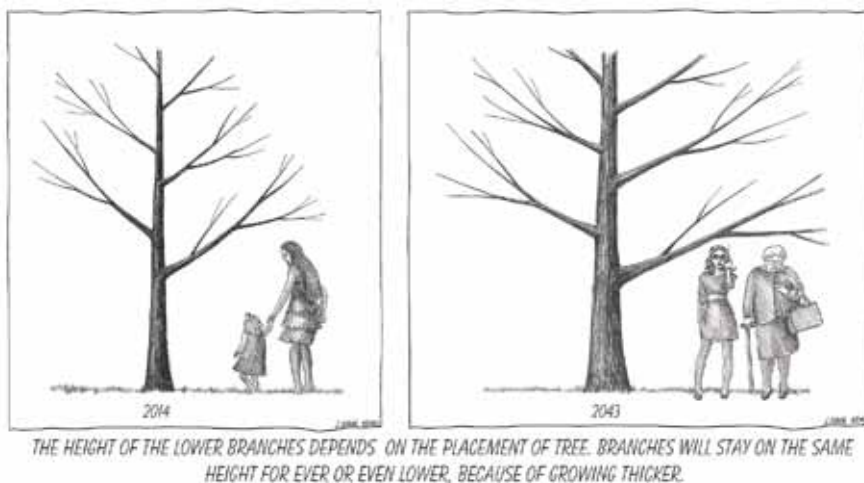
Is another tree-friendly means of maintaining a large tree healthy, relatively small and decorative. At the beginning the crown is thinned and pollard heads are shaped by a professional (optimally – 50 cm from each other, but no less than 20 cm; they should have equal sun and air exposure). It is followed by annual pruning of the new shoots, always retaining the initial pollard point.

Special care and accuracy is required during such pruning. It should be carried out while the tree is dormant – with no leaves. The operation must be repeated regularly, optimally – once a year, but no less than every three years.

Pollarding is suitable only for certain tree and shrub species. The most appropriate in Europe are: *Tilia*, *Salix*, *Ulmus*, *Cornus/Swida*, etc. see Appendix 8 at page 178.

Crown lifting

The required level of lower branches depends on the placement of the tree (street, park, urban forest etc.) and local regulations. One must know that the branches will stay at the same height for ever or become even lower by growing thicker.



Crown lifting enables light to reach the lower parts of the tree. Nevertheless 2/3 of the crown should always remain untouched.

Crown lifting should begin already in the nursery by cutting branches that are no bigger than \varnothing 1.5 cm. Young trees in public spaces should be pruned before branches have reached \varnothing 3–7 cm. Lower limbs that disturb pedestrians or traffic should be removed.

Lower branches of older trees become heavier and longer, and they should be occasionally relieved by reduction. It is recommended that large main branches are not cut due to the risk of large wounds. Secondary branches should be favoured for crown lifting.

IMPROPER PRUNING

Topping (also called heading, tipping, round-over) is the most brutal and unacceptable tree size control technique that literally tops branches – large limbs or tree tops are cut off regardless of the physiology of the tree. The result is a crippled tree with large wounds and a high possibility of decay development.



Usually such inappropriate methods are applied in order to reduce the size of a tree and avoid the potential risks of a large tree. But in fact these practices neither preserve the tree’s vitality and safety, nor do they give any aesthetic benefit. A topped tree becomes a problem tree that requires lots of further attention and work.

Even though epicormic sprouts may appear, the tree is severely damaged – such wounds close slowly or not at all (because of the amount and size of the wounds the tree is unable to heal). Fungi and other organisms have a “free path” to move into the tree, and it will eventually decay.

A common situation is a conflict between large trees and utility lines, and topping should not be chosen as a solution. When planning ahead, an appropriate choice of species should be made. If there already is such a problem then other, more tree-friendly pruning methods should be applied that will preserve both the sustainability and value of the trees. A specialist should assess such a tree to decide the most appropriate kind of pruning.

TREE MAINTENANCE AT DIFFERENT AGES

Young trees are very vigorous, their upwards growth is fast. With minimal effort it is possible to create a beautiful and safe tree that requires little maintenance in the future. Pruning for such trees is carried out only with pruning shears or hand saw. It should be done regularly, preferably once a year or at least every three years. With such treatment the wounds will be small ($\varnothing \sim 2$ cm) and recover quickly (pruning wounds in the nursery should be no larger than $\varnothing 1,5$ cm). 5–10 minutes of work are usually enough for young tree pruning.

Premature trees. At this age trees are still quickly growing upwards. Pruning should be done once every 5–10 years, and the pruning wounds are up to $\varnothing 5$ –7 cm.

A mature tree has reached its maximum height, new growth is rather small and it grows more in width than height. Pruning should be done at least once every 10–20 years. Pruning wounds are up to $\varnothing 5$ –10 cm.

When a tree becomes old, its size begins to diminish as a result of infections and branch tops dying. The tree is trying itself to lower its crown as it is unable to maintain the large size it had in the mature state. The tree is getting weaker and there are higher risks of breaking or uprooting during storms. Through successful maintenance a tree can live in this state for several decades and trees such as *Quercus robur* and *Tilia cordata* even for a few hundred years.

Pruning of old trees should be done once every 5–10 years. Pruning wounds should be no larger than $\varnothing 5$ –10 cm, but there are cases where they are significantly larger than that. Wounds heal slowly or not at all. This is the disintegration phase of the tree – root death evokes the death of other parts of the tree and, meanwhile, large branch removal promotes the death of the roots.













Old trees are precious, but usually they are also hazardous. The goal of maintenance is to ensure as long a life for the tree as possible, providing it is causing no risk to humans and their property.

Various tree species in different ages and environment

ACER PLATANOIDES/ NORWAY MAPLE				
<p>FIRST SIZE TREE, BRITTLE, EASY ACCESSIBLE BY ARBORISTS, BUT THE ANCHOR POINTS MUST BE LOCATED ON RELATIVELY THICK BRANCHES. LONG BRANCHES CAN UNEXPECTEDLY BREAK UNDER THE WEIGHT OF AN ARBORIST. BRANCHING IS DICHOTOMOUS - THE CENTRAL BUD IS FLOWERING AND THE TWO FOLLOWING BUDS - LOCATED OPPOSITE TO EACH OTHER - ARE DEVELOPING BRANCHES THAT ARE COMPETING FOR THE REST OF THEIR LIFE. BOTH THE TRUNK AND SCAFFOLD BRANCHES ARE OFTEN BRANCHING AND FORMING COMPETITIVE CODOMINANTS. CROWN - WIDE, ROUND AND RATHER STRONG. CROWN REDUCTION OF MATURE TREES IS COMPLICATED - THE ACTIVE PHOTOSYNTHESIS IS HAPPENING ONLY AT THE OUTER PART OF THE CROWN BECAUSE OF THE CROWN BECAUSE OF THE LARGE LEAVES AND DENSE FOLIAGE. ROOT SYSTEM - WIDE, FAIRLY STRONG. AFTER FELLING OF A PREMATURE, THERE ARE MANY SPROUTS FROM THE STUMP BASE BUT NO ROOT SPROUTS (SUCKERS), SHADE BEARING TREE THAT REQUIRES FERTILE SOIL. TOLERANT OF URBAN GROWTH CONDITIONS, INTOLERANT OF MARSHY SOIL AND BACKWATER.</p>				
	YOUNG TREE	PRIMATURE TREE	MATURE TREE	OLD TREE
TREE IN A FOREST				
	<p>FAST GROWING UPWARDS. DEVELOPS ONLY FEW TEMPORARY LATERAL BRANCHES. ANNUAL GROWTH UP TO 3M.</p>	<p>VERTICAL GROWTH PROCEEDS. HAVING REACHED BETTER LIGHT CONDITIONS, THE TREE DEVELOPS ITS FIRST SCAFFOLD BRANCHES AND HENCE THE PROBLEMATIC AXILS AND DOUBLE LEADERS.</p>	<p>THE TREE REACHES ITS MAXIMUM HEIGHT, THE CROWN TAKES ALL THE SPACE AVAILABLE SO SOMETIMES IT FORMS ASYMMETRICALLY, WITH SEPARATE LONGER BRANCHES.</p>	<p>OFTEN, AT THE AGE OF 80 YEARS, MAPLE IS ALREADY OLD. IT IS GETTING SMALLER DUE TO DEGRADATION. LARGE SCAFFOLD BRANCHES ARE BREAKING OFF, AND TREE TOP IS DYING. USUALLY DOES NOT PROVIDE A SECONDARY (NEW) CROWN BELOW.</p>
UNTENDED LANDSCAPE TREE				
	<p>WITH NO COMPETITION, FIRST SCAFFOLD BRANCHES AND MULTIPLE LEADERS ARE DEVELOPED ALREADY IN THE FIRST METERS. BRANCH ANGLES ARE OFTEN UNSTABLE, WITH INGROWN BARK.</p>	<p>LARGE LATERAL BRANCHES ARE DEVELOPING ALREADY AT THIS STAGE. MULTIPLE TOPS, MULTIPLE TRUNKS TEND TO BREAK OFF. THE TREE GROWS IN WIDTH AND HEIGHT, CREATING A WIDE OVAL SHAPE.</p>	<p>AN UNTENDED MAPLE ALMOST ALWAYS HAS LARGE BROKEN-OFF SCAFFOLD BRANCHES OR ANY OF THE MULTIPLE TOPS. COMPETITIVE CODOMINANTS ARE DEVELOPING EVERY 1-3M. MANY TORN AND SEMI-BROKEN BRANCHES.</p>	<p>THE TREE BECOMES EXTREMELY HAZARDOUS IN A LUCKY CASE, THE TREE MANAGES ITSELF TO CREATE A NEW LOWER CROWN, BUT USUALLY THE SCARS ARE SO BIG AND THE REMAINING TRUNK SO UNSTABLE THAT THESE TREES FALL DURING A STORM.</p>
WELL-TENDED LANDSCAPE TREE				
	<p>A SINGLE STRAIGHT STEM IS FORMED IN THE NURSERY. THE CROWN IS LIFTED 2-2.5 M HIGH. IF IT IS TO BECOME A STREET TREE - UP TO 4-5m. COMPETITIVE CODOMINANTS ARE PRUNED, DISPROPORTIONATE BRANCHES - REDUCED. MAINTENANCE EVERY 5 YEARS.</p>	<p>GROWN THINNING AND MAINTENANCE (ONCE EVERY 5 YEARS). PROCEED TO MAINTAIN SINGLE STRAIGHT TRUNK AND PROPORTIONAL CROWN.</p>	<p>THE TREE HAS REACHED ITS OPTIMAL SIZE.</p>	<p>THE TREE IS DEVELOPING 1.5M FOLIAGE AREA, WHICH MAKES GROWN REDUCTION DIFFICULT. IT IS NOT EASY, BUT IF A STABLE STRUCTURE IS ACHIEVED, THE CROWN SHOULD BE REDUCED GRADUALLY.</p>

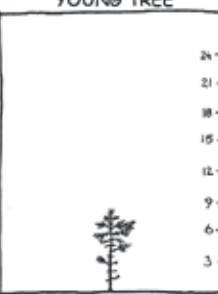
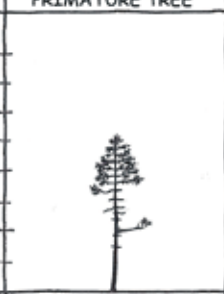
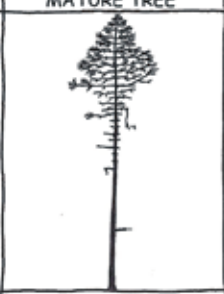

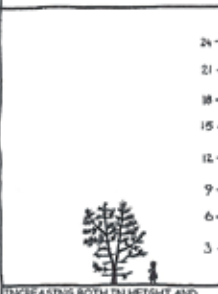
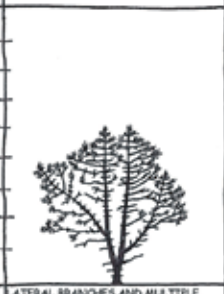



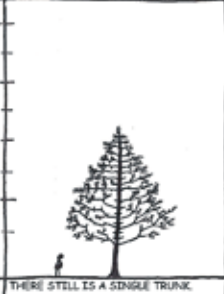


QUERCUS ROBUR / PEDUNCULATE OAK

FIRST SIZE TREE, CONVENIENT FOR MAINTENANCE - EASY ACCESSIBLE FOR ARBORISTS. CROWN - OVAL, WELL BRANCHED, FOR SOLITARY TREES
 - ROUNDED. TRUNK - USUALLY SINGLE WITH THICK BARK. FOREST TREES USUALLY ARE THINNER AND TALLER THAN THE ONES IN UNRESTRICTED LIGHT CONDITIONS - THEY HAVE LOWER AND WIDER CROWNS, MUCH WIDER TRUNKS AND BRANCHES WITH WIDE ANGLES AND BRANCH COLLARS. OLD TREES HAVE DARK GREY BARK, UP TO 10 cm THICK. BRANCHING - STABLE BRANCH CONNECTIONS, WITH FEW EXCEPTIONS IF COMPETITIVE CO-DOMINANTS OR BRANCHES WITH INCLUDED BARK HAVE NOT BEEN PRUNED IN THE JUVENILE AGE. OAKS OFTEN SUFFER BECAUSE OF THIS, AND LATER ON SUCH TREE CAN LOOSE LARGE BRANCHES OR EVEN PART OF ITS TRUNK. AS A RESULT, THE REMAINING CROWN IS SUBJECT TO ENVIRONMENTAL IMPACT, REGARDLESS OF THE GOOD COMPARTMENTALIZATION THAT OAKS HAVE, THE SPREADING PATHOGENS CAN LEAD TO A COMPLETE DESTRUCTION OF THE TREE. WOOD - ONE OF THE STRONGEST, HEAVY, WITH GOOD MECHANICAL AND DECORATIVE PROPERTIES. ROOT SYSTEM - STRONG, THE TAPROOT IS FORMING ALREADY AT THE FIRST YEAR, AND LATER ALSO THE DEEP-REACHING LATERAL ROOTS. LARGER OAK PLANTS ARE HARD TO REPLANT BECAUSE OF THE VAST ROOT SYSTEM.

	YOUNG TREE	PRIMATURE TREE	MATURE TREE	OLD TREE
TREE IN A FOREST	 <p>THERE IS USUALLY A SINGLE TOP AND STRAIGHT STEM IN FOREST CONDITIONS.</p>	 <p>THE TREE STILL HAS A RELATIVELY SMALL DIAMETER STEM, AND IT CONTINUES TO GROW IN HEIGHT RAPIDLY.</p>	 <p>WIDELY BRANCHED CROWN WITH STEADY ANGLES, SOME BRANCHES OFTEN GROW LONGER THAN 10 METERS. DEAD BRANCHES CAN STAY IN THE TREE UP TO 50 YEARS.</p>	 <p>BRANCH ENDS ARE DRYING AND LARGE SCAFFOLD BRANCHES ARE BREAKING. THE TREE IS TRYING TO LOWER ITS CROWN BY FORMING NEW SHOOTS FROM THE DORMANT/ADVENTITIOUS BUDS. TREE BECOMES HAZARDOUS.</p>
UNTENDED LANDSCAPE TREE	 <p>TREE TENDS TO FORM TWO OR MORE STEMS WITHIN UNRESTRICTED LIGHT CONDITIONS. FIRST SCAFFOLD BRANCHES ARE FORMING RIGHT ABOVE THE GROUND.</p>	 <p>SEPARATE SCAFFOLD BRANCHES ARE GROWING INWARDS, CREATING MANY LARGE COMPETITIVE BRANCHES. THE TREE IS GROWING RAPIDLY BOTH IN HEIGHT AND WITH.</p>	 <p>MORE THAN 50% OF SCAFFOLD BRANCHES ARE DEAD, MANY OF THEM HAVE GROWN DISPROPORTIONATELY LONG. CONSEQUENTLY, THE TREE IS CONSIDERED TO BE DANGEROUS.</p>	 <p>THE TREE IS CONSIDERED TO BE HAZARDOUS! THE SIZE OF THE OAK SHRINKS AS THE DISPROPORTIONATELY LARGE BRANCHES ARE BREAKING. ANY OF THE DOUBLE TRUNK AXIS CAN BREAK EVEN DESPITE THE STRONG WOOD, PARTICULARLY HAZARDOUS IN DRY AND HOT WEATHER OR DURING A STORM.</p>
WELL-TENDED LANDSCAPE TREE	 <p>CONTINUE THE TREATMENTS STARTED AT NURSERY. CROWN LIFTING IS PROCEEDED IN CASE OF A STREET TREE. BRANCHES ARE PRUNED BEFORE THEY REACH THE DIAMETER OF 3 CM. BRANCH ANGLES WITH INCLUDED BARK MUST NOT BE PERMITTED.</p>	 <p>CROWN THINNING IS PERFORMED SO THAT THE LOWER BRANCHES GET ACCESS TO LIGHT. SEVERAL AGGRESSIVE SCAFFOLD BRANCHES AND COMPETITIVE CO-DOMINANTS HAVE TO BE REDUCED. DOUBLE TOPS ARE FORMING.</p>	 <p>THE TREE REACHES ITS MAXIMUM HEIGHT AND CONTINUES TO GROW ONLY IN WIDTH. THE CROWN SHOULD BE ADJUSTED BY REMOVING SEVERAL DRY AND DISPROPORTIONATELY LONG LIMBS.</p>	 <p>THE TREE IS REDUCED ACCORDING TO THE STRENGTH OF THE TRUNK AND SCAFFOLD BRANCHES - THE CROWN THUS REMAINS LOWER. CROWN REDUCTION IS A LABORIOUS PROCESS. IF THIS IS DONE PROGRESSIVELY THE LIFE SPAN OF THE TREE EXTENDS, AND SUCH TREATMENTS CAN PROVIDE THE EXISTENCE OF OLD, LARGE-DIAMETER TREES EVEN IN POPULATED AREAS.</p>

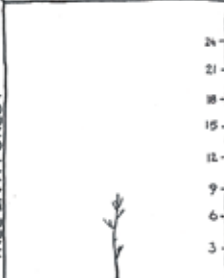

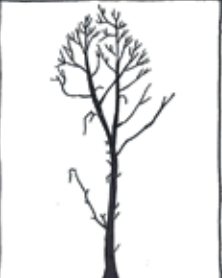

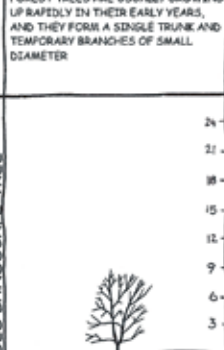
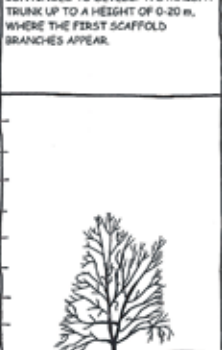


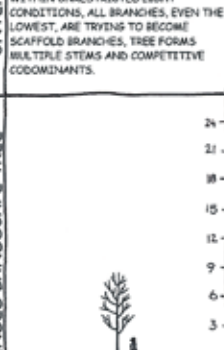
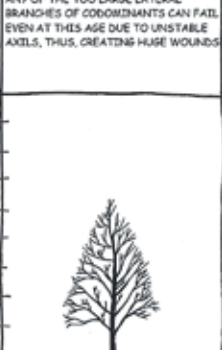


PINUS SYLVESTRIS / SCOTS PINE

FIRST SIZE TREE. CAN REACH THE HEIGHT OF 35 M. GROWS BOTH IN SAND AND FEAT SOILS, WITHIN A FOREST, IT SHAPES TEMPORARY BRANCHES UP TO THE HEIGHT OF 30-20 m AND THESE ARE DROPPING OFF AS THE TREE IS GROWING. THIS SPECIES IS EXTREMELY LIGHT-DEMANDING. THE LOWER PART OF TRUNK IS COVERED BY THICK BARK, WHILE HIGHER IT IS THIN, THUS, IT IS EASY TO HARM THESE TREES DURING THE MAINTENANCE, ESPECIALLY IN SPRINGTIME. **CROWN** - TRANSLUCENT, GROUND VEGETATION IS FORMING BENEATH (USUALLY MINOR). **TRUNK** - STRAIGHT, SLENDER, WELL BRANCHED. **BRANCHING** - WIDE, STABLE ANGLES WITH FEW EXCEPTIONS. BRANCH WHORLS. NEVERTHELESS, IT CAN DEVELOP SEVERAL STEMS AND UNSTABLE BRANCH CONNECTIONS. THE BRANCHES ARE BREAKING EASILY, ESPECIALLY IN WET SNOW CONDITIONS. THESE TREES ARE MORE LIKELY TO BREAK THAN UPROOT. **WOOD** - RESINOUS, WITH REDDISH-BROWN HEARTWOOD AND REMARKABLE GROWTH RINGS. **ROOT SYSTEM** - ADAPTIVE, WITH TAPROOT, LATERAL ROOTS WIDELY SPREAD. WITHIN FEAT SOIL, THERE IS NO TAPROOT AND THE LATERAL ROOTS ARE ONLY IN THE TOP LAYER.

	YOUNG TREE	PRIMATURE TREE	MATURE TREE	OLD TREE
TREE IN A FOREST	 <p>VERY FAST GROWING TREE WITH SINGLE TRUNK AND SMALL DIAMETER LATERAL BRANCHES.</p>	 <p>THERE STILL IS A SINGLE TRUNK. BRANCHES ARE DROPPING OFF. SMALL-DIAMETER LIVE BRANCHES ARE FORMING IN THE UPPER TRUNK.</p>	 <p>A VERY STRAIGHT TRUNK. SEPARATE UPPER SCAFFOLD BRANCHES ARE GROWING THICKER. DRY BRANCHES REMAIN ON THE TREE FOR LONG PERIOD.</p>	 <p>BRANCH ENDS ARE DRY AND THE TREE TOP IS DRYING, TOO. THE HEIGHT OF THE TREE DECREASES.</p>
UNTENDED LANDSCAPE TREE	 <p>INCREASING BOTH IN HEIGHT AND FOLIAGE. MULTIPLE TOPS AND LARGE LATERAL BRANCHES OFTEN BEGIN DEVELOPING AT THIS AGE.</p>	 <p>LATERAL BRANCHES AND MULTIPLE TOPS CONTINUE TO GROW IN THICKNESS. THE TREE GROWS IN WIDTH.</p>	 <p>SUCH TREES ARE USUALLY LOWER, MORE BRANCHED AND WITH LOWER CROWNS THAN THOSE GROWING IN FORESTS. LIVE BRANCHES ARE 2-3 M ABOVE THE GROUND.</p>	 <p>THE PROCESS OF DYING BEGINS. THE TREE CAN LOSE LARGE SCAFFOLD BRANCHES OR EVEN ANY OF THE MULTIPLE TRUNKS DURING STORMS OR AFTER HEAVY SNOWINGS OR ICING.</p>
WELL-TENDED LANDSCAPE TREE	 <p>IN NURSERY THE CROWN IS LIFTED ACCORDING TO THE REQUIREMENTS OF SHAPING A STREET OR PARK TREE.</p>	 <p>THERE STILL IS A SINGLE TRUNK. DOMINANT TOPS ARE REMOVED AS WELL AS THE DRY, CROSSOVER, AND WORTHLESS BRANCHES.</p>	 <p>THE TREE REACHES ITS MAXIMUM SIZE. THE CROWN SHOULD BE THINNED.</p>	 <p>THE TREE HEIGHT SHOULD BE REDUCED. REDUCING AND THINNING SHOULD STILL BE APPLIED TO THE SLOWLY DYING SCAFFOLD BRANCHES.</p>

TILIA CORDATA/ SMALL-LEAVED LIME

FIRST SIZE TREE. DEMANDING CONDITIONS OF OPTIMUM SOIL AND AIR HUMIDITY IN URBAN AREAS. IN FOREST IT REACHES THE FULL HEIGHT IN 40-50 YEARS, IN URBAN ENVIRONMENT - 50-60 YEARS. IN PUBLIC GREENERY, THE LIFE EXPECTANCY CAN SOMETIMES REACH 100-300 YEARS. ONE OF THE MOST SHADE TOLERATING DECIDUOUS SPECIES. CROWN - WIDE, VERY DENSE WITH FINE BRANCHING. TRUNK - RELATIVELY STRAIGHT. BARK - CRACKED, GRAY. ROOT SYSTEM - WIDE, STRONG, DEEP. SIGNIFICANT TAPROOT AND FAR REACHING LATERAL ROOTS. BRANCHING - BRANCHES ARE TENDER AND WELL-BENDING, THEY BREAK SLOWLY, REMAINING LINKED TO THE TREE. OFTEN CREATING NARROW AXILS. THESE TREES ARE OFTEN CRIPPLED IN PUBLIC SPACES BY TOPPING. THE DORMANT BUDS ARE DISPERSED ON THE BRANCHES AND AFTER TOPPING THE CROWN GROWS UNEVENLY AND DEVELOPS DRY STUBS. DECAY IS SPREADING RAPIDLY AFTER SUCH CUTTING, AND THUS THE LIFESPAN OF THESE TREES IN URBAN AREAS USUALLY DOESN'T EXCEED 60-80 YEARS. AFTER A SUDDEN TOPPING OF A LARGE TREE, THE DORMANT BUDS MIGHT NOT SPROUT ANYMORE. IF THEY DO, THEN UNEVENLY, AND SCAR TISSUES CANNOT OVERTHROW THE LARGE STUBS. TREES BECOME UGLY AND HAZARDOUS, AND SOMETIMES THEY DIE.

	YOUNG TREE	PRIMATURE TREE	MATURE TREE	OLD TREE
TREE IN A FOREST	 <p>FOREST TREES ARE USUALLY GROWING UP RAPIDLY IN THEIR EARLY YEARS, AND THEY FORM A SINGLE TRUNK AND TEMPORARY BRANCHES OF SMALL DIAMETER</p>	 <p>CONTINUES TO DEVELOP A STRAIGHT TRUNK UP TO A HEIGHT OF 0-20 m, WHERE THE FIRST SCAFFOLD BRANCHES APPEAR.</p>	 <p>UNFORTUNATELY, THE LARGE SCAFFOLD BRANCHES AND MULTIPLE TOPS ARE OFTEN CREATING UNSTABLE AXILS. THE TREE REACHES ITS MAXIMUM HEIGHT AND CONTINUES TO GROW ONLY IN THICKNESS.</p>	 <p>HUGE WOUNDS ARE FORMING WHEN ANY OF THE LARGE SCAFFOLD BRANCHES OR CODOMINANTS ARE FAILING. THE CROWN OF TREE IS SHRINKING AND THE TREE IS SLOWLY DEGRADING BEHIND OTHER TREES THAT ARE SUSPENDING THE WINDS.</p>
UNTENDED LANDSCAPE TREE	 <p>WITHIN UNRESTRICTED LIGHT CONDITIONS, ALL BRANCHES, EVEN THE LOWEST, ARE TRYING TO BECOME SCAFFOLD BRANCHES, TREE FORMS MULTIPLE STEMS AND COMPETITIVE CODOMINANTS.</p>	 <p>ANY OF THE TOO LARGE LATERAL BRANCHES OF CODOMINANTS CAN FAIL, EVEN AT THIS AGE DUE TO UNSTABLE AXILS, THUS, CREATING HUGE WOUNDS.</p>	 <p>IN SUCH CIRCUMSTANCES, THE TREE USUALLY DOES NOT GROW AS HIGH AS IN THE FOREST, BUT IT MAINTAINS THE BRANCHES TO THE GROUND. DECAY IS FIGHTING WITH THE GROUND. TREE IS HAZARDOUS.</p>	 <p>THE FIGHT ALWAYS ENDS IN FAVOUR OF DECAY, BUT FOR FEW MORE TIMES THE TREE RESTORES A LOW, THICK AND UNSTABLE CROWN. THANKS TO THE FOURTH CODDY BARRIER, A LIME IN THIS STATE CAN LIVE FOR A NUMBER OF RE-GROWTH PHASES/CYCLES.</p>
WELL-TENDED LANDSCAPE TREE	 <p>THE WORK BEGAN IN NURSERY IS CARRIED ON FORMING A SINGLE TRUNK WITH EVENLY DISTRIBUTED SMALL-DIAMETER SCAFFOLD BRANCHES. CROWN RAISED TO HEIGHT OF 2-5 M.</p>	 <p>CUT OUT THE DRY AND CROSSING BRANCHES, SHORTEN THE EXCESSIVELY LARGE ONES WITH UNSTABLE ANGLES. THE LIVE BRANCHES LARGER THAN 4-5 cm ARE NOT REMOVED.</p>	 <p>THE TREE HAS REACHED ITS MAXIMUM HEIGHT AND CONTINUES TO GROW IN WIDTH. ARBORISTS CARRY ON THE TREE MAINTENANCE - USE SHORTENING CUTS TO RAISE THE COW.</p>	 <p>REMOVE LARGE DIAMETER DRY OR DYING BRANCHES, BY APPROPRIATE PRUNING. THE CROWN HEIGHT IS REDUCED PROPORTIONATELY TO THE TRUNK STABILITY. AS A RESULT, THE OLD TREE IS STABLE, SAFE AND AESTHETICALLY NICE.</p>

TREE PROTECTION

Proper measures need to be applied in order to preserve trees during various construction-related works which can be very harmful or even deadly. Maintenance and protection requirements for a particular case should be described in the tree protection plan developed by professional arboriculturalists after a tree inventory.

Trunks and roots should be protected against mechanical trunk damage and compaction of the root area, especially those of trees growing in dense urban areas and close to traffic. Trunk damage can cause decay, while soil compaction can prevent root development and cause dieback.

When any kind of construction work takes place trees must be protected for a specific period, especially during the working process. Tree protection involves the crown, trunk and roots – as described below.

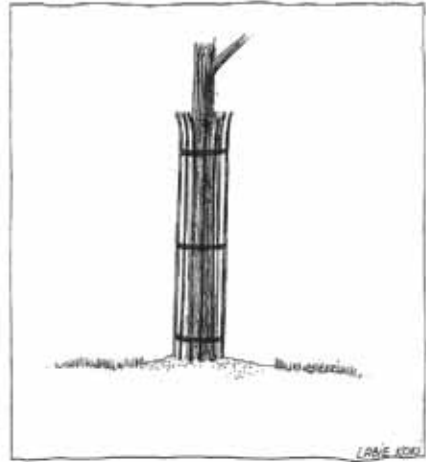
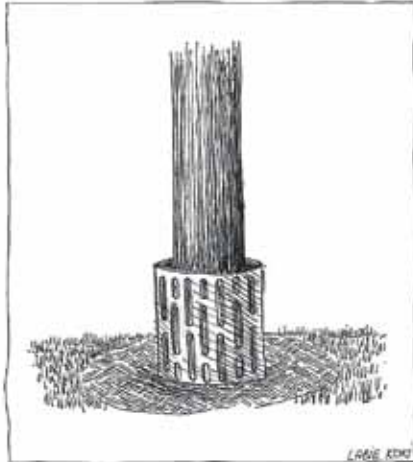
CROWN PROTECTION

Accurate maintenance and pruning are essential for maintaining a healthy crown. Corrective crown pruning should be done before and after construction works. If the crown is not disturbing the works, it should be done only once, after construction.

Separate branches and the lowest scaffold branches can be protected by drawing them in and tying the branches higher during the construction period. Soft shock-absorbing materials can also be applied to the largest lower branches that might suffer from mechanical damage. Only a strict border between trees and the construction site can prevent serious damage.

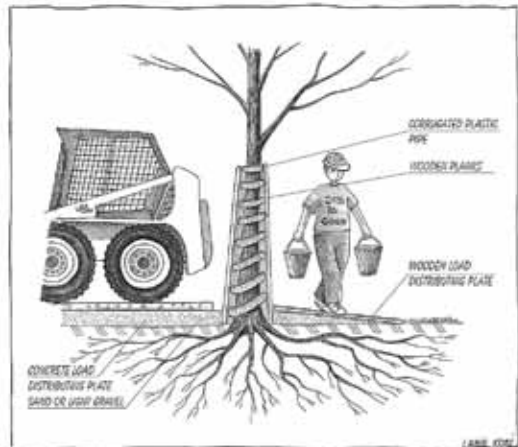
TRUNK PROTECTION

In such places where mechanical damage can be anticipated, trunk protection should be planned beforehand and durable trunk protectors should be installed already during the planting. Such protection can also be applied later on, whenever such risks arise.



TRUNK PROTECTION

During construction work trunk protection should be carried out by surrounding it with hard materials. At least 10 cm thick and soft shock absorbing materials must be applied in between the hard, impact receiving surface and the bark of the tree (corrugated drain pipe, car tyres, foam rubber, or other elastic material).

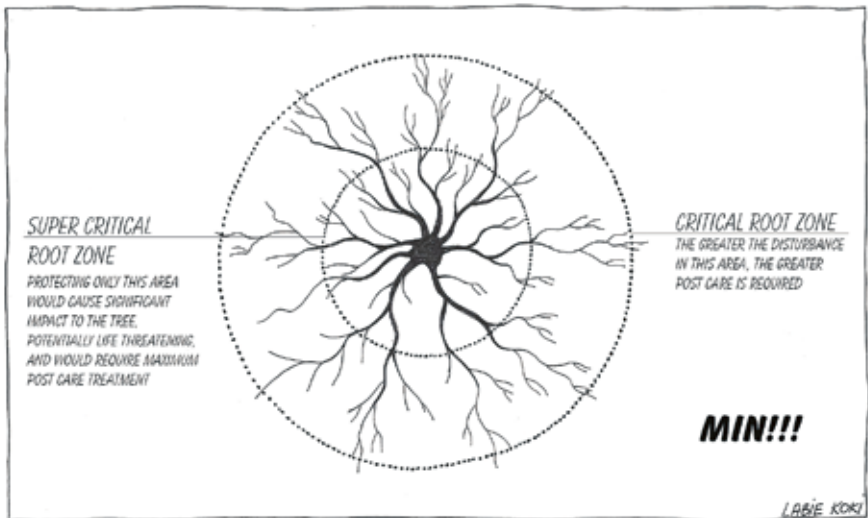


PROTECTION AT CONSTRUCTION SITES

ROOT PROTECTION

While the trunk and crown of the tree are easily visible, the actual root area is impossible to comprehend. Many people believe that root area is equal to the crown projection on the ground, but THIS IS NOT TRUE! It normally extends much further in a well-established tree.

The roots extend as far as the height of the tree or longer, and if the crown has been previously reduced – the roots can even be 3 times longer than the actual tree height. The same applies to specific rootstock species (*Acer platanoides* 'Globosum', *Quercus robur* 'Fastigiata', etc.).



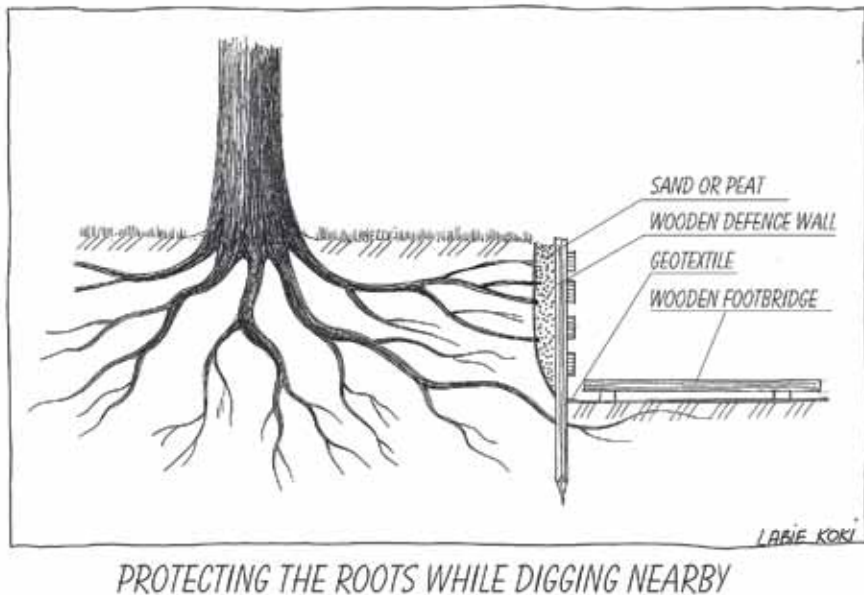
CRITICAL ROOT ZONE

Uncovered and exposed roots

Roots cannot be left uncovered during construction works such as when a ditch or other excavation has been made and they must be covered immediately after pruning them back following damage. Humus-rich soil or compost should be used as well as geotextile, other textiles, wood, or if the ditch is several meters deep – a steel sheet piling or concrete defence wall.

The exposed roots of the tree must be covered by temporary load-distributing plates if any movement is planned over the roots of a valuable tree. Two methods are used:

- footbridges – wood, concrete, metal;
- plates – wood, concrete, metal, temporary asphalt.



Root pruning

Roots that are within the construction area must not be torn off by tractors or other means, as by tearing they can be damaged as far as few meters away from the impact area towards the tree. Small roots should be pruned by bypass (scissor type) pruning shears, roots larger than 1.5 cm diameter by a sharp hand saw.

During the development of the tree protection plan, it is advisable to carry out careful root uncovering (control ditch) at the edges of the estimated protection zone. The works must be done by professionals using a spade or an air-spade with compressed air. Thus, the construction zone can be shifted closer to the tree in case of root absence, or the distance should be increased if the root diameter exceeds 2–7 cm.

If roots larger than \varnothing 7 cm are to be pruned, it is suggested to consider removing the tree and planting a new one after the construction works. The crucial diameter depends on the particular tree and conditions, for instance – the larger and more valuable the tree and the denser the urban environment, the larger the responsibility to maintain a tree with 7 cm (sometimes even 10 cm) thick roots in this area. Tree maintenance must be assessed by a specialist to see if any technical solutions can be applied in order to preserve the tree.

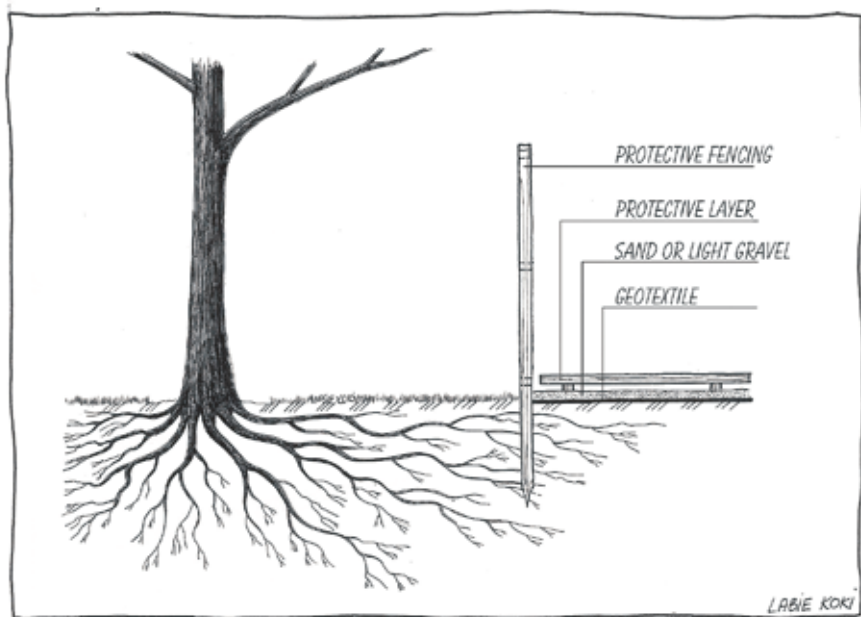
In the best case scenario, it is best not to cut roots wider than 2 cm. In the case of utility instalment lines should preferably be installed below the roots without harming them, as 70–90% of the roots are located no deeper than ~30–70 cm below the surface (depending on soil structure and growth conditions). If roots are cut back, then the tree needs watering every week during the dry period.

Root protection during construction works

If building materials are to be stored near trees, protective layers should be laid on the root area:

- ~20 cm sand or light gravel;
- gratings made from wood or other material.

After the construction is complete, the layers are removed.

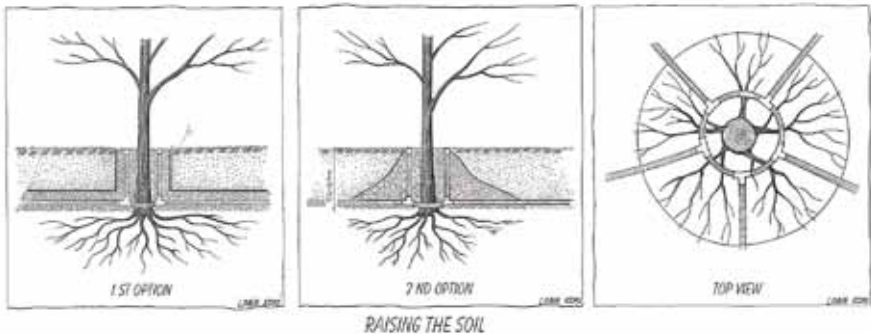


ROOT PROTECTION DURING CONSTRUCTION WORKS

PROTECTION WHILE RAISING THE SOIL SURFACE

Different species of trees tolerate changes in soil level very differently (most delicate is *Picea*). If the soil surface is raised over 30 cm, protection measures have to be brought into use:

- The easiest way is to leave the immediate surroundings of the tree at the same level as before. The formed hole is supported with a wall;
- The trunk is protected with geotextile; light gravel is laid near the trunk and covered with soil.

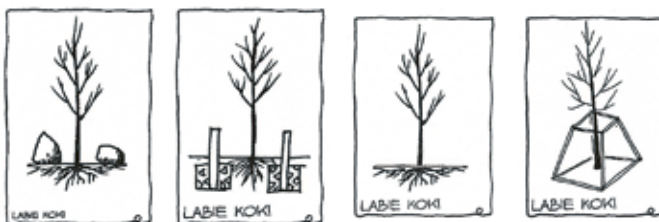


DAMAGE MANAGEMENT

Mechanical damage

Taking care of public areas can sometimes partially or severely damage trees and shrubs.

Protection: Installation of mechanically stable and obvious obstacles (concrete kerbs, large stones, metal frames, stones, poles, tree grilles and guards etc.). After planting, trees can be tied to specially designed, durable stakes that can serve as a shield against mechanical damage in the future.



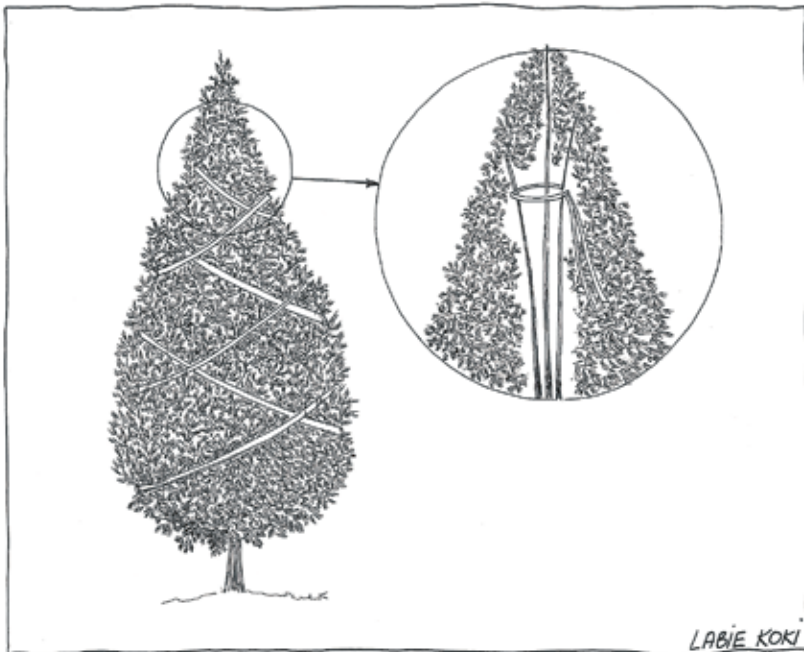
Snow and ice damage

Snow collected from streets should not be stored on green areas, especially when salt is used.

Snow falling off roofs can damage even large trees, and similar harm can be done by workers if they are ignorant of where they throw the snow they remove.

Protection: Snow removal from roofs should be done carefully, or special barriers could be installed on the roofs that prevent snow from falling. If possible such potential damage should be assessed already when choosing the right spot for planting a tree. Wet snow can be a huge additional weight on a tree. The same happens when rain falls in cold weather and ices up the tree branches. Smaller conifers can be tied up to prevent weight damage. Shaping a stable and proportional tree structure can help avoiding serious damage in all cases.

Ice is a problem in early spring when the snow starts to melt, days are warmer and nights are cold. The ice under the trees has to be loosened to speed melting.



*SMALLER CONIFERS CAN BE TIED UP TO PREVENT THE TREES FROM
BREAK BECAUSE OF HEAVY SNOW*

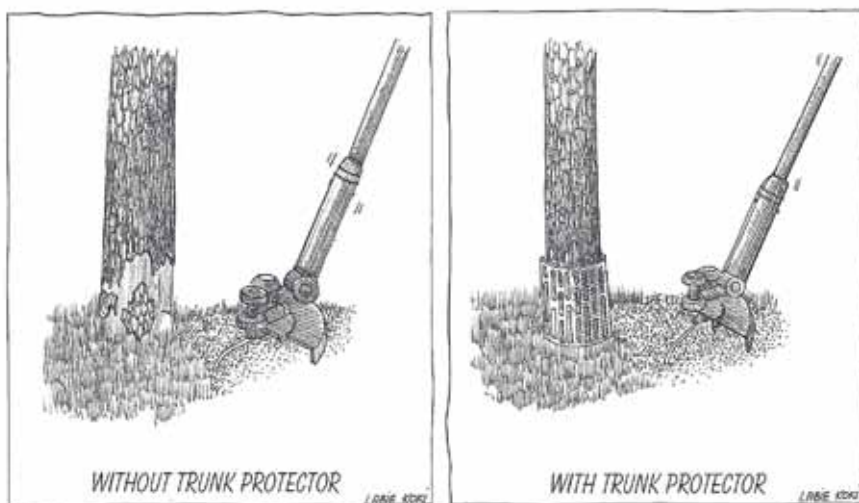
Lawn trimmers and lawn mowers

Lawn trimmers are an extreme problem for young trees. A single untrained and careless worker can severely damage or even kill tens of trees in a single day

Protection: There are special trunk protectors for young trees available (trimmer and rodent protection), and they can also be handmade from plastic or rubber tubes.

Vibration from lawn mowers might seem insignificant, but in fact it causes both soil compaction and the tiny root hair rupture underground. Trunk and root flare can be damaged if mowing is done too close to the tree, and also in the case of exposed roots - they can be mechanically damaged as well.

Protection: weeds should be removed and mulch applied in the area around the tree. For large and valuable trees the mulched area should be equal to the crown projection on the ground.



TREE TRUNK PROTECTOR FROM LAWN TRIMMER

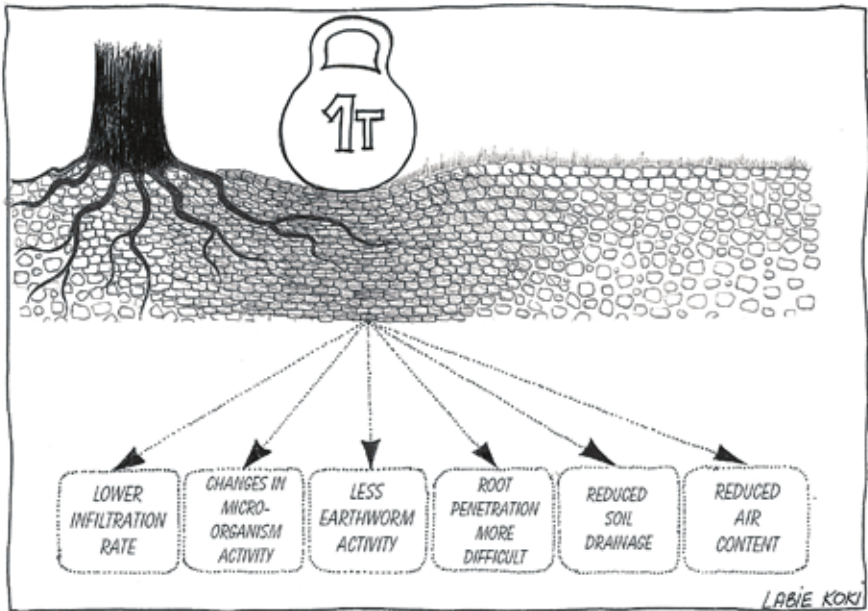
Soil compaction

Main causes of soil compaction:

- Construction works;
- Direct traffic and nearby traffic vibrations;
- Pedestrians – especially harmful to popular trees and areas near crossroads;
- Livestock.



MAIN CAUSES OF SOIL COMPACTION



SOIL COMPACTION: REDUCTION IN PORE SIZE

Solutions for already compacted soil:

- The soil should be changed – the compacted soil is disrupted by an air-spade, removed by a soil vacuum-cleaner, and new, humus rich and most importantly – aerated – soil is applied. Only the upper part of the soil can be improved this way.
- Drilling special holes around the tree and filling them with crushed rock, etc., thus providing air supply to deeper layers of the soil.

The soil should be loosened – by breaking the compacted soil using highly compressed air and special machinery.

Wind and storms

The most common reasons for trees breaking and uprooting are wind and storms. Strong winds can cause tree bending, breaking, losing branches, partial or full uprooting.

Wind tunnel

In some areas the strength of the wind tends to increase to extremes (seaside, large open spaces, hill-tops, “wind tunnels” in between large buildings with poor aerodynamics, etc.), while other places are sheltered (behind large objects, in valleys, trees growing nearby and having a dense canopy, etc.). Wind gusts in combination with heavy rain falls and loamy soil where roots can simply “slip out” are especially dangerous.



Prone to uprooting during storms are:

- Trees that have suffered from previous storms (bent; cracked soil; soil elevation on one side, etc.);
- Trees weakened by fungi;
- Trees damaged by construction and digging (utility line installation, ditches, graveyards, etc.);
- Trees that have lost a “shield” (removal of surrounding trees, house, etc.);
- Extremely big and old trees;
- Trees with shallow and poorly developed roots, usually growing in heavy soil with high ground-water levels as well as in compacted soil;
- Trees that have adapted to heavy anchors above their roots (big stones, house foundation, road surface, etc.) and suddenly have such anchors removed.

Protection: early hazard detection methods – careful visual assessment, inclinometer and pulling tests.

Prone to breaking during storms are:

- Trees weakened by fungi;
- Trees with weak forks, other cracks and all kinds of structural damage;
- Improperly maintained trees – with large wounds, disproportionately shaped crown, extremely lifted crowns;
- Trees that have lost their “shield” (removal of surrounding trees, house, etc.);
- Extremely big and old trees.

Protection: early hazard detection methods – careful visual assessment, elastometer, pulling test, dendrotomograph, resistograph, and other instruments that can detect the degree of tree damage.

Vandalism

Vandalism is extremely dangerous to young trees but can be harmful to older trees as well, especially within densely populated urban areas.

Protection: Choosing large tree plants for such areas with lifted crowns that cannot be broken that easily. Regular care and supervision of trees in the public space is important, as well as public education and information.

Vandalism without intention is also very common – all kind of tying materials around trunk and branches, bird cage and feeder attaching, etc.

Protection: Galvanized nails should be used for bird cages and they should not be deeply inserted (only in sapwood). Young trees are usually tied for support – they must be released in time. Elastic materials should be used for any kind of tying. Inelastic materials must be changed every year (they are usually tight and trees are growing in width). The worst materials that must never be used are all kinds of wires.

Fungi, diseases and insects

Not all fungi are harmful but some are dangerous and spread very quickly (like *Armellaria*, *Ganoderma*, etc.). Most visible symptoms of fungi are fruiting bodies on the tree trunk and branches, also on the root flare and roots near the trunk.

Solutions: A specialist should be approached (by sending photos or describing the obvious symptoms), as they can tell from the fruiting body whether the fungi are breaking down cellulose or lignin (if it is brown or white decay) or both, and whether a more thorough investigation is necessary.

There are also various kinds of insects, some of them being more and some less harmful.

Solutions: A specialist should also be approached if the colour or shape of the leaves or the entire foliage seems abnormal. It can be related to diseases, insects or inappropriate growth conditions. Insects can be treated with chemical repellents. Chemicals are seldom practiced for mature trees in Europe as they can harm other animals and have some side effects. Bio-solutions are available for specific cases. A wide range of insecticides are available for small trees and shrubs.

Animals

Various animals can create mechanical damage. It is mainly caused by:

- Rodents and deer that gnaw the bark of trees;
- Deer and elk that rub their antlers against tree trunks;
- Sapsuckers: woodpeckers and similar birds who drink sap from live trees;
- Beavers: occasionally living in urban areas and parks near water;
- Livestock in farmlands: they can cause bark damage, soil compaction, and destroy root flares.

Protection: Trunks should be covered in order to protect them from mechanical damage. Chemical repellents can also be used sometimes. The traditional way of protecting against hares, deer and other animals is binding the trunk with conifer branches or straw, but there are also specially designed protectors available both for bare trunks and trunks with branches. Plastic, metals and other materials can be applied, and metal screens are used in against beavers. Repellents or thick cloth can be used in case of woodpeckers, keeping in mind that they tend to return to the same place.

Sun burns and frost

The first years after nursery are crucial, as the trunk is usually much more exposed than the tree is used to. The same can happen with replanted trees and in other cases when a tree has lost its previous sun shield and becomes exposed. Sun scalding is not always caused by direct sun; it can also be reflected by glass, white walls and snow.

Protection: Almost all nurseries recommend installing reed, straw, or bamboo mats or similar materials around the trunk up to the height of the first branches or ~2 m high (the standard mat size). They reflect the sun and do not heat up.

The same solution can also be used as insulation. Sometimes such protectors can be applied even higher in the crown in order to protect the largest scaffold branches. Nurseries recommend this for all young trees but especially trees with thin bark – such as *Tilia*, *Fagus*, *Acer*, *Salix*. The protectors should remain around the tree up to the time the crown is big enough to protect itself. The tree will slowly adapt to its new conditions as the material gradually degrades.

Evergreens often suffer from spring sun when the ground is frozen and covered by snow – that doubles the negative effect of the sun. The same danger is from strong winds in winter that can dry young evergreen plants. It is extremely dangerous if at least two of the conditions (sun, wind, frost) coincide.

Species such as *Quercus*, *Acer*, *Tilia*, *Aesculus hippocastanum*, *Juglans*, *Fagus*, *Malus sylvestris*, etc., can suffer from sudden temperature drops (below -25°C) when large cracks appear on the trunk. It is more common and visible on large diameter trunks. The cracks usually appear suddenly, and they are wide (2–5 cm) and very deep, reaching along medullary rays into the core. With temperature raising above 0°C these cracks gradually close and become invisible. At the beginning such closed cracks might not be dangerous, but eventually decay can get in, and if such a crack has appeared once, it is more than likely that it will re-appear during further temperature drops. Usually they begin at the lower part of the trunk and can proceed higher. If a crack opens regularly, the tree develops callus on it, and in several years of re-opening even frost ribs can appear.

Some species like oaks can successfully close such cracks with no damage at all.

Protection: Similar protectors as used against sun burns can be applied against frost cracks.

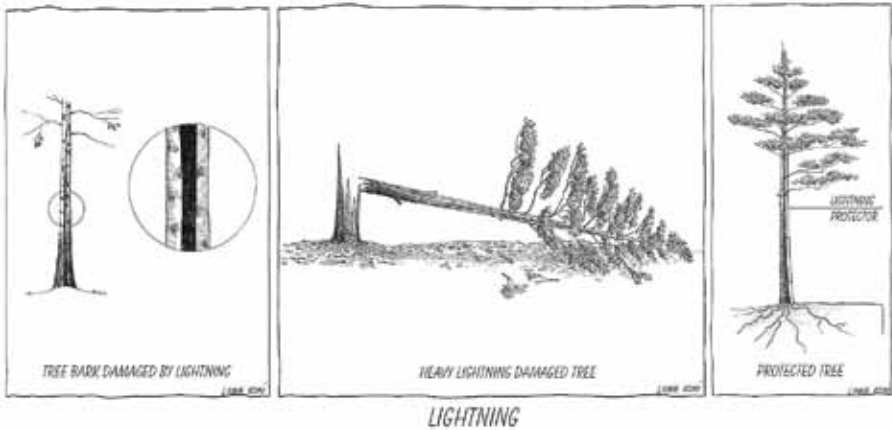


STRAW TRUNK PROTECTOR

Lightning

Each year thousands of trees suffer from lightning. Trees can often survive it, however, some damage remains. Even though lightning will most likely hit the tree top, it goes down to the ground affecting bark and also wood tissue. Minor damage can be overgrown by the tree itself, while deeper damage can seriously weaken the tree or even literally blow it up.

Protection: There are special lightning conductors, which, unfortunately, are seldom applied, but they should be installed on trees in risk areas or at least on very valuable trees. Otherwise the damage can be severe and even lethal for the trees.



Chemical damage

The most common chemical enemies of the trees are:

- Salt (used for icy roads and pavements);
- Weed killers;
- Animals (dog/livestock urine and bird droppings).

Both trunk and roots suffer from these. Bark is the natural protection against various types of damage, thus older trees with thick bark are less prone to such damage while young trees with thin bark can suffer more. Meanwhile, many chemicals that appear in the root area can get in contact with the roots and do more or less harm to the tree.

Dogs are especially dangerous to solitary trees in urban areas. Similarly it is with livestock in farmlands and rural areas, and animals at the Zoo.

Protection: The best solution is to prevent the causes as much as possible, and to use trunk protectors, display obstacles on the root area that reduce the contact between the tree and intruders. Soil rinsing or exchange, mulching or mulch exchange can be carried out in such cases. Dog excrement should in any case be picked up and removed by the owners.

TREE SUPPORT SYSTEMS

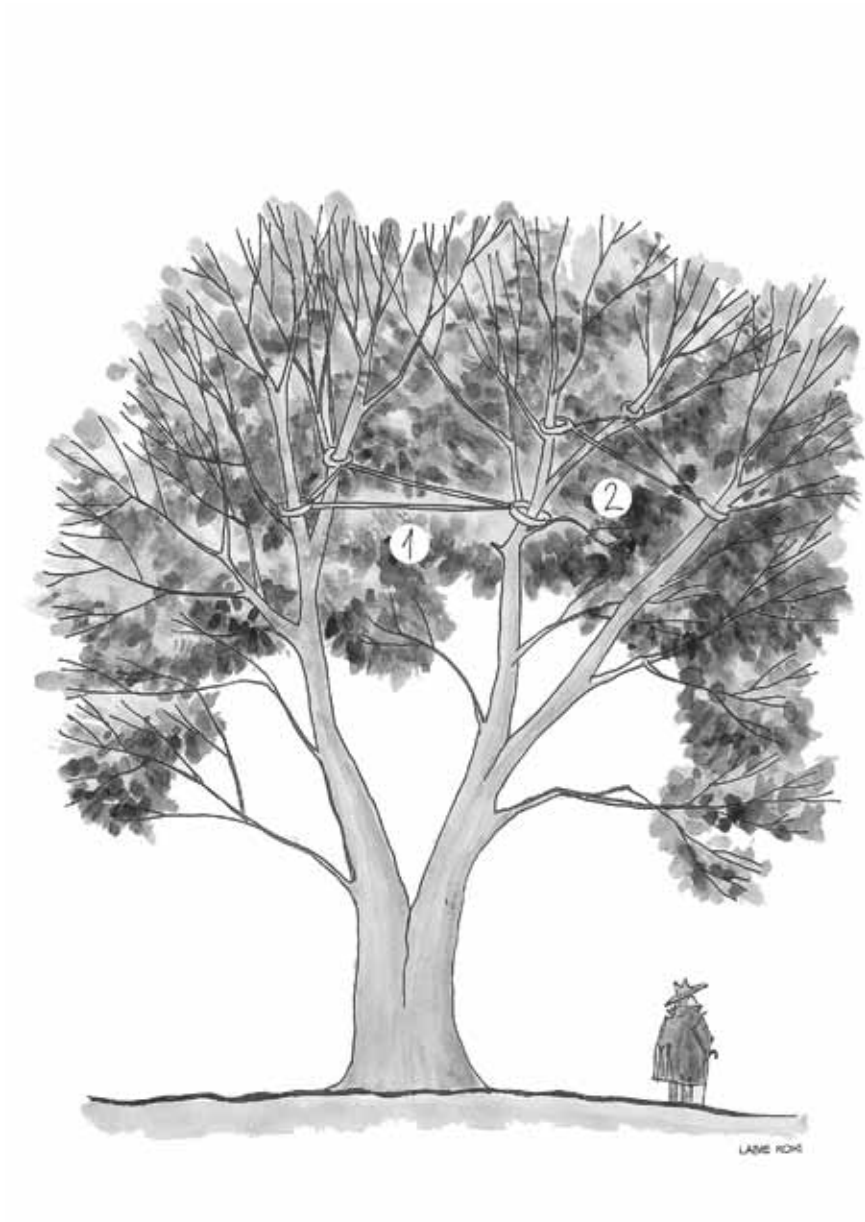
DYNAMIC TREE SUPPORT SYSTEMS

Dynamic cabling systems (using straps, belts, dynamic ropes) are the least invasive for trees. Unlike static cabling they do not interfere with the natural mechanisms within the tree. There is no drilling involved and these systems are not tensioned (they tension only in the case of strong winds or storms).

Proper installation of dynamic systems must be carried out, otherwise they may harm the trees (for instance – when inserted too tight such a system can promote the breaking of branches). There should be no friction with any side branches or stem as it can rapidly weaken the system.

Dynamic systems should be installed as high as possible, assessing the anchor points that have to bear the load of the system. The average recommended height is $2/3$ of the tree height above the damaged location.

Durability requirements for these systems are 8 years and at least 10 years after implementation the dynamic system must be examined. None of the support systems can give 100% safety guarantee in extreme wind conditions. Dynamic systems are considered to be better, but they cannot solve all problems. For instance – if an irreversible deformation has already occurred, then a static method will be more appropriate as it is keeping the problematic part of the tree in a fixed position.



1 - Dynamic system. Double stem support; 2 - Dynamic system supporting a large scaffold branch.

STATIC TREE SUPPORT SYSTEMS

Static systems are usually applied in the lower part of trunk in between multiple trunks or trunk and large scaffold branches, or they are supporting large scaffold branches from the ground. These systems are usually applied for heritage trees and other old and valuable trees where this is the only possible method.

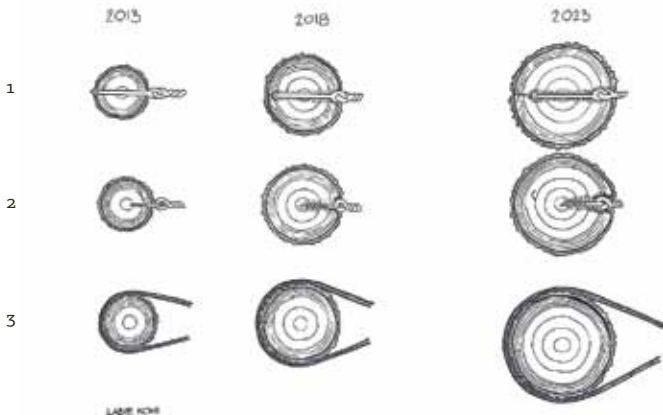
Static cabling should be applied as seldom as possible, as it prevents the adaptive growth of the tree. A static system remains inserted until the tree has to be removed – the tree becomes dependant on this support and if the system is removed earlier, there is very high risk of tree failure.

Support from the ground

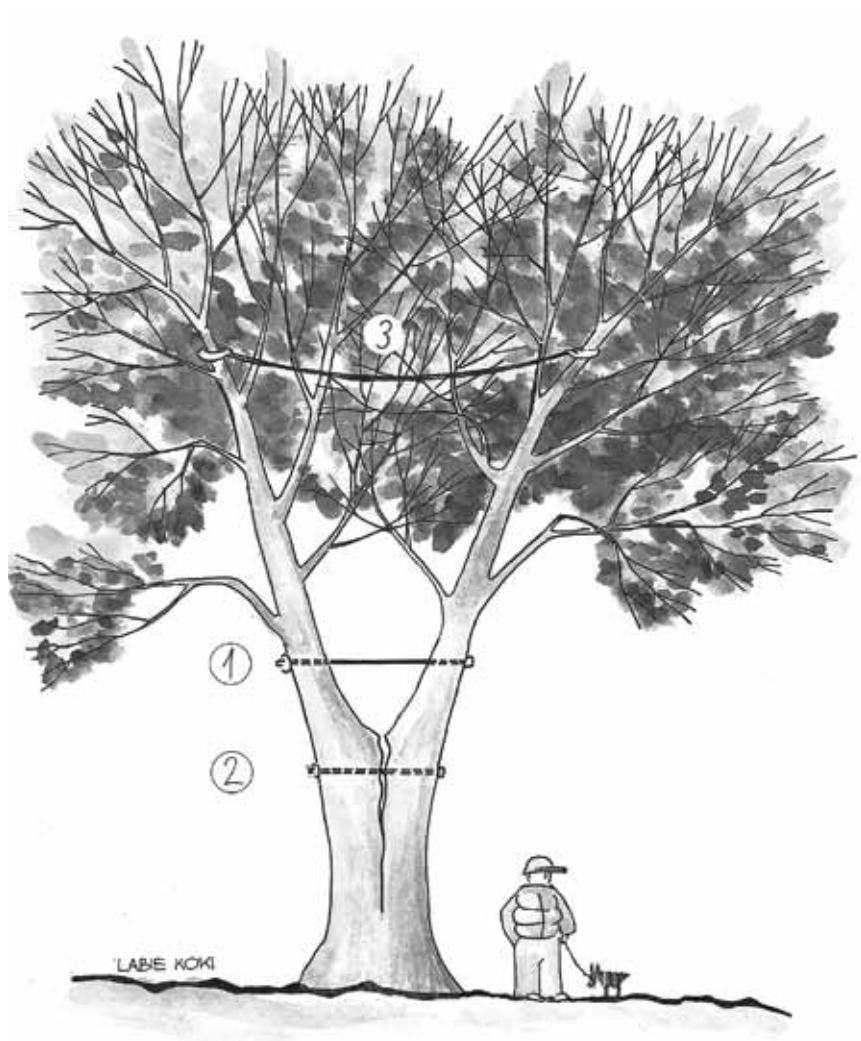
This is probably the oldest method used for large tree support, also popular in orchard and heritage tree maintenance. They can have one or two footholds, and sometimes the height can be regulated.

Tethering systems: Separate horizontal, dangerous and large branches that cannot be shortened or removed and cannot be accessed by vertical ground support can be supported with static vertical cables or tethering systems.

Ways of fastening the support systems



1 – A rod / bolt drilled through a tree can cause decay!; 2 – A drilled in hook can cause decay and be pulled out by storm; 3 – Slings are mostly used in Europe. This is a durable and a least harmful solution.



1 - A bolt inserted through the tree; 2 - A rod through both axes; 3 - Dynamic support system

APPENDICES

1. SPECIES SUITABLE FOR PLANTING ACCORDING TO CLIMATE ZONES

Zones >	2	3	4	5	6	7
Conifers						
<i>Abies alba</i>				•		
<i>Abies balsamea</i>			•			
<i>Abies concolor</i>			•			
<i>Abies fraseri</i>			•			
<i>Abies holophylla</i>			•			
<i>Abies koreana</i>			•			
<i>Abies lasiocarpa</i>			•			
<i>Abies sachalinensis</i>			•			
<i>Abies sibirica</i>			•			
<i>Abies veitchii</i>			•			
<i>Chamaecyparis lawsoniana</i>					•	
<i>Chamaecyparis nootkaensis</i>					•	
<i>Chamaecyparis pisifera</i>				•		
<i>Juniperus chinensis</i>			•			
<i>Juniperus communis</i>		•				
<i>Juniperus conferta</i>			•			
<i>Juniperus davurica</i>			•			
<i>Juniperus horizontalis</i>			•			
<i>Juniperus × pfitzeriana</i> (syn. <i>J. × media</i>)			•			
<i>Juniperus sabina</i>		•				
<i>Juniperus scopulorum</i>			•			

Zones >	2	3	4	5	6	7
<i>Juniperus squamata</i>			•			
<i>Juniperus virginiana</i>			•			
<i>Larix decidua</i>		•				
<i>Larix kaempferi</i>		•				
<i>Larix × marschlinsi</i>		•				
<i>Larix russica</i>		•				
<i>Microbiota decussata</i>		•				
<i>Picea abies</i>		•				
<i>Picea glauca</i>		•				
<i>Picea mariana</i>	•					
<i>Picea obovata</i>		•				
<i>Picea omorika</i>		•				
<i>Picea pungens</i>		•				
<i>Pinus banksiana</i>				•		
<i>Pinus cembra</i>		•				
<i>Pinus cembra</i> var. <i>sibirica</i> (syn. <i>Pinus sibirica</i>)		•				
<i>Pinus contorta</i> var. <i>latifolia</i>		•				
<i>Pinus mugo</i>		•				
<i>Pinus nigra</i>			•			
<i>Pinus peuce</i>		•				
<i>Pinus pumila</i>		•				
<i>Pinus sylvestris</i>	•					
<i>Pseudotsuga menziesii</i>		•				
<i>Taxus baccata</i>				•		
<i>Taxus cuspidata</i>			•			
<i>Thuja koraiensis</i>		•				
<i>Thuja occidentalis</i>		•				

Zones >	2	3	4	5	6	7
<i>Thuja plicata</i>			•	•		
<i>Thujopsis dolabrata</i>				•		
<i>Tsuga canadensis</i>				•		
Deciduous trees						
<i>Acer campestre</i>				•		
<i>Acer negundo</i>			•			
<i>Acer platanoides</i>		•				
<i>Acer pseudoplatanus</i>				•		
<i>Acer saccharinum</i>			•			
<i>Acer spicatum</i>			•			
<i>Acer tataricum</i>			•			
<i>Acer tataricum</i> var <i>ginnala</i>			•			
<i>Aesculus hippocastanum</i>			•			
<i>Aesculus octandra</i> (syn. <i>A. flavum</i>)			•			
<i>Alnus glutinosa</i>		•				
<i>Alnus incana</i>	•					
<i>Amelanchier alnifolia</i>	•					
<i>Amelanchier spicata</i>	•					
<i>Betula humilis</i>	•					
<i>Betula pendula</i>	•					
<i>Betula pubescens</i>	•					
<i>Carpinus betulus</i>				•		
<i>Cydonia oblonga</i>					•	
<i>Fagus sylvatica</i>				•		
<i>Fraxinus excelsior</i>			•			
<i>Fraxinus pennsylvanica</i>		•				
<i>Juglans cinerea</i>			•			

Zones >	2	3	4	5	6	7
<i>Juglans mandshurica</i>						
<i>Juglans</i>						
<i>Malus baccata</i>	•					
<i>Malus cv. cv</i>			•			
<i>Malus sargentii</i>		•				
<i>Malus prunifolia</i> 'Dolgo'			•			
<i>Malus toringoides</i>			•			
<i>Malus zumii</i>			•			
<i>Morus alba</i>					•	
<i>Populus alba</i>		•				
<i>Populus × canadense</i>		•				
<i>Populus nigra</i>		•				
<i>Populus simonii</i>		•				
<i>Populus tremula</i>		•				
<i>Prunus cerasifera</i>			•			
<i>Prunus maackii</i>		•				
<i>Prunus padus</i>		•				
<i>Prunus pensylvanica</i>		•				
<i>Prunus serotina</i>			•			
<i>Prunus spinosa</i>				•		
<i>Prunus virginiana</i>		•				
<i>Pyracantha coccinea</i>					•	
<i>Pyrus communis</i>				•		
<i>Quercus palustris</i>					•	
<i>Quercus petraea</i>					•	
<i>Quercus robur</i>		•				
<i>Quercus rubra</i>		•				

Zones >	2	3	4	5	6	7
<i>Robinia pseudoacacia</i>			•			
<i>Salix alba</i>		•				
<i>Salix caprea</i>		•				
<i>Salix fragilis</i>		•				
<i>Sorbus aucuparia</i>		•				
<i>Sorbus intermedia</i>	•					
<i>Tilia cordata</i>	•					
<i>Tilia × euchlora</i>		•				
<i>Tilia platyphyllos</i>		•				
<i>Ulmus glabra</i>		•				
<i>Ulmus laevis</i>		•				
<i>Ulmus procera</i>			•			
<i>Ulmus pumila</i>			•			
Deciduous bushes						
<i>Aronia melanocarpa</i>		•				
<i>Aronia × prunifolia</i>		•				
<i>Artemisia abrotanum</i>				•		
<i>Berberis koreana</i>				•		
<i>Berberis × ottawensis</i>			•			
<i>Berberis thunbergii</i>				•		
<i>Berberis vulgaris</i>		•				
<i>Buxus sempervirens</i>				•		
<i>Calluna vulgaris</i>		•				
<i>Caragana arborescens</i>	•	•				
<i>Caragana frutex</i>	•	•				
<i>Cerasus japonica</i>					•	
<i>Chaenomeles japonica</i>				•		

Zones >	2	3	4	5	6	7
<i>Cornus alba</i>	•					
<i>Cornus mas</i>				•		
<i>Cornus sanguinea</i>			•			
<i>Cornus sericea</i>			•			
<i>Cornus stolonifera</i>		•				
<i>Corylus avellana</i>		•				
<i>Corylus maxima</i>					•	
<i>Cotinus</i>					•	
<i>Cotoneaster bullatus</i>				•		
<i>Cotoneaster horizontalis</i>				•		
<i>Cotoneaster lucidus</i>	•					
<i>Cotoneaster multiflorus</i>				•		
<i>Crataegus alemanniensis</i>				•		
<i>Crataegus douglasii</i>		•				
<i>Crataegus flabellata</i>				•		
<i>Crataegus horrida</i>				•		
<i>Crataegus laevigata</i>			•			
<i>Crataegus monogyna</i>			•			
<i>Crataegus × mordenensis</i>			•			
<i>Crataegus submollis</i>		•				
<i>Cytisus scoparius</i>				•		
<i>Daphne mezereum</i>	•					
<i>Deutzia × hybrida</i>					•	
<i>Deutzia lemoinei</i>					•	
<i>Deutzia scabra</i>				•		
<i>Eleagnus angustifolia</i>			•			
<i>Eleagnus argentea</i>		•				

Zones >	2	3	4	5	6	7
<i>Elaeagnus commutata</i>		•				
<i>Eleagnus multiflora</i>				•		
<i>Erica tetralix</i>				•		
<i>Euonymus alatus</i>			•			
<i>Euonymus europaeus</i>		•				
<i>Forsythia × intermedia</i>				•		
<i>Forsythia suspensa</i>				•		
<i>Frangula alnus</i>		•				
<i>Hippophae rhamnoides</i>			•			
<i>Holodiscus discolor</i>				•		
<i>Hydrangea arborescens</i>		•				
<i>Hydrangea heteromalla</i>		•				
<i>Hydrangea paniculata</i>		•				
<i>Hypericum calycinum</i>					•	
<i>Hypericum kalmianum</i>					•	
<i>Kolkwitzia amabilis</i>					•	
<i>Laburnum alpinum</i>				•		
<i>Laurocerasus officinalis</i>					•	
<i>Ligustrum tschonoskii</i>				•		
<i>Ligustrum vulgare</i>				•		
<i>Lonicera caerulea</i>	•					
<i>Lonicera involucrata</i>		•				
<i>Lonicera kamtschatica</i>	•					
<i>Lonicera nitida</i>					•	
<i>Lonicera pileata</i>					•	
<i>Lonicera tataricum</i>			•			
<i>Lonicera xylosteum</i>	•					

Zones >	2	3	4	5	6	7
<i>Mahonia aquifolia</i>				•		
<i>Philadelphus coronarius</i>		•				
<i>Philadelphus lemoinei</i>			•			
<i>Physocarpus opulifolius</i>		•				
<i>Potentilla fruticosa</i>		•	•			
<i>Rhamnus catharticus</i>		•				
<i>Rhododendron canadense</i>		•				
<i>Rhododendron dauricum</i> var. <i>sempervirens</i>		•				
<i>Rhododendron japonicum</i>		•				
<i>Rhododendron luteum</i>		•				
<i>Rhododendron schlippenbachii</i>		•				
<i>Rhododendron smirnowii</i>		•				
<i>Rhododendron vaseyi</i>		•				
<i>Ribes alpinum</i>	•					
<i>Ribes aureum</i>		•				
<i>Ribes rubrum</i>		•				
<i>Ribes sanguineum</i>		•				
<i>Rosa pimpinellifolia</i>		•				
<i>Rosa rugosa</i>		•	•			
<i>Rubus odoratus</i>			•			
<i>Salix purpurea</i>			•			
<i>Salix × rubens</i>			•			
<i>Salix viminalis</i>			•			
<i>Sambucus racemosa</i>		•				
<i>Sambucus nigra</i>				•		
<i>Sorbaria sorbifolia</i>		•				
<i>Sorbus koehneana</i>				•		

Zones >	2	3	4	5	6	7
<i>Sorbus thuringiaca</i>			•			
<i>Spiraea chamaedryfolia</i>			•			
<i>Schisandra chinensis</i>		•				
<i>Spiraea × cinerea</i>			•			
<i>Spiraea betulifolia</i>			•			
<i>Spiraea japonica</i>			•			
<i>Spiraea media</i>			•			
<i>Spiraea nipponica</i>			•			
<i>Spiraea trilobata</i>			•			
<i>Stephanandra incisa</i>		•				
<i>Symphoricarpos albus</i>			•			
<i>Symphoricarpos rivularis</i>				•		
<i>Syringa chinensis</i>			•			
<i>Syringa josikaea</i>		•				
<i>Syringa meyeri</i>		•				
<i>Syringa reticulata</i>		•				
<i>Syringa villosa</i>			•			
<i>Syringa vulgaris</i>		•				
<i>Syringa wolfii</i>			•			
<i>Tripterygium regelii</i>			•			
<i>Vaccinium corymbosa</i>				•		
<i>Viburnum lantana</i>		•				
<i>Viburnum lentago</i>		•				
<i>Viburnum opulus</i>		•				
<i>Weigela middendorffiana</i>			•			
<i>Weigela praecox</i>			•			
<i>Weigela florida</i>				•		

Zones >	2	3	4	5	6	7
Vines						
<i>Actinidia kolomikta</i>			•			
<i>Aristolochia macrophylla</i>			•			
<i>Celastrus scandens</i>		•				
<i>Clematis alpina</i> (syn. <i>Atragene alpina</i>)		•				
<i>Clematis alpina</i> var. <i>sibirica</i>		•				
<i>Clematis tangutica</i>		•				
<i>Lonicera caprifolium</i>				•		
<i>Lonicera periclymenum</i>			•			
<i>Parthenocissus quinquefolia</i>		•				
<i>Vitis amurensis</i>		•				

2. SPECIES SUITABLE FOR THE URBAN ENVIRONMENT

Grasslands and meadows

Dry meadows	Semimoist meadows	Moist meadows
<i>Achillea millefolium</i>	<i>Agrostis stolonifera</i>	<i>Achillea ptarmica</i>
<i>Agrostis capillaris</i>	<i>Alchemilla</i> spp	<i>Agrostis capillaris</i>
<i>Alchemilla</i> spp	<i>Anemone sylvestris</i>	<i>Agrostis stolonifera</i>
<i>Anthoxanthum odoratum</i>	<i>Campanula glomerata</i>	<i>Alchemilla</i> spp
<i>Anthyllis vulneraria</i>	<i>Campanula patula</i>	<i>Alopecurus pratensis</i>
<i>Armeria elongata</i>	<i>Campanula persicifolia</i>	<i>Anthriscus sylvestris</i>
<i>Campanula rapunculoides</i>	<i>Campanula rapunculoides</i>	<i>Briza media</i>
<i>Campanula rotundifolia</i>	<i>Dactylis glomerata</i>	<i>Caltha palustris</i>
<i>Dianthus arenarius</i>	<i>Dianthus superbus</i>	<i>Cirsium heterophyllum</i>
<i>Dianthus deltoides</i>	<i>Elymus repens</i>	<i>Deschampsia cespitosa</i>
<i>Festuca ovina</i>	<i>Festuca pratensis</i>	<i>Festuca rubra</i>
<i>Festuca rubra</i>	<i>Filipendula vulgaris</i>	<i>Filipendula ulmaria</i>
<i>Festuca trachyphylla</i>	<i>Galium mollugo</i>	<i>Geranium pratense</i>
<i>Galium verum</i>	<i>Galium verum</i>	<i>Geranium sylvaticum</i>
<i>Helichrysum arenarium</i>	<i>Geum rivale</i>	<i>Geum rivale</i>
<i>Helictotrichon pubescens</i>	<i>Geranium sanguineum</i>	<i>Inula salicina</i>
<i>Helictotrichon pratense</i>	<i>Geranium sylvaticum</i>	<i>Lathyrus pratensis</i>
<i>Hieracium pilosella</i>	<i>Geranium pratense</i>	<i>Lysimachia vulgaris</i>
<i>Lathyrus pratensis</i>	<i>Helianthemum nummularium</i>	<i>Lythrum salicaria</i>
<i>Leucanthemum vulgare</i>	<i>Lathyrus pratensis</i>	<i>Myosotis palustris</i>
<i>Linaria vulgaris</i>	<i>Leucanthemum vulgare</i>	<i>Poa pratense</i>
<i>Lotus corniculatus</i>	<i>Phleum pratense</i>	<i>Polemonium caeruleum</i>

<i>Plantago lanceolata</i>	<i>Plantago media</i>	<i>Polygonum istorta</i>
<i>Plantago media</i>	<i>Poa pratensis</i>	<i>Thalictrum aquilegifolium</i>
<i>Potentilla reptans</i>	<i>Primula veris</i>	<i>Thalictrum lucidum</i>
<i>Prunella vulgaris</i>	<i>Ranunculus acris</i>	<i>Trollius europaeus</i>
<i>Pulsatilla spp</i>	<i>Ranunculus repens</i>	<i>Potentilla anserina</i>
<i>Sedum spp</i>	<i>Taraxacum officinale</i>	<i>Valeriana officinalis</i>
<i>Scleranthus perennis</i>	<i>Thalictrum sp</i>	
<i>Senecia jacobaea</i>	<i>Thalictrum lucidum</i>	
<i>Tanacetum vulgare</i>	<i>Trifolium medium</i>	
<i>Thymus serpyllum</i>	<i>Trifolium repens</i>	
<i>Trifolium medium</i>	<i>Veronica chamaedrys</i>	
<i>Trisetum pratense</i>	<i>Veronica spicata</i>	
<i>Verbascum nigrum</i>	<i>Vicia cracca</i>	
<i>Veronica spicata</i>	<i>Viscaria vulgaris</i>	
<i>Viscaria vulgaris</i>		

Trees and shrubs

Tall street trees	Low street trees
<i>Acer platanoides</i>	<i>Acer platanoides</i> 'Globosum'
<i>Acer platanoides</i> 'Columnare'	<i>Crataegus douglasii</i>
<i>Acer pseudoplatanus</i>	<i>Crataegus levigata</i> 'Rubra Plena'
<i>Acer saccharinum</i>	<i>Malus</i> cv
<i>Aesculum hippocastanum</i>	<i>Salix pentandre</i>
<i>Alnus glutinosa</i>	<i>Salix triandra</i>
<i>Alnus glutinosa</i> 'Pyramidalis'	<i>Salix fragilis</i> 'Bullata'
<i>Betula papyrifera</i>	<i>Sorbus aria</i>
<i>Betula pendula</i>	<i>Sorbus aucuparia</i> cv
<i>Fraxinus pensylvanica</i>	<i>Sorbus hybrida</i>
<i>Juglans cinerea</i>	<i>Sorbus intermedia</i>
<i>Malus baccata</i>	<i>Sorbus thuringiata</i> 'Fastigiata'
<i>Populus alba</i> f <i>pyramidalis</i>	
<i>Populus beralinensis</i>	
<i>Populus tremula</i> 'Erecta'	
<i>Populus</i> × <i>canadensis</i>	
<i>Populus koreana</i>	
<i>Populus nigra</i>	
<i>Populus</i> × <i>wettsteini</i>	
<i>Prunus maackii</i>	
<i>Pyrus pyraster</i>	
<i>Pyrus communis</i>	
<i>Quercus robur</i>	
<i>Quercus robur</i> 'Fastigiata'	
<i>Quercus rubra</i>	
<i>Salix alba</i>	

<i>Salix × rubens</i>	
<i>Tilia × euchlora</i>	
<i>Tilia platyphyllos</i>	
<i>Tilia × europaea</i>	
<i>Tilia tomentosa</i>	
<i>Ulmus glabra</i> 'Exoniensis'	
<i>Ulmus laevis</i>	
<i>Ulmus minor</i> 'Purpurea'	
Shrubs suitable for traffic areas	Shrubs for hedges in towns
<i>Cornus stolonifera</i> 'Kelsey' (Dwarf)	<i>Aronia mitschurinii</i>
<i>Diervilla</i> sp	<i>Caragana frutex</i>
<i>Potentilla fruticosa</i> cv	<i>Cornus</i> sp
<i>Ribes glandulosum</i>	<i>Corylus avellana</i>
<i>Rubus caesius</i>	<i>Cotoneaster lucidus</i>
<i>Salix purpurea</i> 'Nana Gracilis'	<i>Crataegus</i> sp
<i>Spiraea betulifolia</i>	<i>Ligustrum tschonoskii</i>
<i>Spiraea betulifolia</i> 'Tor'	<i>Ligustrum vulgare</i>
<i>Spiraea decumbens</i>	<i>Lonicera</i> sp
<i>Spiraea japonica</i>	<i>Philadelphus</i> sp
<i>Spiraea nipponica</i> 'June Bride', 'Halvards Silver'	<i>Physocarpus opulifolius</i>
<i>Stephanandra incisa</i> 'Crispa'	<i>Ribes alpinum</i>
<i>Rubus crategifolius</i> 'Prelude'	<i>Ribes aureum</i>
<i>Salix arenaria</i>	<i>Symphoricarpos albus</i>
<i>Salix × aurora</i> (<i>S. finnmarchica</i>)	<i>Syringa</i> sp
<i>Salix actophila</i> (<i>S. glauca</i> var <i>callicarpea</i>)	<i>Taxus</i> sp
	<i>Thuja occidentalis</i> 'Brabant', 'Fastigiata', 'Pyramidalis', 'Smaragd'

Shrub roses and frost-hardy cultivars

Rosa rugosa 'F.J. Grootendorst', 'Pink Grootendorst', 'Ritausma', 'Foxi Pavement', 'Robusta', 'Pink Robusta', 'Hansa'

Rosa pimpinellifolia 'Poppius', 'Williams' Double Yellow', 'Maija Hesperia', 'Plena', 'Nils'

Other cultivars: 'Moje Hammarberg', 'Dart's Defender', 'Minette', 'Martin Frobisher', 'Maiden's Blush'

Rosa × *malyi*, *R. gallica* 'Officinalis', *R. acicularis*, *R. blanda*, *R. carolina*, *R. glauca*, *R. majalis* 'Foecundissima', *R. nitida*, *R. rubiginosa* 'Magnifica' *R.* × *rugotida*, *R.* × *spaethiniana*, *R. foetida* 'Persian Yellow'

Tolerant climbers

Actinidia kolomikta

Aristolochia macrophylla

Celastrus orbiculatus

Clematis alpina

Clematis tangutica

Clematis × *jackmanii*

Humulus lupulus

Lonicera caprifolium

Lonicera periclymenum

Parthenocissus quinquefolia

Vitis amurensis

3. DISTANCES BETWEEN HEDGE PLANTS

Planting deciduous hedges

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Acer ginnala</i> , <i>campestre</i> , <i>semenovii</i> , <i>tataricum</i> , <i>negundo</i>		0,5...0,8		0,4...0,7
<i>Amelanchier lamarckii</i> , <i>spicata</i>	1...1,5	0,8...1		
<i>Amelanchier sanguinea</i>	0,3...0,4			
<i>Aronia melanocarpa</i>	0,7...1,0	0,4...0,6		
<i>Berberis amurensis</i>	0,6...0,7	0,35...0,45		0,3...0,4
<i>Berberis koreana</i>	0,6...0,7	0,35...0,45		0,3...0,4
<i>Berberis thunbergii</i>	0,4...0,6	0,25...0,3	0,15...0,2	0,2...0,3
<i>Berberis × ottawensis</i>	0,6...0,7	0,35...0,45		0,3...0,4
<i>Berberis vulgaris</i>	0,6...0,7	0,35...0,45		0,3...0,4
<i>Buxus sempervirens</i>	0,2...0,4	0,15...0,3	0,1...0,15	0,1...0,2
<i>Caragana arborescens</i>	0,5...0,8	0,4...0,5		0,3...0,5
<i>Caragana frutex</i>	0,4...0,6	0,3...0,4		
<i>Chaenomeles japonica</i>	0,5...1,0	0,3...0,6		
<i>Cornus alba</i>	0,5...1,0	0,25...0,4		0,2...0,4
<i>Cornus sanguinea</i>	0,5...1,0	0,25...0,4		0,2...0,4
<i>Cornus stolonifera</i> 'Flaviramea'	0,6...1	0,3...0,4		
<i>Corylus avellana</i> 'Fuscorubra'	1,5...2	0,6		
<i>Cotinus coggygria</i>	0,5...0,8			

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Cotoneaster lucidus</i>	0,5...0,8	0,3...0,4		0,3...0,4
<i>Crataegus</i> sp	1,2...1,5	0,5...0,7		0,6...0,7
<i>Elaeagnus commutata</i>	1,2...1,6	0,4...0,6		0,4...0,6
<i>Euonymus alatus</i>		0,7...1,0		
<i>Euonymus alatus</i> 'Compactus'	0,5...0,7			
<i>Euonymus europaeus</i>		0,4...0,6		0,4...0,5
<i>Forsythia</i> × <i>intermedia</i> , <i>ovata</i>	0,8...1,5			
<i>Hortensia arborescens</i> , <i>paniculata</i>	0,4...0,7			
<i>Hortensia</i> <i>bredschneiderii</i>	0,7...1,2			
<i>Ligustrum vulgare</i>	0,5...0,7	0,3...0,4	0,3...0,4	0,3...0,4
<i>Lonicera alberti</i>	0,5...0,8	0,4...0,5		0,3...0,4
<i>Lonicera alpigena</i> , <i>korolkowi</i> , <i>maackii</i> , <i>xylostemum</i> , <i>coerulea</i> , <i>tatarica</i>	0,8...1,2	0,4...0,5		0,3...0,4
<i>Mahonia aquifolium</i>	0,4...0,6	0,2...0,4	0,2...0,4	
<i>Malus domestica</i> , <i>sylvestris</i> , <i>niedzwedzkyana</i> , <i>sargentii</i> , × <i>zumi</i> , <i>baccata</i>		0,5...1,0		0,4...0,7
<i>Philadelphus</i> <i>coronarius</i> , × <i>lemoinei</i>	0,6...1,0	0,6...1,0		0,4...0,6
<i>Philadelphus</i> <i>coronarius</i> 'Nana'	0,5...0,8			
<i>Physocarpus</i> <i>opulifolius</i>	0,5			
<i>Potentilla fruticosa</i>	0,4...0,6	0,25...0,5		0,2...0,4

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Prunus spinosa</i>	0,6...1,0	0,8...1,2		
<i>Pyrus communis</i>		0,5...1,0		0,5...0,8
<i>Quercus robur</i>		0,6...0,8		0,5...0,8
<i>Rhamnus catarthicus</i>		0,4...0,5		0,3...0,4
<i>Ribes alpinum, aureum, nigrum</i>	0,3...0,8	0,25...0,35		0,2...0,3
<i>Rosa pimpinellifolia</i>	0,6...1	0,6...1		
<i>Rosa rugosa</i>	0,6...1	0,6...1		
<i>Rosa glauca</i>	0,8...1,5			
<i>Rubus odoratus</i>	1...1,5			
<i>Salix alba, daphnoides, caspica, fragilis 'Bullata', purpurea</i>	1,2...2	1...1,2		
<i>Salix purpurea 'Nana'</i>	0,3...0,4	0,3...0,4	0,3...0,4	
<i>Sambucus nigra</i>	0,5...1,0			
<i>Sorbaria sorbifolia</i>	0,8...1,2	0,5...0,8		
<i>Spiraea cinerea 'Grefsheim'</i>	0,5...0,8			
<i>Spiraea japonica, betulifolia, bumalda</i>	0,3...0,4	0,15...0,3		0,1...0,3
<i>Spiraea nipponica, crenata, chamaeryfolia, douglasii, hypericifolia, media</i>	0,4...0,5	0,3...0,4		0,3...0,4
<i>Spiraea × vanhouttei</i>	0,5...0,8			
<i>Symphoricarpos albus</i>	0,4...0,6	0,25...0,45	0,25...0,45	0,2...0,4
<i>Syringa josikaea, S.villosa, S.wolfii</i>	0,7...1,0	0,6...0,8		0,6...0,8
<i>Syringa vulgaris</i>	0,7...1,0	0,6...0,8		0,6...0,8

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Tilia platyphyllos, cordata</i>		0,6...0,8		0,6...0,8
<i>Ulmus glabra</i>		1...1,5		0,5...0,8
<i>Viburnum lantana, opulus</i>	0,8...1,2			
<i>Viburnum opulus</i> 'Nanum' 'Compactum'	0,5...0,8			
<i>Weigela praecox, middendorffiana, florida</i>	1,5...2			

Planting conifer hedges

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Abies balsamea, sibirica</i>		0,6...0,8		0,4...0,6
<i>Abies balsamea</i> 'Nana'		0,3...0,4		
<i>Chamaecyparis pisifera</i>		0,5...0,8		
<i>Chamaecyparis pisifera</i> 'Minima'	0,25...0,4	0,25...0,4		
<i>Juniperus communis</i>	0,5...1,0	0,4...0,6		
<i>Juniperus communis</i> 'Suecica'	0,8...1			
<i>Juniperus communis</i> 'Hibernica'	0,5...1			
<i>Juniperus scopulorum</i> 'Blue Arrow'	0,5...0,6			
<i>Juniperus scopulorum</i> 'Skyrocket'	0,4...0,5			

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Juniperus scopulorum</i> 'Blue Arrow'	1...2	0,3...0,4		
<i>Juniperus scopulorum</i> 'Skyrocket'	1...2	0,3...0,4		
<i>Juniperus × media</i> 'Mint Julep'	120...150			
<i>Larix sp</i>		0,6...0,8		0,4...0,7
<i>Picea abies, glauca</i>	2...3	0,6...0,7	0,35...0,45	0,5...0,6
<i>Picea pungens</i> 'Argentea'	2 <	0,6...0,7	0,35...0,45	0,5...0,6
<i>Picea pungens</i> 'Montgomeri'	0,5...0,7	0,35...0,5	0,35...0,45	
<i>Picea abies</i> 'Gregoryana', 'Echiniformis'	0,5...0,7	0,35...0,5	0,35...0,45	
<i>Pinus mugo</i>	1...2	0,5...1		
<i>Pinus mugo</i> var <i>mughus</i>	1,2...1,5			
<i>Pinus mugo</i> var <i>pumilio</i>	0,8...1			
<i>Pinus pumila</i> 'Globe', 'Nana'	0,4...0,8			
<i>Taxus baccata</i>		0,2...0,4		
<i>Taxus baccata</i> 'Repandens'	1,5			
<i>Taxus cuspidata</i>		0,3...0,5	0,2...0,4	0,2...0,5
<i>Taxus × media</i> 'Densifformis'	1...1,2			
<i>Taxus × media</i> 'Fastigiata Robusta'	0,5	0,3...0,4		
<i>Taxus × media</i> 'Hicksii'	0,7...0,9	0,3...0,4		

	Informal hedge (m)	Formal hedge (m)	Border (m)	Multiple rows. Dist. betw. rows
<i>Taxus × media</i> 'Hilliit'	0,8...1,2	0,3...0,4		
<i>Thuja occidentalis</i>	0,6...1,2	0,4...0,6		0,4...0,5
<i>Thuja occidentalis</i> 'Danica'	0,3...0,5	0,2...0,4	0,2...0,4	0,2...0,4
<i>Thuja occidentalis</i> 'Pyramidalis Compacta'	1,2			
<i>Thuja occidentalis</i> 'Aurea'		0,3...0,4		
<i>Thuja occidentalis</i> 'Ellwangeriana Aurea'		0,3...0,4		
<i>Thuja occidentalis</i> 'Fastigiata'	0,4...0,6			
<i>Thuja occidentalis</i> 'Semperaurea'		0,3...0,4		
<i>Thuja occidentalis</i> 'Brabant'		0,3...0,4		
<i>Thuja occidentalis</i> 'Holmstrup'	0,8...1	0,3...0,4		
<i>Thuja occidentalis</i> 'Smaragd'	1,2	0,3...0,4		
<i>Thuja occidentalis</i> 'Tiny Tim'	0,5...0,6	0,2...0,3		

4. PROPERTIES OF SHRUBS

	Edible	Decorative	Poisonous
<i>Amelanchier spicata</i>	•		
<i>Aronia melanocarpa</i>	•		
<i>Berberis thunbergii</i>		•	
<i>Berberis thunbergii</i> 'Atropurpurea'		•	
<i>Berberis thunbergii</i> 'Aurea'		•	
<i>Berberis thunbergii</i> 'Carmen'		•	
<i>Berberis thunbergii</i> 'Erecta'		•	
<i>Berberis thunbergii</i> 'Green Carpet'		•	
<i>Berberis thunbergii</i> 'Red Chief'		•	
<i>Berberis thunbergii</i> 'Red Pilar'		•	
<i>Berberis thunbergii</i> 'Rose Glow'		•	
<i>Berberis vulgaris</i> 'Atropurpurea'	•		
<i>Chaenomeles</i> × <i>speciosa</i> 'Rubra Grandiflora'	•	•	
<i>Cornus alba</i> 'Aurea'		•	
<i>Cornus alba</i> 'Elegantissima'		•	
<i>Cornus alba</i> 'Gouchaultii'		•	
<i>Cornus alba</i> 'Kesselringii'		•	
<i>Cornus alba</i> 'Siberian Pearl'		•	
<i>Cornus alba</i> 'Sibirica'		•	
<i>Cornus stolonifera</i> 'Flaviramea'		•	
<i>Corylus avellana</i>	•		
<i>Corylus avellana</i> 'Aurea'	•		
<i>Corylus avellana</i> 'Contorta'		•	
<i>Corylus avellana</i> 'Fuscorubra'	•		
<i>Corylus avellana</i> 'Pendula'	•		

	Edible	Decorative	Poisonous
<i>Corylus maxima</i>	•		
<i>Corylus maxima</i> 'Purpurea'	•		
<i>Cotoneaster dammeri</i>		•	
<i>Cotoneaster dammeri</i> 'Skogholm'		•	
<i>Cotoneaster dielsianus</i>		•	
<i>Cotoneaster horizontalis</i>		•	
<i>Cotoneaster lucidus</i>		•	
<i>Crataegus submollis</i>	•		
<i>Empetrum nigrum</i>		•	
<i>Euonymus europaeus</i>		•	•
<i>Gaultheria procumbens</i>		•	•
<i>Hippophae rhamnoides</i> 'Botaniceskaja Lubitelskaja'	•		
<i>Laburnum alpinum</i>		•	•
<i>Laburnum anagyroides</i>		•	•
<i>Ligustrum vulgare</i> 'Atrovirens'		•	•
<i>Ligustrum vulgare</i> 'Aureovariegatum'		•	•
<i>Ligustrum vulgare</i> 'Lutea'		•	•
<i>Lonicera edulis</i>	•		
<i>Lonicera kamschatica</i>	•		
<i>Lonicera kamschatica</i> 'Pärsteigums'	•		
<i>Lonicera periclymenum</i> 'Serotina'		•	
<i>Lonicera tatarica</i>		•	
<i>Mahonia aquifolium</i>		•	
<i>Malus baccata</i> 'Brouwers'		•	
<i>Malus sargentii</i>		•	
<i>Malus toringoides</i>		•	
<i>Malus</i> × <i>purpurea</i> 'Pendula'		•	

	Edible	Decorative	Poisonous
<i>Malus × purpurea</i> 'Royalty'		•	
<i>Phellodendron amurense</i>		•	
<i>Prunus avium</i> 'Colorata'		•	
<i>Prunus cerasifera</i> 'Nigra'	•		
<i>Prunus cerasifera</i> subsp <i>divaricata</i>	•		
<i>Prunus cerasifera</i> subsp <i>divaricata</i> 'Spidola'	•		
<i>Prunus maackii</i>		•	
<i>Prunus pumila</i> var <i>depressa</i>		•	
<i>Prunus tomentosa</i>	•		
<i>Prunus virginiana</i> 'Schubert'		•	
<i>Pyracantha coccinea</i>		•	
<i>Ribes alpinum</i> 'Schmidt'		•	
<i>Ribes aureum</i>	•		
<i>Ribes aureum</i> 'Laila'	•		
<i>Ribes sanguineum</i>		•	
<i>Sambucus nigra</i> 'Aurea'		•	
<i>Sambucus racemosa</i> 'Plumosa Aurea'		•	
<i>Sorbus aria</i> 'Lutescens'		•	
<i>Sorbus aria</i> 'Magnifica'		•	
<i>Sorbus aucuparia</i> 'Granatovoje'	•		
<i>Sorbus aucuparia</i> 'Pendula'		•	
<i>Sorbus aucuparia</i> 'Red Tip'		•	
<i>Sorbus aucuparia</i> 'White Swan'		•	
<i>Sorbus intermedia</i>		•	
<i>Symphoricarpos doorenbosii</i> 'Arvid'		•	
<i>Vaccinium corymbosum</i>	•		
<i>Vaccinium corymbosum</i> 'Blue Haven'	•		

	Edible	Decorative	Poisonous
<i>Vaccinium corymbosum</i> 'Coville'	•		
<i>Vaccinium oxycoccos</i> 'Stevens'	•		
<i>Vaccinium vitis-idaea</i> 'Koralle'	•		
<i>Viburnum lantana</i>		•	
<i>Viburnum opulus</i> 'Fastigiata'		•	
<i>Viburnum opulus</i> 'Roseum'		•	
<i>Taxus baccata</i>			•
<i>Taxus baccata</i> 'Elegantissima'			•
<i>Taxus baccata</i> 'Fastigiata'			•
<i>Taxus baccata</i> 'Fastigiata Robusta'			•
<i>Taxus baccata</i> 'Semperaurea'			•
<i>Taxus baccata</i> 'Summergold'			•
<i>Taxus baccata</i> 'Washingtonii'			•
<i>Taxus cuspidata</i>			•
<i>Taxus cuspidata</i> 'Nana'			•

5. INFORMAL / FORMAL HEDGES

Conifers	Informal	Formal
<i>Chamaecyparis lawsoniana</i> 'Alumii'	•	
<i>Chamaecyparis lawsoniana</i> 'Glauca'	•	•
<i>Chamaecyparis pisifera</i> 'Filifera Nana'	•	
<i>Juniperus communis</i> 'Cracovica'	•	
<i>Juniperus communis</i> 'Hibernica'	•	
<i>Juniperus communis</i> 'Stricta'	•	
<i>Juniperus communis</i> 'Suecica'	•	
<i>Juniperus scopulorum</i> 'Blue Arrow'	•	
<i>Juniperus scopulorum</i> 'Skyrocket'	•	
<i>Juniperus scopulorum</i> 'Springbank'	•	
<i>Juniperus virginiana</i> 'Fastigiata'	•	
<i>Juniperus virginiana</i> 'Fastigiata Glauca'	•	
<i>Picea glauca</i>	•	•
<i>Picea omorika</i>	•	•
<i>Picea pungens</i> f <i>glauca</i>	•	•
<i>Pinus mugo</i>	•	•
<i>Taxus baccata</i>	•	•
<i>Taxus baccata</i> 'Fastigiata'		•
<i>Taxus baccata</i> 'Washingtonii'		•
<i>Taxus cuspidata</i>		•
<i>Taxus cuspidata</i> 'Nana'		•
<i>Thuja occidentalis</i>	•	•
<i>Thuja occidentalis</i> 'Albovariegata'	•	•

Conifers	Informal	Formal
<i>Thuja occidentalis</i> 'Aurea'	•	
<i>Thuja occidentalis</i> 'Bodmeri'	•	•
<i>Thuja occidentalis</i> 'Boothii'	•	•
<i>Thuja occidentalis</i> 'Brabant'		•
<i>Thuja occidentalis</i> 'Columna'	•	•
<i>Thuja occidentalis</i> 'Danica'	•	
<i>Thuja occidentalis</i> 'Dumosa'	•	•
<i>Thuja occidentalis</i> 'Europe Gold'	•	•
<i>Thuja occidentalis</i> 'Globosa'	•	
<i>Thuja occidentalis</i> 'Holmstrup'	•	•
<i>Thuja occidentalis</i> 'Hoveyi'		•
<i>Thuja occidentalis</i> 'Ovālā'	•	
<i>Thuja occidentalis</i> 'Rheingold'		•
<i>Thuja occidentalis</i> 'Salaspils'	•	
<i>Thuja occidentalis</i> 'Smaragd'	•	•
<i>Thuja occidentalis</i> 'Variegata'		•
<i>Thuja occidentalis</i> 'Wagneri'	•	•
<i>Thuja occidentalis</i> 'Wagneri'-lielā	•	•
<i>Thuja × plicatoides</i> 'Semperaurea'		•
<i>Tsuga canadensis</i>		•

Deciduous	Informal	Formal
<i>Amelanchier spicata</i>	•	•
<i>Berberis thunbergii</i>	•	•
<i>Berberis thunbergii</i> 'Atropurpurea'	•	•
<i>Berberis thunbergii</i> 'Erecta'	•	
<i>Berberis thunbergii</i> 'Green Carpet'	•	
<i>Berberis thunbergii</i> 'Red Pilar'	•	
<i>Berberis vulgaris</i> 'Atropurpurea'	•	•
<i>Buxus sempervirens</i>	•	•
<i>Caragana arborescens</i>	•	•
<i>Cornus alba</i> 'Aurea'	•	•
<i>Cornus alba</i> 'Elegantissima'	•	•
<i>Cornus alba</i> 'Gouchaultii'	•	•
<i>Cornus alba</i> 'Kesselringii'	•	•
<i>Cornus alba</i> 'Siberian Pearl'	•	•
<i>Cornus alba</i> 'Sibirica'	•	•
<i>Cornus stolonifera</i> 'Flaviramea'	•	•
<i>Cotoneaster dielsianus</i>	•	
<i>Cotoneaster lucidus</i>	•	•
<i>Crataegus laevigata</i> 'Paul's Scarlet'	•	
<i>Crataegus submollis</i>	•	•
<i>Euonymus europaeus</i>	•	
<i>Forsythia</i> 'Freja'	•	•
<i>Forsythia ovata</i>	•	•
<i>Forsythia</i> × <i>intermedia</i> 'Nana'	•	•
<i>Hippophae rhamnoides</i> 'Botaniceskaja Lubitelskaja'	•	
<i>Hydrangea paniculata</i> 'Grandiflora'	•	
<i>Kerria japonica</i>	•	

Deciduous	Informal	Formal
<i>Kolkwitzia amabilis</i>	•	
<i>Ligustrum vulgare</i> 'Atrovirens'		•
<i>Ligustrum vulgare</i> 'Lutea'		•
<i>Lonicera edulis</i>	•	
<i>Lonicera kamschatica</i>	•	
<i>Lonicera tatarica</i>	•	
<i>Philadelphus coronarius</i> 'Aurea'	•	
<i>Philadelphus inodorus</i> var <i>grandiflorus</i>	•	
<i>Philadelphus</i> 'Virginal'	•	
<i>Philadelphus</i> × <i>lemoinei</i> 'Erectus'	•	•
<i>Philadelphus</i> × <i>virginialis</i>	•	
<i>Philadelphus</i> × <i>virginialis</i> 'Minnesota Snowflake'	•	
<i>Physocarpus opulifolius</i> 'Darts Gold'	•	•
<i>Physocarpus opulifolius</i> 'Diabolo'	•	•
<i>Physocarpus opulifolius</i> 'Luteus'	•	•
<i>Potentilla fruticosa</i> 'Abbotswood'	•	
<i>Potentilla fruticosa</i> 'Daydawn'	•	
<i>Potentilla fruticosa</i> 'Floppy Disc'	•	
<i>Potentilla fruticosa</i> 'Fridheim'	•	•
<i>Potentilla fruticosa</i> 'Goldfinger'	•	
<i>Potentilla fruticosa</i> 'Goldteppich'	•	
<i>Potentilla fruticosa</i> 'Jolina'	•	
<i>Potentilla fruticosa</i> 'McKey's White'	•	
<i>Potentilla fruticosa</i> 'Mount Everest'	•	
<i>Potentilla fruticosa</i> 'Primrose Beauty'	•	
<i>Potentilla fruticosa</i> 'Princess'	•	
<i>Potentilla fruticosa</i> 'Red Ace'	•	

Deciduous	Informal	Formal
<i>Potentilla fruticosa</i> 'Red Robin'	•	
<i>Potentilla fruticosa</i> 'Tilford Cream'	•	
<i>Prunus cerasifera</i> 'Nigra'		•
<i>Prunus cerasifera</i> subsp <i>divaricata</i>		•
<i>Prunus cerasifera</i> subsp <i>divaricata</i> 'Spīdola'		•
<i>Ribes alpinum</i> 'Schmidt'		•
<i>Ribes aureum</i>	•	
<i>Ribes aureum</i> 'Laila'	•	
<i>Ribes sanguineum</i>	•	
<i>Spiraea betulifolia</i> 'Tor'	•	
<i>Spiraea japonica</i> 'Anthony Waterer'	•	
<i>Spiraea japonica</i> 'Arnold'	•	•
<i>Spiraea japonica</i> 'Crispa'	•	•
<i>Spiraea japonica</i> 'Foebelii'	•	•
<i>Spiraea japonica</i> 'Little Princess'	•	
<i>Spiraea japonica</i> 'Macrophylla'	•	•
<i>Spiraea japonica</i> 'Shirobana'	•	
<i>Spiraea nipponica</i> 'Snowmound'	•	•
<i>Spiraea</i> × <i>arguta</i>	•	•
<i>Spiraea</i> × <i>cinerea</i> 'Grefsheim'	•	•
<i>Spiraea</i> × <i>vanhouttei</i>	•	•
<i>Stephanandra incisa</i> 'Crispa'	•	
<i>Symphoricarpos doorenbosii</i> 'Arvid'	•	
<i>Syringa vulgaris</i> hybrid	•	
<i>Viburnum lantana</i>	•	

6. INFORMAL HEDGES

Deciduous hedges	Commonly used species	Dwarf	Low	Medium	Tall
<i>Acer</i>	<i>campestre, ginnala, spicatum, tataricum</i>				•
<i>Aesculus</i>	<i>hippocastanum</i>				•
<i>Alnus</i>	<i>glutinosa</i>				•
<i>Amelanchier</i>	<i>alnifolia, spicata</i>				•
<i>Aronia</i>					•
<i>Artemisia</i>	<i>abrotanum</i>		•		
<i>Berberis</i>	<i>thunbergii, vulgaris</i>		•		
<i>Buxus</i>	<i>sempervirens</i>	•	•		
<i>Calluna</i>	<i>vulgaris</i>	•			
<i>Caragana</i>	<i>arborescens</i>		•		
<i>Chaenomeles</i>	<i>japonica</i>	•	•		
<i>Cornus (Swida)</i>	<i>mas, alba</i>		•	•	
<i>Corylus</i>	<i>avellana, maxima</i>				•
<i>Cotoneaster</i>	<i>bullatus, horizontalis, lucidus, multiflorus</i>	•	•		
<i>Crataegus</i>	<i>alemanniensis, flabellata, horrida</i>				•
<i>Deutzia</i>	<i>lemoinei</i>		•		
<i>Eleagnus</i>	<i>angustifolia, commutata, multiflora</i>		•		
<i>Erica</i>	<i>tetralix</i>	•			
<i>Euonymus</i>	<i>alata</i>		•		
<i>Euonymus</i>	<i>europaea</i>			•	
<i>Forsythia</i>	<i>intermedia, suspensa</i>		•		
<i>Hippophae</i>	<i>rhamnoides</i>		•	•	
<i>Hydrangea</i>			•		
<i>Hypericum</i>	<i>calycinum, kalmianum</i>		•		
<i>Kolkwitzia</i>	<i>amabilis</i>		•		
<i>Laurocerasus</i>	<i>officinalis</i>		•		

Deciduous hedges	Commonly used species	Dwarf	Low	Medium	Tall
<i>Ligustrum</i>	<i>vulgare</i>		•		
<i>Lonicera</i>	<i>caerulea, kamtschatica, nitida, pileata</i>		•		
<i>Mahonia</i>		•	•		
<i>Malus</i>	<i>baccata, sargentii, toringoides, zumii</i>		•	•	
<i>Philadelphus</i>	<i>coronarius, lemoinei</i>		•	•	
<i>Physocarpus</i>	<i>opulifolius</i>		•	•	
<i>Populus</i>	<i>simonii, tremula</i>				•
<i>Potentilla</i>	<i>fruticosa</i>	•	•		
<i>Prunus</i>	<i>cerasifera, spinosa</i>			•	•
<i>Pyrus</i>	<i>communis</i>				•
<i>Quercus</i>	<i>palustris, petraea, robur</i>				•
<i>Rhamnus</i>	<i>catharticus</i>			•	•
<i>Rhododendron</i>			•	•	
<i>Ribes</i>	<i>alpinum, aureum, sanguineum</i>		•	•	
<i>Rosa</i>	<i>pimpinellifolia, rugosa</i>		•	•	
<i>Salix</i>	<i>alba, purpurea</i>			•	•
<i>Sambucus</i>	<i>nigra, racemosa</i>			•	
<i>Sorbaria</i>	<i>sorbifolia</i>		•		
<i>Sorbus</i>	<i>intermedia, koehneana, thuringiaca</i>			•	•
<i>Spiraea</i>	<i>betulifolia, japonica, nipponica, trilobata</i>		•		
<i>Stephanandra</i>	<i>incisa</i>	•	•		
<i>Symphoricarpos</i>	<i>albus, rivularis</i>		•		
<i>Syringa</i>	<i>chinensis, josikaea, villosa, vulgaris</i>			•	•
<i>Ulmus</i>	<i>procera, pumila</i>				•
<i>Vaccinium</i>	<i>corymbosa</i>	•			
<i>Viburnum</i>	<i>lentago, opulus</i>		•	•	
<i>Weigela</i>			•	•	

Conifer hedges	Commonly used species	Dwarf	Low	Medium	Tall
<i>Abies</i>	<i>koreana, sibirica, veitchii</i>				•
<i>Chamaecyparis</i>	<i>lawsoniana, pisifera</i>			•	•
<i>Juniperus</i>	<i>chinensis, sabina, virginiana</i>		•		
<i>Juniperus</i>	<i>communis</i> 'Hibernica'				•
<i>Larix</i>	<i>decidua, kaempferi, sibirica</i>				•
<i>Picea</i>	<i>abies, glauca, omorica</i>				•
<i>Pinus</i>	<i>mugo, peuce, pumila</i>			•	•
<i>Pseudotsuga</i>					•
<i>Taxus</i>	<i>baccata, cuspidata, × media</i>		•	•	
<i>Thuja</i>	<i>occidentalis</i> 'Holmstrup'			•	
<i>Thuja</i>	<i>occidentalis</i> 'Smaragd'			•	•
<i>Thuja</i>	<i>occidentalis</i> 'Tiny Tim'		•		
<i>Thujopsis</i>	<i>dolabrata</i>			•	
<i>Tsuga</i>	<i>canadensis</i>			•	
<i>Thuja</i>	<i>occidentalis</i> 'Pyramidalis Compacta'				•
<i>Thuja</i>	<i>occidentalis</i> 'Holmstrup'			•	
<i>Thuja</i>	<i>occidentalis</i> 'Smaragd'				•
<i>Thuja</i>	<i>occidentalis</i> 'Boothii'				•
<i>Thuja</i>	<i>occidentalis</i> 'Wagneri'				•
<i>Thuja</i>	<i>× plicatoides</i> 'Semperaurea'			•	
<i>Taxus</i>	<i>× media</i> 'Hillii'		•	•	
<i>Taxus</i>	<i>× media</i> 'Hicksii'		•	•	
<i>Taxus</i>	<i>× media</i> 'Fastigiata Robusta'			•	
<i>Taxus</i>	<i>× media</i> 'Densiformis'	•	•		
<i>Taxus</i>	<i>baccata</i> 'Repandens'	•			
<i>Pinus</i>	<i>mugo</i>			•	•
<i>Pinus</i>	<i>mugo</i> var. <i>pumilio</i>		•	•	
<i>Pinus</i>	<i>mugo</i> var. <i>mughus</i>			•	
<i>Juniperus</i>	<i>communis</i> 'Hibernica'			•	•
<i>Juniperus</i>	<i>communis</i> 'Suecica'			•	•
<i>Juniperus</i>	<i>scopulorum</i> 'Blue Arrow'			•	•
<i>Juniperus</i>	<i>scopulorum</i> 'Skyrocket'			•	•
<i>Juniperus</i>	<i>× media</i> 'Mint Julep'		•	•	

7. FORMAL HEDGES

Formal hedges of deciduous trees

Commonly used species		Trimming is possible but not suggested	Trimming is possible	Ideal for trimming	Height of hedge m
<i>Aesculus</i>	<i>hippocastanum</i>	•			2...10 <
<i>Alnus</i>	<i>glutinosa</i>	•			1...10 <
<i>Carpinus</i>	<i>betulus</i>			•	0,4...10 <
<i>Fagus</i>	<i>sylvatica</i>			•	0,8...10 <
<i>Malus</i>			•	•	0,5...5
<i>Populus</i>	<i>simonii, tremula</i>	•			2...10
<i>Pyrus</i>	<i>communis</i>		•		0,5...5
<i>Quercus</i>	<i>robur</i>		•	•	1,5...10 <
<i>Salix</i>	<i>alba, purpurea</i>	•			0,5...10 <
<i>Tilia</i>	<i>cordata, euchlora, tomentosa, vulgaris</i>			•	0,8...10 <
<i>Ulmus</i>	<i>procera, pumila</i>	•			1...10

Formal hedges of deciduous bushes

	Commonly used species	Trimming is possible but not suggested	Trimming is possible	Ideal for trimming	Height of hedge m
Acer	<i>campestre, ginnala, spicatum, tataricum</i>	•	•		0,5...10
Alnus	<i>glutinosa</i>	•			1...10 <
Amelanchier	<i>alnifolia, spicata</i>		•		0,5...5
Aronia			•	•	0,5...3
Artemisia	<i>abrotanum</i>		•		0,2...1
Berberis	<i>thunbergii, vulgaris</i>			•	0,3...1,5
Betula	<i>humilis, pendula, pubescens</i>	•			1...10
Buxus	<i>sempervirens</i>			•	0,1...6
Calluna	<i>vulgaris</i>		•		0,2...0,5
Caragana	<i>arborescens</i>		•	•	0,8...3
Carpinus	<i>betulus</i>			•	0,4...10 <
Chaenomeles	<i>japonica</i>		•		0,3...1
Cornus (Swida)	<i>alba, mas</i>	•			0,8...2,5
Corylus	<i>avellana, maxima</i>	•			1...4
Cotinus		•			0,5...2
Cotoneaster	<i>bullatus, horizontalis, lucidus, multiflorus</i>			•	0,3...1,6
Crataegus	<i>alemanniensis, flabellata, horrida</i>			•	0,5...5
Cytisus	<i>scoparius</i>	•			0,5...1,5
Deutzia	<i>lemoinei</i>	•	•		0,5...2
Eleagnus	<i>angustifolia, commutata, multiflora</i>		•	•	0,5...4,5
Erica	<i>tetralix</i>		•		0,1...0,3
Euonymus	<i>alata, europaea</i>		•	•	0,3...3
Forsythia	<i>intermedia, suspensa</i>		•		0,5...2

Commonly used species		Trimming is possible but not suggested	Trimming is possible	Ideal for trimming	Height of hedge m
<i>Hippophae</i>	<i>rhamnoides</i>	•			0,5...3
<i>Hydrangea</i>		•	•		0,5...1,2
<i>Hypericum</i>	<i>calycinum, kalmianum</i>		•		0,5...1,5
<i>Kolkwitzia</i>	<i>amabilis</i>		•		0,5...2,5
<i>Laurocerasus</i>	<i>officinalis</i>			•	0,4...3,5
<i>Ligustrum</i>	<i>vulgare</i>			•	0,3...2
<i>Lonicera</i>	<i>caerulea, kamtschatica, nitida, pileata</i>		•	•	0,3...3
<i>Malus</i>	<i>baccata, sargentii, toringoides, zumii</i>		•	•	0,5...5
<i>Philadelphus</i>	<i>coronarius, lemoinei</i>		•	•	0,4...3
<i>Physocarpus</i>	<i>opulifolius</i>		•	•	0,5...2,5
<i>Potentilla</i>	<i>fruticosa</i>		•		0,3...1
<i>Prunus</i>	<i>cerasifera, spinosa</i>		•	•	0,8...4
<i>Pyracantha</i>	<i>coccinea</i>			•	0,5...3,5
<i>Quercus</i>	<i>palustris, petraea, robur</i>		•	•	1,5...10 <
<i>Rhamnus</i>	<i>catharticus</i>		•	•	0,8...4,5
<i>Ribes</i>	<i>alpinum, aureum, sanguineum</i>			•	0,3...1,5
<i>Rosa</i>	<i>pimpinellifolia, rugosa</i>	•			0,3...1,5
<i>Salix</i>	<i>alba, purpurea</i>	•			0,5...10 <
<i>Sambucus</i>	<i>nigra, racemosa</i>	•			1...4
<i>Sorbaria</i>	<i>sorbifolia</i>		•		0,6...2,5
<i>Sorbus</i>	<i>intermedia, koehneana, thuringiaca</i>		•		1...6
<i>Spiraea</i>	<i>betulifolia, japonica, nipponica, trilobata</i>		•	•	0,3...2,5
<i>Stephanandra</i>	<i>incisa</i>		•	•	0,3...1
<i>Symphoricarpos</i>	<i>rivularis</i>			•	0,3...1,5

Commonly used species		Trimming is possible but not suggested	Trimming is possible	Ideal for trimming	Height of hedge m
<i>Syringa</i>	<i>chinensis, josikaea, villosa</i>			•	0,8...2,5
<i>Tilia</i>	<i>cordata, euchlora, tomentosa, vulgaris</i>			•	0,8...10 <
<i>Vaccinium</i>	<i>corymbosa</i>	•	•		0,3...1
<i>Viburnum</i>	<i>lentago, opulus</i>		•	•	0,5...4,5
<i>Weigela</i>			•		0,4...1,5

Trimmed hedges from conifers

Commonly used species		Trimming is possible but not suggested	Trimming is possible	Ideal for trimming
<i>Abies</i>	<i>koreana, sibirica, veitchii</i>		•	•
<i>Chamaecyparis</i>	<i>lawsoniana, pisifera</i>			•
<i>Juniperus</i>	<i>chinensis, sabina, virginiana</i>		•	
<i>Larix</i>	<i>decidua, kaempferi, sibirica</i>		•	•
<i>Picea</i>	<i>abies, glauca, omorica</i>		•	•
<i>Pinus</i>	<i>mugo, peuce, pumila</i>		•	
<i>Pseudotsuga</i>			•	•
<i>Taxus</i>	<i>baccata, cuspidata, × media</i>			•
<i>Thuja</i>	<i>occidentalis</i>			•
<i>Thujaopsis</i>	<i>dolabrata</i>		•	•
<i>Tsuga</i>	<i>canadensis</i>		•	

8. TREE SPECIES SUITABLE FOR POLLARDING

	Ideal for pollarding	Pollarding is possible	Pollarding is impossible
<i>Acer negundo</i>	•		
<i>Acer sp</i>			•
<i>Aesculus hippocastanum</i>	•	•	
<i>Carpinus spp</i>		•	
<i>Cercis canadensis</i>		•	
<i>Fagus spp</i>		•	
<i>Fraxinus</i>	•		
<i>Populus</i>	•		
<i>Quercus</i>	•		
<i>Robinia pseudoacacia</i>		•	
<i>Salix alba</i> 'Vitellina'	•		
<i>Salix fragilis</i> 'Belgium Red'	•		
<i>Salix sp</i>		•	
<i>Salix triandra</i> 'Black Maul'	•		
<i>Salix viminalis</i>	•		
<i>Sambucus</i>	•		
<i>Tilia</i>	•		
<i>Ulmus</i>	•		

9. TIMETABLE FOR URBAN GREEN SPACE MANAGEMENT ACTIVITIES

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
STREET TREES				
Loosen the snow under the crown	III...IV	1	-	-
Change the ties of newly planted trees	IV...V, IX...X	2	2	2
Dig over and add soil under the trees	IV...V	1	1	1
Loosen the soil under the crown	IV...VIII	5	5	5
Weeding around the trunk:				
• deciduous trees	V...VIII	5	3	3
• conifer trees	V...VIII	5	3	3
Loosening of compacted soil around the trunk, drilling the holes for air conditioning	IV...V	3	1	-
Watering of trees	V...VIII	30	20	15
Spraying the crowns of conifers with detergents	V...VIII	10	6	6
Spraying the crowns of deciduous trees with detergents	V...VIII	8	3	3
Fertilizing with organic fertilizers	IV	1	1	1
Fertilizing with mineral fertilizers	IV...V, IX	2	2	1
Adding growth regulators into the soil under the crown	IV...V	2	2	1
Formation pruning	I...III	1	1	-
Cleaning the crown	VI...VII	1	1	1/2

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
Cleaning the crown of deciduous trees:				
• pruning out dead branches	I...XII	1	1	1/2
• thinning, pruning poorly grown branches and damaged branches	IV...VIII, I...III	1	1	1/2
Removal of sprouts:				
<i>Populus, Salix</i>	V...VIII	2	1	1/2
other species	V...VIII	1	1	1/2
SHRUBS				
Loosen the snow under the shrubs	IV	1	1	1
Thinning the shrubs	IX...IV	1	1	1/2
Formation pruning				
• first 3 years	I...XII	2	1	1
• older than 3 years	I...XII	3	2	1
Rejuvenation pruning	XII...III	1/3	1/4	1/5
Fertilizing with organic fertilizers	IV...VIII	1	1	1
Fertilizing with mineral fertilizers				
• dry granules	V...VII	3	1	1
• liquid	V...VIII	3	2	1
Weed-killing and loosening soil around shrubs	IV...IX	4	3	2
Watering of shrubs	V...VIII	30	20	15
HEDGES				
Loosening the snow under hedges	III...IV	1	1	1
Trimming of formal hedges	V...VIII	4	3	2
Cleaning pruning	I...XII	3	2	1
Rejuvenation pruning	I...IV	1/2	1/4	1/5

	Time	Frequency per year or 1/n per years		
		I	II	III
NON-HARDY SHRUBS AND CLIMBERS				
Preparing for winter, tie up	X...XI	1	1	1
Mounding and insulating with special material	XI	1	-	-
Removing insulation after winter	IV	1	-	-
Untying the plants	IV	1	1	1
Tying up the climbers	IV	2	1	1
Loosening and adding extra soil	IV...V	1	1	1
Fertilizing with organic fertilizers	IV	1	1	1
Fertilizing with mineral fertilizers	IV...VI	3	1	1
Adding growth regulators into the soil	IV...VI	3	1	1
Weed-killing and loosening soil	V...VIII	5	3	3
Watering shrubs	V...VIII	15	5	5
Deadheading flowers	VI...VIII	3	1	1
Rejuvenation of shrubs	I...IV	1/4	1/4	1/5
LAWNS AND MEADOWS				
Loosening the snow, spreading it evenly over the whole area	III...IV	1	1	1
Cleaning the lawns of sand from nearby streets	III...V	1	1	1
Flushing the lawns next to streets after cleaning sand	IV...V	1	1	1
Raking leaves and rubbish from lawns, removal	IV...V	2	2	1
Raking leaves from lawns, removal				
• average amount of leaves	IX...X	8	4	2
• a lot of leaves	IX...X	10	5	2
Fertilizing with mineral fertilizers:				
• regular lawns	IV...VIII	3	3	1

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
• parterre	IV...VIII	3	3	1
Mowing, cleaning and removal of mown grass:				
• regular ones	V...IX	15	10	7
• parterres	V...IX	20	15	7
• meadows	VII, IX	2	1	1
Mowing with trimmers, cleaning and removal of mown grass:				
• regular lawns	V...IX	15	10	7
• parterre	V...IX	20	15	7
• meadows	VII, IX	2	1	1
• slopes	V–IX	20	15	7
Irrigation of lawns				
• regular lawns	V...IX	25	25	25
• parterre	V...IX	40	25	25
• meadows	VII, IX	2	1	1
• slopes	V...IX	10	10	10
Weed-killing with herbicides with selective action	IV...V, VIII, IX	1	–	–
Mulching lawns:				
• regular lawns	V...IX	3	2	1
• parterre	IV...V, IX...X	4	3	2
Recovering of trampled, winterkilled or damaged lawns	IV...X	2	1	1
ANNUALS, PERENNIALS INCLUDED GROUNDCOVERS				
Loosening the snow on flowerbeds for:				
• planted annuals and biennials	III...IV	1	1	1
• annuals grown from seed	III...IV	2	2	2

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
• groundcovers	III...IV	2	2	-
Digging the compacted soil, breaking the clods, removing stones and roots, soil levelling, installing irrigation systems in flower beds for planting:				
• annuals and biennials	IV...V, X	2	2	2
• annuals grown from seed	IV	1	1	1
• groundcovers	IV, X	2	2	-
Addition of organic fertilizers and incorporating it into the soil of flower beds	V...VI	1	1	1
Addition of mineral fertilizers with incorporating it into the soil of flower beds	V...VI	2	1	1
Planting flowers: marking the places, planting, watering, cleaning the area after planting, cleaning and removal of containers:				
• annuals and biennials	V...VI	2	2	2
• groundcovers	V...VI	2	2	-
Seeding annuals	IV...V	1	1	1
Thinning of flower plants with loosening of soil and weeding in beds of annuals sown in the ground	V...VI	2	2	2
Irrigation of flowerbeds:				
• annuals	V...IX	60	30	30
• biennials	V...IX	40	20	20
• annuals grown from seed	V...IX	60	30	30
• groundcovers	V...VIII	70	60	-
Digging up soil, checking withered stalks and roots of plants, removal and disposal of crop residues, in flower beds from:				
• annuals and biennials	V, X	2	2	2
• annuals grown from seed	IX	1	1	1
• groundcovers	V, IX	2	2	-

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
Weed-killing and loosening of soil in flowerbeds:				
• annuals and biennials	VI...IX	8	6	6
• annuals grown from seed	V...X	8	6	6
• groundcovers	VI...IX	10	8	–
BEDS OF BULBS				
Watering of flowerbeds	V...IX	15	10	10
Weed-killing and loosening of flowerbeds	V...X	8	6	6
Fertilizing with liquid mineral fertilizers	IV...VII	4	3	3
Covering the flowerbeds with peat for better wintering	X...XI	1	1	1
Removal of peat from flowerbeds	IV	1	1	1
BEDS OF BULBS				
Digging the compacted soil, breaking clods, removing stones and roots, soil levelling after digging up the bulbs	VIII...IX	2	2	–
Addition of organic fertilizers and incorporating it into the soil of flower beds	IX	1	1	–
Addition of mineral fertilizers and incorporating it into the soil of flower beds	V...VI	1	1	–
Fertilizing with liquid mineral fertilizers:				
Tulips, narcissus, hyacinth	V...VI	2	2	–
gladiolus	V...VIII	3	3	–
lilies	V...VII	3	3	–
Planting flowers: marking the places, planting, watering, cleaning the area after planting, cleaning and removal of containers:				
Tulips, hyacinth	IX...X	1	1	–
narcissus	VIII	1	1	–

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
gladiolus	V	1	1	-
lilies	VIII...IX	1	1	-
Watering of flowerbeds	V...VI; III...X	2	2	-
Weed-killing and loosening of flowerbeds	V...VI	3	3	-
Digging up bulbs:				
Tulips, hyacinth	VII	1	1	-
narcissus	VII	1/4	1/4	1/4
gladiolus	IX...X	1	1	-
lilies	VIII	1/3	1/3	-
FLOWERBEDS OF ROSES				
Watering of flowerbeds:				
• first year after planting	V...VIII	40	40	-
• following years	V...VIII	20	20	-
Weed-killing and loosening of flowerbeds:				
• first year after planting	V...VI	1	1	-
• second year after planting	VI...VII	1	1	-
• following years	VII...IX	2...6	2...5	-
Fertilizing with organic fertilizers				
• first year after planting	V...VI	1	1	-
• following years	V...VI	2	2	-
Fertilizing with mineral fertilizers				
• first year after planting	V...VII	1	1	-
• following years	V...VII	4	2	-
Pruning medium-sized roses	IV...V	3	2	-
Pruning tea-hybrid and polyanth roses	IV...V	1	1	-
Selective pruning of dead plants	VII...IX	6	5	-

	Time	Frequency per year or 1/n per years		
		Category		
		I	II	III
Removal of wild branches of roses	VI...VIII	4	3	-
Spraying roses against pests and diseases	VI...VIII	3	2	-
Pre-pruning for wintering and bending plants down	X...XI	1	1	-
Insulating rose bushes for the winter:				
mulching	X	1	1	-
covering	X...XI	1	1	-
Removal of covering, mulch and bending plants up	IV	1	1	-
Vertical gardening and flower containers:				
Loading, transport, unloading, installation at the facility in the spring and collecting in the autumn for winter storage structures of vertical flower beds, flower vases	IV...VI, IX...XI	2	2	-
Filling flower containers with drainage and soil; thickening the soil	III...V	1	1	-
Planting	IV...VII	2	2	-
Watering of flower containers after planting	IV...IX	40	20	-
Loosening the soil	IV...IX	5	5	-
Fertilizing with liquid mineral fertilizers	IV...IX	4	2	-
Deadheading flowers	V...IX	20	20	15
Spraying against pests and diseases	IV...VIII	3	1	-
Removal of impurities and washing the surface of flower containers	V...IX	15	10	-

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