

A Survey of Computerised Systems for Tree Management used by Local Authorities in the North of England

A dissertation submitted
to the

University of Central Lancashire

In particular fulfilment of the requirements
for the degree of

Bachelor of Science with Honours

In

Arboriculture

By

Robert W. Parkin

Facilities of Land Based Studies and Science

May 2003

Abstract

Abstract of a Dissertation entitled 'A Survey of Computerised Systems for Tree Management used by Local Authorities in the North of England' submitted by Robert Parkin for the BSc. (Hons.) in Arboriculture at the University of Central Lancashire in May 2003.

Computerised tree management systems are a relatively new development. There are currently a number of systems available that can perform a variety of tree management functions. In the UK, their use in Local Authorities (LAs), to manage and improve the nation's tree population is of growing interest and importance.

Previous research has identified that 50% of LAs in the UK use some form of computerised system for tree management. However, very little research has been carried out on the effects this has had and any improvements that may have arisen as a result.

A Survey of LAs in the north of England was carried out to assess the extent and uses of computerised systems, and the feelings of those who are using them.

The results indicated that 43% of LAs in the north of England are using some form of computerised system. However; there are wide-ranging differences between the different LAs. This appears to be the result of the fragmented nature of local government coupled with the lack of a national policy towards tree management. The use of computerised systems is likely to increase with time as hardware costs decrease and the need to defend against litigation and manage trees more effectively increases.

Acknowledgements

The author would like to gratefully acknowledge the assistance given to him in the writing of this work, especially the 47 busy arboricultural officers who found the time to complete the questionnaire, without their participation this survey would not have been possible. Thanks also to Dr Mark Johnson for his guidance throughout the project and also to Mr Mark Rosbotham for his statistical advice. A special thanks also goes to Jenny Longbottom and David and Pam Parkin for their proof reading skills.

Table of Contents

Chapter 1: Urban trees and their management

Introduction	1
Evolution of the computerised system	3
Advantages of using a computerised tree management system	4
Specifications of a tree management system	6
A range of systems available in the UK	9
Conclusion	10

Chapter 2: Research

Research aims	12
Survey methods	12
Format of the Questionnaire and Presentation of the Results	14
Response rate and name of the Local Authority (LA)	15
Part one, General Questions	16
Part two, Computer hardware and software	22
Part three, Evaluation	31
Part four, Local Authorities without a computerised system	34
Part five, Information gathered outside the survey	36

Chapter 3: General conclusions

References	42
Bibliography	45
Glossary of terms	46
Appendix 1. Statistical tests	47

Chapter 1: Urban trees and their management

Introduction

Man and trees have always been close associates (Davey 1909). From the earliest stages of civilisation right through to the present, trees have been utilised, not only for fuel and building material but also for shade and appearance. In urban areas trees have been planted in huge numbers for aesthetic purposes. Following the American Industrial Revolution, tree ordinances were passed calling for the planting and maintenance of trees on public rights of way and in parks (Johnston 1996). In Europe too, trees became central to city design, with the great tree lined avenues of London and Paris standing testimony to the forethought of the city planners.

There is growing evidence that trees give many benefits. Trees ameliorate a city's climate by providing shade, reducing noise, wind velocity, [the sun's] glare and by deflecting and absorbing city noises (Thurman 1983a). Studies also show that areas planted with trees have stronger community bonds, less violence, less crime and the people living in such areas generally are in better health (Kuo 1997).

Trees are a vital part of our urban environment. In order for them to flourish and continue, man must manage them (Thurman 1983b). The level of management sophistication within tree departments in the UK remains very variable. They range from one man with a pen and paper, to a large team using a fully networked computerised database and handheld data capturing devices. In many cases the difference is from town to town, depending on the political will (and the associated funding) of any given council and its policies towards the trees it maintains.

In the management of the urban forest in the UK, which is mainly the responsibility of the many Local Authorities (LAs), many methods have been used over the years. Card based systems were developed during the 1970s but these proved unworkable due to the large volume of data. They are also considered to be unsuitable for handling records on individual trees. This is because the volume of data is so great that storage, organisation and retrieval are unwieldy and time consuming. Crossen (1989) remarks that records on traditional paper based systems are impossible to analyse effectively due to the labour costs involved. The computer is now emerging to be the easiest and most efficient way to manage large tree populations. This initially led to the development of the computerised tree inventory system, which has

now evolved into the computerised tree management system as computers have become more powerful.

Comprehensive knowledge is needed on the status and performance of the urban forest in order to preserve and enhance it (Pauleit and Duhme 2000). From a budget point of view it allows managers to spend their finances in the best and most efficient ways. Local authorities are under pressure to reduce or maintain current levels of expenditure resulting in the need for increased efficiency. Planned management in terms of routine tree inspections and maintenance ensures that resources are targeted where they are most needed and problems are dealt with before they become incidents (Grainger 1989).

It is important to distinguish between simple computerised tree inventories and computerised tree management systems (Wager and Smiley 1990). The two terms have been well classified as the following; a tree inventory is a database of the individual trees containing relevant information about each tree. A tree management system includes an inventory but also has additional capabilities to combine information about individual trees into management plans, such as the ability to generate work programmes and formulated strategies (Johnston 2002). In fact there are very few purely inventory systems available, as they do not offer the benefits of a management system yet still require a huge amount of resources to set up. Record keeping is a means to better management, not an end in itself (Wagar and Smiley 1990).

In part due to advances in computer technology, there has been growth in the number of local authorities in Britain using computer management systems. In a survey of urban forestry in Britain, Johnston and Rushton (1999) found that 50% of local authorities questioned had some kind of computerised tree inventory system, leaving 50% without. Out of the trees held on such systems 90% were highway or street trees. The high number of street trees on the survey shows that in order to protect the safety of the public this area has to be maintained to a higher standard than trees in parkland. The survey also showed that authorities with large tree populations were more likely to have a computerised inventory system. This may be due to authorities with large tree populations being more likely to have a dedicated arboricultural department, although funding is also an issue. It was also found that 41% of those systems were management systems, able to formulate systemic work plans.

Evolution of the Computerised System

The use of the computer for tree inventories started in the United States during the 1970s, where many municipalities started using the basic software available. Since then there has been huge growth in the use of such systems around the world. The US continues to lead the way in this field with systems such as CITYGreen¹ that can give monetary value to the urban forest and its benefits. Being able to describe exactly how much money trees save makes it much easier to argue for the allocation of more funds to manage local authorities or municipality's trees

The United States of America has for many years been at the forefront of the international urban forestry movement (Johnston 1996). It is difficult to recall many significant recent developments in urban tree management that were not initially pioneered in America (Johnston and Rushton 1998). Therefore it is correct to assume that the use of the computerised system began there. Miller (1997) describes the development of computer systems in the US. Computer use began in the 1970s where they were seen as an opportunity to finally devise an inventory that was accessible, usable and would provide summaries of specific tree parameters. However, the costs of purchasing and maintaining these systems meant that they often had to be shared with other city departments, many of whom had higher priority for their use. It was not until the advent of the microcomputer (today's PC) that tree departments began to have their own dedicated computer systems.

As the hardware was developing, so was the software that was used on these systems. Initially individual users often developed their own programmes or had others do so. However with the availability of commercially produced programmes specifically designed for tree inventory use, it became more economical to purchase a programme and apply some local adjustments. It is now unusual to build a completely new computer program for individual use and according to Domke (1990), as far back as in 1990 it was becoming more economically viable to purchase programs from specialised vendors, with only small variations being added by the end user.

¹ See Bibliography

Smiley (1989) and Wagar and Smiley (1990) (as described by Miller 1997) describe the common functions of reviewed commercially available tree inventories then available.

- Tree data files
- Work history
- Service request files
- Data summaries
- Tree lists
- Computer mapping

As newer systems became available, more advanced features were added. With the increased ability to carry out management tasks they became known as management systems rather than the original inventory. These systems incorporated more advanced functions;

- Retrieving, displaying and reviewing records
- Creating work records
- Computing tree values
- Summarising records
- Mapping tree locations in CAD and GIS
- Graphical creation
- Cost tracking
- Forecasting future workloads

Some early surveys utilised commonly available databases such as Microsoft Works or Lotus 1-2-3 (Warrick and Williams 1993). While these systems provide an efficient way of storing numbers they were severely limited in their abilities compared to today's standards. They were, however a huge advancement at the time.

Advantages of using a Computerised Tree Management System

The management of urban trees is very difficult (Thurman 1983b). The advantage of using computers is their ability to store and display huge amounts of data quickly and efficiently. The more efficient a system is the better it can perform and as the biggest obstacle at the present time facing effective street tree management is lack of funds (Thurman 1983) the more efficient the management the better. Savings can be expected by reducing the time needed to produce the various reports and other time saving measures the computerised management system allow (Wagar and Smiley 1990). There is no alternative to computerised tree records if trees are to be managed cost-effectively (Bridgeman 1983). A computerised

system can actually save money by increasing the efficiency of the tree programme (Reeder and Gerhold 1993).

Computerised information systems will be essential tools for our future (Abbot 2000). Using a computerised management system allows for budget forecasting and an objective method of accounting for funds expended on the management of trees. Using stored computerised data, the annual costs of maintaining the tree population can be itemised, calculated and justified (Crossen 1989). By increasing the effectiveness and efficiency of management, computerised records can contribute not only to growing professionalism but also to coping with ever-present budget constraints (Wager *et al.*, 1990)

In the United Kingdom, every LA has the responsibility of maintaining an effective treescape on their property (Bridgeman 1983). As part of this, the LAs have a duty of care to persons using the areas under their control. Trees in public areas are the responsibility of LAs and must be kept in a safe condition. This in turn minimises the chances of litigation from the public due to tree failure. Crossen (1989) remarks that in the US municipalities that are shown to exercise reasonable care are in a favourable position regarding liability for damages. The same can be said for the UK. According to UK legal precedent ², cases where defendants can be shown to have carried out systematic inspection and maintenance have been acquitted, while those who have not are convicted. A landowner's most effective way to avoid litigation is to carry out a regular system of programmed safety inspections; by competent persons accurately and thoroughly recorded and where appropriate, remedial works [are] undertaken (Eden 2003). It must be remembered however that whatever the management level, trees can be unpredictable. Even an apparently sound specimen can fail if winds are strong enough (Lonsdale 1999).

In fully surveyed areas a computer management system can be used to calculate specifically local objectives. Bartsch *et al.*, (1985) explains the system used in Palo Alto, California, USA. A computer model was used to calculate the new tree planting needed for the implementation of a policy adopted by the city authorities that required that at least half of the public street be shaded at noon on the 21st of June of each year. The reasoned and planned proposals provided the justification for an 800% increase in tree planting. In other instances computerised

² Chapman v Barking & Dagenham London Borough Council. 1997,
Cunliffe v. Bankes. 1945
Kent v Marquis of Bristol. 1947 (See bibliography)

inventories have also proved useful. In Sacramento, California a computerised inventory was used to develop an integrated pest management policy (Chan and Cartwright 1979). Also, in Arbor, Michigan, USA, Basset (1978) describes a computerised study of girdling roots in different species, cultivar and their growth performance. The results were used to select better trees to plant as replacement stock. Such schemes reveal the ability of the computer to analyse data and produce meaningful results.

Specifications of a Tree Management System

Traditional survey inventories are limited to counting the trees and recording their name, location, condition, diameter breast height (DBH) (1.4m), and maintenance needs. State of the art tree management software packages allow for entry of tree information, tracking of work requests and work histories and facilitating the creation of custom reports for urban forest resource management purposes (Godfrey 2001).

In order to work effectively a system must be tuned for the job it has to perform. Of course this may vary but the majority of local authorities are likely to have similar needs. Johnston and Rushton (1999) found that of LAs that had computerised tree management systems 91% had highway trees, 58% had Park trees, 51% had open space trees, 45% local authority housing stock and 16% had tree preservation orders (TPO) trees on their systems.

Geographical data can be plotted on a plan by computer using either CAD (Computer Aided Design) or GIS (Geographical Information System). It is important to recognise the difference between these systems. CAD only allows simple querying while GIS has the same ability but with the addition of being able to interact with a database, this makes GIS much more powerful. For example, with tree survey information attached to a GIS map that includes tree points, it could be queried to find out how many trees are in poor condition or any other attribute that is recorded in the database (Godfrey 2001). It is also possible to overlay aerial photographs of an area to give a real-life view of that area.

Many modern systems now use GIS. GIS allows a survey to be combined with a geographical survey of an area allowing easier identification of specific trees. GIS allows photographs to be digitised from aerial photographs. The heads-up digitisation process uses the system mouse to delineate features from the on screen aerial photograph as either points or lines of polygons (Olig and Miller 1997). The use of a Geographical Positioning System (GPS) further allows the pinpointing of tree co-ordinates, especially as the system is becoming ever more accurate

(Byrne 2002). Global positioning systems allow rapid and accurate mapping of landscape features while the use of GIS technology allows rapid access, processing and updating of tree information (Widdicombe and Carlisle 1999). Many LAs will already have GIS systems for their lighting and highway infrastructure, it may be possible to integrate a system already in use to allow easier communication between departments and reduce costs.

The basics of an inventory are likely to include;

- Date
- Tree count
- Address
- Condition
- Tree site number
- DBH (diameter breast height 1.4m)
- Genus, Species
- Maintenance needs
- Overhead utilities (presence / absence)
- Comments
- Tree height

While management systems available are able to include the additional features;

- Tree information, TPO, Conservation area, etc
- Tree History
- Tracking of work requests and histories
- Allows custom report creation
- Summarised records
- Mapping of tree location
- Allow the creation of graphs
- Cost tracking
- Profiling of species performance
- Graphical creation
- Forecasting of future workloads
- Works ordering
- Unchangeable records (if an entry cannot be changed it can be used as evidence)
- Picture ability
- Graphical Data representation
- Mapping capabilities, GPS, GIS, CAD
- Contract preparation

Different software packages vary in their capabilities. It is important to decide what is needed when setting up a system. Before selecting a system, management goals must be decided. Unless you have clear management objectives and see how specific software would help reach these objectives, you are not ready to computerise (Wagar and Smiley 1990). Once management objectives have been established the correct data needed to effectively manage the urban forest can then be collected, bearing in mind that you do not collect data that will not be used as this will only raise the cost of surveying (Smiley and Baker 1988).

In deciding management objectives the following should be remembered. Whilst not collecting useless information, full advantage of a computerised management system should be taken, the more extensive the information it holds the more it can achieve. Rather than just storing simple tree information like an inventory, it would usually be better to utilise the power of a computer system and allow the recording of information needed to perform complex management tasks. For example, if inventory data includes fields for species diameters and tree condition ratings the Council of Tree and Landscape Appraisers (CTLA) valuation formulae can be applied (Wager and Smiley 1990) giving monetary value to the urban forest.

Data collection methods between computerised systems can vary widely. Small handheld systems can be used to input data out on the street which is uploaded to the main database later. Paper based systems can be effective and are certainly cheaper in the short term. However, most errors occur during data entry (Grainger 1989), removing the need to enter data into the main computer from hand-written survey schedules greatly reduces these errors. An investment in handheld devices may well be worthwhile in terms of man-hours and the overall accuracy of the system.

A range of systems available in the UK

Systems range in functionality from basic tree inventory to fully integrated tree and park management packages. As always, the amount spent on a system will determine the quality of the system in place.

A representative sample of systems available in the UK are;

- CONFIRM Arboriculture by SouthBank Systems Plc
- FastGROUNDS Tree Module by Innogistics Plc
- EzyTreev by R and A Software Systems LTD
- Arbotrack by Arbotrack and Tri Nova systems LTD
- Treebase from Fujikura Europe

Table 1. A comparison of system abilities, requirements and costs

	Confirm Arboriculture	Fastgrounds Tree Module	Ezytreev	Arbotrack	Treebase
Operating System	Windows based	Windows based	Windows based	Windows based	Windows based
Hardware Needed	Complete Local Area Network, PCs, portable data capturing devices	PC	PC, optional network Palm Pilot	PC, handheld data capture device	Handheld computer, optional PC, optional tags
Cost (£)	50,000	5,000 (software only)	12,000	15,000	5,000 (Software only)
OS Mapping integration	Yes	No	Yes	No	No
Additional Office programs integration	Yes	Yes	Yes	No	No
GIS/GPS	GIS	GIS	GIS optional	CAD	N/A

Whilst this does not include all the available systems it does give a good comparison of the varying abilities and costs of systems. The basic package gives little more than an inventory while the most advanced gives completely integrated computerised management. The choice of a system is of course governed by the needs of the client. While smaller populations of trees can be managed by simpler systems the large and often complex populations managed by Local Authorities require the advanced features of the more capable systems.

Conclusion

The growth in city living over the last century, while slowing and even shrinking in some parts of the developed world, is continuing in many areas, especially in the developing world. By the year 2030, for the first time in history, 60% of the world's population will be in cities (Zwingle 2002). This is continuing to, and will ultimately result in huge areas becoming built up and becoming the urban neighbourhoods that many city-dwellers live in. The introduction of suitably planted, well managed street trees would make a huge difference to the character of these areas and also has the potential to have a similar effect on the lives of people living there. The development of suitable management systems would eventually allow the effective management of such huge tree populations.

Tree locating is set to improve through increased accuracy of positioning devices such as the GPS network. Future projects like the European Galileo project, due to be launched in 2006, will boost urban GPS coverage to 95%, as well as improving accuracy and reliability overall (Byrne 2002). With improved performance of technology the ability to manage a widely distributed but highly specific resource like the urban forest is becoming more and more within the reach of limited budget organisations such as the Local Authority.

Computerised systems have revolutionised urban tree management where previously essential information was unavailable or difficult to manage (Johnston 2002). As computer tree management systems are becoming more advanced, the use of such systems is growing. Local authorities are continuing to become more and more environmentally aware, which is linked to central government's ongoing push towards a more environmentally responsible approach. This is demonstrated with compliance with Local Agenda 21 and continuing global agreements like the Kyoto Protocol 2001.

Identifying and describing the benefits of the urban forest to a community is the first step in gaining support for an urban forestry programme of tree planting, maintenance, and replacement (Dwyler and Miller 1999). Once a tree survey has been carried out and is kept up to date further analysis can be implemented. The use of GIS programmes such as CITYgreen can put an actual monetary value on the urban tree population, having definite monetary values for a resource adds great weight in budget reviews and could even convince the powers that be that more funding would be a wise decision.

While it is known that 50% of local authorities in Britain have some form of tree inventory (Johnston and Rushton 1999) the exact specifications of such systems and indeed their effectiveness is unclear. There may be many different systems being used or possibly very few. It is necessary to gauge what systems are being used, the successes, workability, reliability and the true costs of these systems. The most effective method to carry this out would be in the form of questionnaire. This allows the researcher to collect the data in an impersonal way that reduces some of the problems of influence over the respondent by the researcher that may occur in an interview (Johnston and Rushton 1998). This would be distributed to as many Local authorities throughout Britain as possible. The return of a representative sample would allow projections to be made and conclusions reached as to the condition of urban forestry management within local authorities in Britain.

The use of computerised management systems is set to increase as local authorities assess the superior tree management carried out by their neighbours with computerised systems. This will be particularly evident when a system demonstrates a clear improvement in tree management practices, resulting in better customer satisfaction, especially as the customer is ultimately the person who has voted those in a position of power into office.

There would be many advantages in having knowledge of the systems used and the successes and problems encountered with these systems. Communication and discussion is the key to effectively managing a resource such as urban trees. Knowing the state of the management systems currently in use by local councils would allow standards to be gauged and for those who are lagging behind, it would give a valuable argument to push for more resources.

Having a computerised tree survey is likely to reveal trends such as an increase or decrease in tree cover, more controversially figures such as the number of trees planted will be easily available. However; if it is easy to clearly demonstrate that although tree planting may have decreased, the overall population health and long term viability was being increased by using the budget in other areas, it would be possible to gain acceptance of such methods. Certainly trees must have some value or society would not spend money planting and maintaining them (Grey 1986). The ability of computers to simply and graphically demonstrate these points is a tool that should be used to ensure the future of the urban forest. We need to record our successes and failures. And, as we do this, we can increase the successes and greatly reduce the failures (Shigo 1991).

Chapter 2: Research

Research aims

As no survey has gained specific information on computerised system use for tree management by LAs in the UK, there is no information regarding attributes such as the number of users, types of system, funding levels, and satisfaction with systems.

Many LAs manage the urban tree population in the UK. The quality of this management is variable, depending on the policies of individual authorities. Computerised systems for management are being used in some areas. Whilst the extent of this use is known from the result of a previous survey Johnston and Rushton (1999), the particulars of this use are still largely unknown, as there has been no specific research carried out on the topic.

There would be many advantages in having knowledge of the systems used and the successes and problems faced with these systems. Communication and discussion is the key to effectively managing a resource such as urban trees. Knowing the state of the management systems currently in use by local councils would allow standards to be gauged and for those who are lagging behind, it would give a valuable argument to push for more resources.

The survey aims to gain information from a feasible number of LAs regarding their use of computerised systems for tree management. In doing so information will be gained that would also be of use for a national survey of this type. By identifying the many factors involved in the topic this survey should be able to play a part in the improvement of the urban forest in the UK.

Survey methods

Once the survey aims were identified, it was decided that social science research methods were appropriate. This was thought appropriate since studying the structure and function of local government and other organisations is a traditional area within the social sciences (Haralambos and Holborn 1995).

The survey had to be conducted within the resources available; this was the limiting factor of the target area. It was decided that the 77 LAs in the north of England would be a suitable and achievable target size for the survey. This area was defined as being the regions contained within the geographical confines of Yorkshire and both the North West and North East of England.

A questionnaire was devised that covered the subject area, asking specific questions regarding computerised systems. The questionnaire was also aimed at LAs without a computerised system, allowing some results to be obtained as to why they were without such systems.

A postal survey was decided upon as being the most appropriate and feasible method of distributing the questionnaire and for receiving the completed replies.

Participants were identified using a variety of different means. The appropriate LAs were identified using the Oultwood LG web index (See bibliography). The identified LAs were then contacted verbally using contact information available in the Tree Sourcebook (2002). The identity of the person (or persons) responsible for tree management in each LA was identified verbally by telephone and his or her participation requested, either directly or through their work colleagues. Contact details were then verified in the same manner. The survey was then addressed directly to the participant.

Further information was enclosed with the questionnaire giving details of the survey, its reasons and contact information. Completed questionnaires were returned in reply-paid envelopes.

A time period was clearly stated in the covering letter, after which those participants who had failed to reply were again contacted verbally and politely reminded to return the questionnaire.

Format of the Questionnaire and Presentation of the Results

Some of the questions were deliberately modelled (with permission) on a previous survey by Johnston and Rushton (1998), to allow comparisons to be drawn. However the majority of questions are original, so no comparisons can be carried out.

The questionnaire was designed with a number of sections. The initial section included all respondents but the later sections were two tiered, separating those without a computerised system from those with, in order to gain as much information as possible, and attempt to identify any correlating factors. A final section was added comprising of publicly available information that was gathered independently by the author.

The majority of questions were presented in a closed format, where the respondent marked the most appropriate response. The response to these questions was generally good. The remaining questions were open format, where the respondents filled in their own answers. The response rates to the open format questions were generally low. However; valuable information was received by this method.

On occasions where results are presented as the percentage frequency, the total may be over 100%. This is due to rounding-up errors or where multiple answers were received or were possible.

The results are presented broadly in the format they were asked in the questionnaire, except in a few instances where they have been grouped to enable the results to be compared.

In most cases the results have been categorised, this is useful for statistical analysis and also the grouping of similar responses.

Data was manipulated and analysed using the following software - Snap 6, Minitab, MS Excell and MS Works. Statistical analysis was carried out using chi-squared tests, and relationships are not reported unless they were significant at the 5% level.

Response rate and name of the Local Authority (LA)

Information collected on individual LAs by this survey was for analytical purposes only. Assurances were given to all respondents that replies would be kept in confidence, with no individual information being released at any time in the future without the prior approval of the persons involved.

All the Local Authorities in the north of England were targeted. This was defined as being the regions contained within the geographical confines of Yorkshire and both the North West and North East of England. A reasonable balance was achieved in the response, although the North East was slightly under-represented by the replies received.

Total LAs targeted: 77

North East	22	(28.6%)
North West	43	(55.8%)
Yorkshire	12	(15.6%)

Total LAs responding: 47 (61%)

North East	9	(19.1%)	from 22	(40.9%)
North West	29	(61.7%)	from 43	(67.4%)
Yorkshire	9	(19.4%)	from 12	(75.0%)

Part one, General Questions

This section was aimed at all participants; aiming to gain some insight into the working conditions of those involved.

1. Staff Numbers

The number of arboricultural staff, as a full time equivalent employed by LAs.

Average 2.2

Standard deviation 1.8

Range 0-7

The responses were then classified into the following for analytical purposes.

Table 2. Staff numbers, in full time equivalent

No of Staff	
0	4.3%
0.5	6.4%
1	31.9%
2	23.4%
3	12.8%
4	4.3%
5	4.3%
6	4.3%
7	4.3%
Did not state	4.0%

Conclusions,

This shows that the majority of LAs maintain only a small number of arboricultural staff, with arboricultural duties often only being part time duty. However a significant minority maintain higher levels of staff, showing that low staff numbers are not always the case. In many LAs arboricultural staff levels are a residual post, with many LAs simply maintaining their long-standing staffing levels.

2. Department Titles

Respondents were asked to list the relevant departments where arboricultural officer (and other staff) were based. The results were then classified according to Johnston and Rushton (1998) into the following broad groups. The percentage total of over 100% is because some LAs have staff in multiple locations.

Table 3. Department titles (1)

Department	
Leisure/Recreation/Parks/Horticulture	36.2%
Environmental Services	23.4%
Planning/Development	44.7%
Others	34.0%

The grouping did not fit the responses well as the ‘other’ category was excessively large. The following classification system was devised.

Table 4. Department titles (2)

Department	
Planning/Regeneration	40.4%
Countryside/Grounds maintenance/Recreation/Parks/Leisure/Amenity services	46.8%
Development/Environment/Direct services	23.4%
Technical/ Commercial services	8.5%
Others- Housing/District assemblies/Ranger services/Local projects/Neighbourhood services	14.9%

Conclusions,

The majority of tree officers are grouped under various leisure, parks and amenity management headings. A significant number also come under various planning headings, with others attached to the most relevant departments within the LAs.

3. Strategy Document

The existence of a strategy document that applied to trees was assessed.

Table 5. Existence of a strategy document

Response	
Yes	38.3%
No	55.3%
Did not state	6.4%

Conclusions,

The existence of a strategy document gives an indication of the organisation levels within the LA. The fact that the majority are without such a document indicates the lack of planned management towards trees within LAs.

4. Budget

The LAs total tree budget was asked. This included the salaries and wages of all in-house staff.

Average	£246,708
Standard deviation	£349,581
Range	£15,280 – £1,600,000

The responses were divided into the following categories for analytical purposes.

Table 6. Funding levels

Budget	
Below £100,000	19.1%
£100,000 - £199,999	23.4%
£200,000 - £299,999	8.5%
£300,000 - £399,999	0.0%
£400,000 - £499,999	4.3%
£500,000 - £599,999	2.1%
£600,000 - £999,000	0.0%
Over £1,000,000	4.3%
Did not state	38.3%

Conclusions,

There is a huge variance in the budgets. This variance indicates that there are no national standards towards tree budgets, with individual LAs setting their own tree budget. This is without any clear idea of the appropriate funding levels needed to maintain a healthy tree population. The fact that 38% did not state the level of funding they receive reflects the guarded attitude adopted by many towards revealing their budget.

5. Satisfaction with funding

Respondents were asked to rate their satisfaction with the LAs tree budget.

Table 7. Satisfaction with funding

Satisfaction Rating	
Very satisfactory	2.1%
Satisfactory	25.5%
Unsatisfactory	51.1%
Very unsatisfactory	12.8%

Conclusions,

The majority (63.9%) of tree officers were not satisfied with their budget. Interestingly there is no correlation between the size of the budget and the rating given. It is likely that budgets are not increased beyond the level where the increased finances only result in further work being identified, leaving the feeling of an unobtainable objective. Only massive funding increases can address this. It is also possible that there will always be dissatisfaction with funding, whatever the level. Interestingly the only respondent to the ‘very satisfactory’ category was by an LA with an advanced computerised system.

6. Number of street trees

Street trees were identified as being the tree population that LA would most likely hold records on. The LAs were asked the number of these trees that they were responsible for.

Average population	38,548
Standard deviation	98,421
Range	0 - 447,000

For analytical purposes the replies were classified in the following

Table 8. Number of street trees

Number of street trees	
Below 50,000	59.6%
50,000 – 99,999	0.0%
100,000 – 149,999	0.0%
150,000 – 199,999	0.0%
200,000 – 249,999	0.0%
250,000 +	6.4%
Did not state	35.0%

Conclusions,

The majority of LAs were responsible for less than 50,000 street trees. There is some huge variation in numbers though. It is disturbing that 35% of respondents did not answer this question. This indicates that a large number of LAs do not have any idea of the number of street trees within their responsibility. Interestingly, the higher populations were those with advanced management systems.

6.1 Reliability of records

LAs that responded to question 6 were also asked if the figure they gave was an estimate or a known figure.

Table 9. Reliability of street tree records

Response	
Estimate	53.3%
Known figure	14.9%
Did not state	31.8%

Conclusions,

The majority of LAs do not have any reliable figures for their street tree data. 85% of LAs have no definitive idea of the numbers of street trees they are responsible for.

7. Tree surveys

Respondents were asked to detail the state of tree surveys. The question was divided into 8 tree categories. There were four options for each category, sample, partial, full and no survey.

For the purposes of this survey, a sample survey is a representative survey of an entire tree population and a partial survey is a non-representative survey of part of an area

Table 10. Tree survey details

Tree classes	Full	Sample	Partial	None
All trees and woodland, both public and private	2.1%	6.4%	23.4%	68.1%
All local authority trees and woodland	2.1%	8.5%	36.2%	53.2%
Highway (street) trees	23.4%	8.5%	38.3%	29.8%
Park trees	4.3%	8.5%	53.2%	35.0%
Open space trees	0.0%	6.4%	46.8%	46.8%
Local Authority woodland	4.3%	8.5%	29.8%	57.4%
Local Authority housing stock	10.6%	6.4%	17.0%	66.0%
Trees and woodland in private ownership, non-TPO	2.1%	8.5%	10.6%	78.8%

Conclusions,

The results indicate the poor state of record keeping by tree departments. There is much scope for improvement, with only 1 LA having a full tree survey of all the trees in its area. Highway and park trees are among the most surveyed populations. This is possibly due to legal reasons, with LAs having a duty of care to people on their land, most of which by definition is publicly accessible.

Part two, Computer hardware and software.

With the exception of question 1 this section comprises of the responses of those with a computerised system.

8. Computerised systems

Respondents were asked if they used any type of computerised system for tree management. Those without were directed to part four of the questionnaire.

Table 11. Use of computerised system

Response	
Had a computerised system	42.6%
Were without a computerised system	57.4%

Conclusions,

The results are marginally lower than found by Johnston and Rushton (1999), who found a 50% use rate of a computerised system. However, the survey carried out by Johnson and Rushton was nation-wide while this survey is limited to the north of England. The results can only serve to show that the use of computerised systems is below the national average in the north of England and not as an indication of an overall decrease in the use of computerised systems. There remains a significant minority who do use computerised systems for at least part of their tree management.

9. Computer programmes

Respondents were asked to detail the computer programmes that they used. The responses were then grouped into the following.

Table 12. Software programmes used

Programme	
Amenity trees	5%
Cartology	5%
Microsoft access based	25%
Microsoft excel based	10%
Confirm Arboriculture	10%
Arbortrack	5%
Map info	5%
Ezytreeve	10%
Fujicura	5%
Mayrise	5%
Trimble GEO	5%
Developed their own systems or did not state	10%

Conclusions,

It is clear that while the majority of users have purchased a commercially produced computerised system, a significant minority (35-45%) have developed a system using software that is commonly available. These systems do not require purchasing or considerable additional expense (see question 14). This indicates that users recognise the advantages of a computerised system but are often unable to obtain a dedicated arboricultural management software package. This leaves them having to tailor the programs that are available to them.

The level of sophistication between systems varies significantly. Due to a lack of data about the different levels of sophistication it is difficult to assess the exact abilities of the specific systems. However roughly 50% of those with a computerised system can be said to have a sophisticated management system.

10. System functions

Respondents were asked to detail the functions they used. The variable responses meant that the responses were then classified into three categories. These were; basic tree inventory details that recorded individual tree information, and two further categories that investigated computer use as more of a management perspective. These were customer enquiry details and works order / scheduled works generation.

Table 13. System functions

Function	
Tree inventory details – Location, site, species, condition, history etc	90%
Customer enquiry details	20%
Works order / Scheduled works generation	65%

Conclusions,

As would be expected, the highest use is to store repetitive, high volume data. However; there is considerable use for management categories such as the works order generation and to a lesser degree customer enquiry details, which gives an indication that more advanced, management systems being used.

11. Installation year

Table 14. Computerised system installation year

No. of systems	Year	No. of systems	Year
1	1983	3	1998
1	1993	4	1999
0	1994	2	2000
0	1995	0	2001
2	1996	3	2002
0	1997	1	2003

- 3 did not state

Conclusions,

The number of computer systems being installed is increasing with time. This may be due to an ongoing decrease in the cost of hardware. Comparing this to the survey carried out by Johnston and Rushton (1999) indicates the use of computer systems in LA tree management is increasing with time.

12. System updates

Respondents were asked if they had purchased any updates of hardware or software.

Table 15. Updates to system

Response	
Yes	35%
No	65%

Of the 7 respondents who had responded yes:

Table 16. Type of update applied

Update type	
Software	100.0%
Hardware	16.7%

Conclusions,

This shows that only a small minority of LA's have updated their system. If this is looked at with the results of question 11 this suggests that the lack of updates is probably because many of the systems are still very new. The lack of updates may also indicate that the systems are reliable.

13. Location of system

The location of the computerised system within the LAs departments was asked to gauge the extent of system integration.

Table 17. Location of system

Department(s)	
One department	75%
Two or more departments	15%
Networked computer system	10%

Conclusions

The majority of LAs had the system based in one department. Of those who did have networked systems certain functions, such as graphics were unavailable on some parts of the system. The networked systems were part of advanced systems. It is unfortunate that more LAs do not utilise computer networks to enable other LA departments to quickly assess the impact of trees on their operations.

14. Initial setting up cost

Respondents were asked the cost of setting up the system counting hardware, software and technical support.

Average	£11,980
Standard deviation	£6,544
Range	£2,300 – £20,000

Table 18. Initial setting up cost of computerised systems

Cost	
below £5,000	10%
£5,000 - £9,999	10%
£10,000 - £14,999	5%
£15,000 - £19,999	10%
£20,000 plus	10%
In-house development	35%
Did not state	20%

Conclusions,

A large number (35%) of respondents were unsure of the cost of setting up the system as it was developed ‘in-house’ often using commonly available software as a base (see question 9). This type of development indicates that there are not the resources available to purchase dedicated systems, with staff being forced to develop their own as and where they can.

Another 35% of respondents had spent over £5,000 on their systems, with 10% spending £20,000 or more. This shows that there are some authorities who give trees a high priority and funding accordingly. The average cost of a computerised system was almost £12,000.

The funding given to LA tree departments ranges from £15,280 – £1,600,000 (see question 4), at the present funding levels a computerised inventory would be impossible for some tree departments.

15. Annual running cost

The yearly cost of running the system was asked. This was limited to hardware, software and technical support. The responses were categorised for analytical purposes.

Average	£1,924
Standard deviation	£756
Range	£1,000 - £3,000

Table 19. Annual running cost

Cost	
Below £1,000	5%
£1,000 - £1,999	20%
Part of other packages	50%
Did not state	25%

Conclusions,

As a large number of systems are part of a wider package it is impossible to quantify the specific results. However those who did reply gave some indication that running even the most advanced systems costs less than £2,000 annually.

Half of respondents were unable to give a response to this question as the software they used was part of a wider package, used by many departments within their LA (see questions 9 & 14).

16. Data collection

Respondents were asked the methods they used to collect data on their tree populations.

Table 20. Data collection systems

System	
Paper based system	65%
Portable data capture devices	50%
Did not state	0%

Conclusions,

While the majority still use paper based methods, half of those using computerised systems used some form of portable data capturing devices. In some cases both methods are run simultaneously. There are advantages to both methods of data collection. The use of

portable devices eliminates the chances of human error that is always a possibility when entering data collected by paper methods. This reliability comes at an increased cost. Portable devices may be worth the investment, as the accumulated costs of manual data input and the possible consequences of any errors will more than offset the cost over time. Another encouraging factor is that all those using data capturing devices felt they were reliable (see question 25).

17. Training (recommended)

Respondents were asked what level of training was recommended for new users by the system supplier.

Table 21. Recommended training duration

Training duration	
Day	30%
Week	15%
On the job	40%
Other	15%

Conclusions,

The large number (45%) of suppliers recommended some level of formal training while another 40% adopted an 'on the job' approach, with another 30% recommending a single day of instruction. Only a very small number recommended a long period of instruction, this was for the more advanced systems. The respondents to the 'other' category were those who had developed an 'in-house' system and as such required no formal training.

18. Training (actual)

Respondents were asked to state the actual training given to new users of the system.

Table 22. Actual training duration

Training duration	
Day	25%
Week	0%
On the job	70%
Other	5%

Conclusions,

The majority who received on the job training reflects the likelihood that there will be limited new users to the system and where there are new users they will be trained to use the system by the other system users. Also the lack of any users being given a week of training possibly reflects the lack of funding. It is unfortunate that all new users to a system do not receive full formal training, as the quality of 'on the job' instruction is likely to be variable. The full potential of a system may not be realised and bad practices may be allowed to continue without some independent period of instruction.

19. Tree classes

Respondents were asked what types of trees they held on the system.

Table 23. Tree classes held on computer systems

Tree class		Average no.	Standard deviation	Range
Highway (street) trees	75%	7,966	7,025	500- 20,000
Park trees	50%	4,061	4,600	500 - 9000
Open space trees	50%	3,792	6,635	500 - 20,000
TPO trees	30%	630	265	390 - 1,000
LA housing stock	45%	3,060	1,983	1,000 - 6,800
Schools	20%	6,325*	5,245*	1,000 - 15,000*
Social services	20%	n/a	n/a	n/a
other	15%	n/a	n/a	n/a

*Figures for 'schools', 'social services' and 'other' categories are combined as all three were combined in the original questionnaire and therefore cannot be differentiated between.

Conclusions,

The tree populations on the systems reflect the trees that are the highest priority for LAs. this is related to their duty of care and obligations to keep highways clear. The differences in the 'range' category is considerable. This is a reflection of the resources available, with those having more resources typically having higher numbers of trees on their systems. This would indicate that many LAs are unable to identify and manage all the trees they have responsibility for.

Part three, Evaluation

20. System reliability

Respondents were asked to rate the reliability of their system.

Table 24. Reliability of computer system

Response	
Very reliable	15%
Reliable	75%
Unreliable	0%
Very unreliable	5%
Did not state	5%

Conclusions,

The results indicate that the vast majority of systems are considered to be reliable by the people using them. This is encouraging, as reliability is an absolute necessity for a system of this type. The fact that many systems are based on other commonly available software (see question 9) may affect this.

21. Improvements to tree management

Respondents were asked if they felt that having a computerised system had improved tree management.

Table 25. Affects of computerised systems on tree management

Response	
Improved tree management greatly	20%
Improved tree management	70%
No affect	5%
Did not state	5%

Conclusions,

The vast majority felt that having a computerised system had improved management. No respondents felt that a computerised system had been detrimental to tree management. This response demonstrates that using a computerised system is an effective tool to improving tree management.

22. Improvements to service

Respondents were asked if they felt that having a computerised system had improved the service they provide to the public.

Table 26. Affects of computerised systems on service

Response	
Felt strongly yes	20%
Felt yes	65%
Felt no	5%
Felt strongly no	5%
Did not state	5%

Conclusions,

The vast majority felt that having a computerised system had improved the service they provide. In the one case where the response was negative this was due to funding for data entry being withdrawn before the system was fully functional, leaving the system unusable.

23. System recommendations

Respondents were asked if they would recommend the system they are currently using to another LA similar to theirs.

Table 27. Recommendation of system to other LAs

Response	
Yes	75%
No	20%
Did not state	5%

Conclusions,

The majority are happy with their systems to the extent they will recommend it to others.

The negative responses to this question were all from LAs who had developed their own systems. These systems by definition would be limited in their usefulness to other authorities, being specifically tailored for use by an individual authority.

24. Ease of use

Respondents were asked how easy the system was to use.

Table 28. System ease of use

Response	
Easy	25%
Moderately easy	75%

Conclusions,

All the users felt that the system was easy to use. The lack of negative replies reflects the general user-friendliness of windows-based software

25. Portable data collection devices

The 8 users of portable devices rated their reliability

Table 29. Reliability of portable data collection devices

Response	
Very reliable	12.5%
Reliable	87.5%

Conclusions,

All the respondents felt that portable devices were reliable.

This was the end of the questionnaire for those with a computerised system.

Part four, LAs without a Computerised System

26. Type of inventory kept

Respondents were asked what type of tree inventory was maintained.

Table 30. Type of inventory

Inventory used	
None	40.7%
Paper/card based	55.6%
Did not state	3.7%

Conclusions,

The results indicate that those without a computerised system did not have an improved way of managing their tree population, with many lacking any form of tree inventory at all.

27. Satisfaction with current system

Respondents were asked if they were happy with their current system.

Table 31. Satisfaction with current system

Response	
Yes	18.5%
No	77.8%
Did not state	3.7%

Conclusions,

The vast majority were not satisfied with their current system. This suggests that management with a computerised system is the only feasible way of managing large numbers of urban trees.

28. Opinions of computerised systems

Respondents were asked if they felt a computerised system would be beneficial.

Table 32. Opinion of a computerised system

Response	
Yes	96.3%
Did not state	3.7%

Conclusions,

The vast majority felt that a computerised system would be beneficial. It is likely that those without a computerised system would welcome any increase in resources that enables them to improve their situation. However; the results overall indicate that there is vast scope for the expanded use of computerised systems.

Part five, Information gathered outside the survey

In order to minimise the number of questions respondents had to complete; and for purposes of data reliability, general information about the LAs was gathered independently from the Municipal Yearbook Directory (2002). The data in this section covers 100% of the populations surveyed as the information was gathered without the need for a response.

29. LA population size

Full Results

Average	152,214
Standard Deviation	114,645
Range	24,992 – 680,722
Sum	11,568,229 people

Table 33. Population size

No of people in LA	
Under 100,000	34.0%
100,000 - 199,999	46.8%
200,000 - 299,999	12.8%
300,000 - 399,999	0.0%
400,000 - 499,000	2.1%
500,000 - 599,999	0.0%
600,000 - 699,999	2.1%
Unavailable	2.1%

Conclusions,

The majority of LAs surveyed have populations below 200,000 people, many living in urban or city areas where the ‘urban forest’ has a significant role in their living environment.

On a broader scale, the ‘urban forest’ in the north of England affects the environment of over 11,000,000 people.

30. Land area (hectares)

Full Results

Average	41,453
Standard Deviation	47,725
Range	4,325 – 222,096
Sum	3,150,445

Table 34. Land area of LAs

Area (hectares)	
Under 20,000	48.9%
20,000 - 39,999	14.9%
40,000 - 59,999	10.6%
60,000 - 79,999	4.3%
80,000 - 99,999	6.4%
100,000 - 119,999	6.4%
120,000 - 139,999	4.3%
140,000 - 159,999	2.1%
160,000 - 179,999	0.0%
180,000 - 199,999	0.0%
200,000 - 119,999	0.0%
220,000 - 239,000	2.1%

Conclusions,

Many LAs have small areas (under 40,000 hectares), but there is a significant variation in land size.

Larger areas were shown to be less likely to have a computerised system (See appendix 1. Test 1) although these areas are likely to be rural and have low populations, with the associated lower resources. These areas also have a smaller proportion of street trees, possibly reducing the need for such a comprehensive system.

31. LA Type

The type of LA of respondents was recorded

Table 35. LA Type

LA type	
Unitary	29.8%
Borough	23.4%
Metropolitan	10.6%
City	8.5%
District	27.7%

Conclusions,

There is good spread between unitary, borough and district councils. Metropolitan and city councils are less well represented, reflecting their lower frequency in the survey area.

Statistical analysis indicated that unitary councils are more likely to have a computerised system (See appendix 1. Test 2). A national survey would have to be carried out to confirm this. This finding should be viewed with caution, as the largest type of LAs in this survey were unitary authorities.

Chapter 3: General Conclusions

The reliability of the data contained in the responses can and should be questioned. It is reasonable to assume that in any survey of this kind many of the cities [(or LAs)] which bother to respond are those with more advanced urban management thus giving a more optimistic picture than in reality is the case (Johnston 1996). However; in this case, as the majority of the surveyed population replied; and with less than half of respondents fitting the requested criteria; the balance of replies can be considered to be representative. The level of computer use is also similar to that found by Johnston and Rushton (1999).

The population surveyed was too small to distinguish most statistical trends. Exhaustive statistical testing has proved inconclusive and unsafe due to lack of data. As the response rate was good the only conclusion can be that the target size was too small, and should be extended in any future survey.

In order to gauge the full extent of computer use and to allow reliable statistical analysis, a similar survey is needed on a national scale, including all authorities that have any responsibility for tree management. Similarly, in order to discuss the individual strengths and weaknesses of the many computerised systems a larger sample size is necessary than was attempted in this survey.

The most significant factor affecting the use of computerised systems for tree management appears to be political will. There are very few, if any correlating factors governing the likelihood of a LA using a computerised system for tree management. This can only be explained by the independent actions of different governing bodies affecting their own individual areas.

Linked to political will is the funding that goes with it. Funding is the most significant factor that affects the management of trees in LAs. The levels of funding vary enormously, depending on the area, political will and local policy.

The existence of strategic documents regarding trees gives an indication of systematic management. Only 38.9% of responding LAs had such a document. The absence of which gives an indication of a lack of a systematic approach towards trees by the majority of LAs.

All the respondents who had large street tree populations also had advanced tree management systems. This gives an indication that the majority of LAs do not have any realistic idea of the number of trees they are responsible for. This results in an underestimate of tree numbers through ignorance. Without reliable surveying it is impossible to know the numbers of trees involved. County Councils are responsible for street trees in some areas, but this is true of only a small number of cases. Unfortunately this survey only included local levels of government. However; identifying the tree management role played by higher levels of government is important for any future research of this type.

The management of trees through contractual arrangement was also not considered for this survey. LA tree departments managed by commercial companies were outside the scope of this survey, and as such could not be included.

A large number of LAs would financially qualify for the American tree city scheme, were it introduced here. The scheme aims to highlight areas where trees are managed in a sustainable and sensible manner through a number of criteria. Having a similar scheme in the UK would give recognition on a national scale to LAs who manage trees well. The scheme would also demonstrate correct ways to manage tree populations to poorly managed areas, who would then have an incentive to improve their practices.

In 35-45% of cases computerised systems are being developed with the adaptation of existing software. Whilst this does not involve any additional expense, the question is raised as to how much the real cost would be if tree officer time were factored into the equation. It is unfortunate that this is necessary, as there are a number of reliable systems available that do not cost large sums of money and will pay for themselves in the long term through increased performance. This type of development indicates that there are not the resources available or forethought in higher management to allow the purchase of dedicated systems.

Although transitional phases can cause problems, and systems are only as good as the information recorded on them, the overall benefits of a computerised system are clear. Respondents described the following advantages of having a computerised system. They give LAs the ability to reassure the public that work will be carried out at a specific time, reduce site visits, allow readily available customer information that is up-to-date to be in

one place, eliminate duplicates (with their associated potential for confusion), and generally allow less reliance on paperwork.

A computerised system means a systematic approach can be adopted, and financial projections can be made. This means that pruning and maintenance regimes can be maintained, tree population statistics can be produced and analysed. Allowing, amongst others benefits, the monitoring of age and size classes and the evaluation of tree works.

It is possible to increase professionalism through greater accountability due to records that can be audited. It is also possible to defend against litigation and insurance claims through the same reliable records.

LAs have financial figures for all other resources they own and manage. It is possible to obtain a monetary figure for an LA's road network or street light infrastructure. Why then do LAs not attach a financial figure to trees? It is ludicrous that many LAs do not even know the number of trees in their area of responsibility, let alone the value of this precious resource. Now the technology exists to accurately obtain this information, the means to gather it should be put in place

The future promises to see an improvement in tree management practices in LAs. This will be brought about by a number of factors. The public's perception of their environment continues to increase. Comparisons with well-managed areas are inevitable, with the likelihood of future demands being made to reach these standards in many more areas.

There is a need for LAs to ensure the safety of the trees they are responsible for. As many of the trees planted in large Victorian era construction projects reach the end of their life span, the number of possibly dangerous trees is growing. These trees must be well managed, as when defects are not identified the repercussions can have fatal consequences.

Tree management in the north of England affects the living environment of over eleven million people. The funding given to the trees that make up a large part of their living environment is small by comparison. It is time to give trees the recognition they deserve, allowing those who manage them to get away from the 'fire-fighting' approach of tree management that has prevailed for so long. This would leave them free to develop a sustainable; well managed tree population.

References

Abbot, R (2000) *The Future of Urban Forestry*. City Trees - The Journal of the Society of Municipal Arborists Vol. 36 no 4 July/August 2000

Bartsch, D Hook, J Prince, E Schrom, D (1985) *Using Computer Simulation to Plan a Sustained-Yield Urban Forest*. Journal of Forestry vol 83 pp372-375

Basset, J, B (1978) *Vegetation Inventories: Need and Uses*. Proceedings National Urban Forestry Conference ESF Ppu 80-003 Syracuse :SUNY pp 632-644 Cited in: Miller, R W (1997) *Urban Forestry, Planning and Managing Urban Greenspaces*. Second ed, Prentice hall, inc ISBN 0134585224

Bridgeman, P (1983) *Computerisation of Tree Inventories*. (edited by Bickmore and Hall), A B Academic Publishers ISBN 0907360092

Byrne, G (2002) *Global Fix*. New Scientist Magazine Vol. 174 issue 2341 4th May 2002 pp32

Chan, F, J and Cartwright, G (1979) *Tree management Aided by Computer*. Journal of Arboriculture 5:1 pp 16-20 Cited in: Miller, R W (1997) *Urban Forestry, Planning and Managing Urban Greenspaces*. Second ed, Prentice hall, inc ISBN 0134585224

Crossen, T,I (1989) *The management of urban street trees using computerized inventory systems*. Journal of Arboriculture 15:1 pp1-5

Davey, J, (1909) *The Salvation of our Trees*. The Davey Tree Expert Co, Kent, Ohio, USA. In: Shigo, A, L (1991) *Modern Arboriculture*. Shigo and Trees Associates, Durham, New Hampshire USA. ISBN 0943563097

Domke, D, A (1990) *The Development of Computerised Plant Management Systems: The Role of the Manager*. Journal of Arboriculture 16:7 pp179-181

Dwyer, M, C and Miller, R, W (1999) *Using GIS to Assess Urban Tree Canopy Benefits and Surrounding Distributions*. Journal of Arboriculture 25:2 pp102-107

Eden, N (2003) A '*liability*' too far? Essential ARB (magazine) 8:2-3 Spring 2003

Grey, D (1986) (reprinted 1992) *Urban Forestry*. Krieger Publishing Company, Florida, USA ISBN 0894647040

Godfrey, C, G (2001) *GIS and GPS in Urban Forestry*. City Trees - The Journal of The Society of Municipal Arborists. Vol 37 no 3 May/June 2001

Granger, D (1989) *The Role of Computers in Managing the Urban forest*. Urban Forests (Journal) 1:7

Haralambos, M and Holborn, M (1995) *Sociology, Themes and Perspectives* fourth edition. Collins Educational Cited in: Johnston and Rushton (1998) *A Survey of Urban forestry in Britain, Part I: Aims and Method of Research*. Arboricultural Journal 22:129-146

Johnston, M (1996) *A Brief History of Urban Forestry in the United States*. Arboricultural Journal 20 pp257-278

Johnston, M (2002) *BSc Arboriculture Lecture notes*. Module: Management of Tree Growth and Function (unpublished)

Johnston, M and Rushton B, S (1998) *A Survey of Urban Forestry in Britain, Part I: Aims and Methods of Research*. Arboricultural Journal 22:129 pp129-145

Johnston, M and Rushton, B,S (1999) *A Survey of Urban Forestry in Britain*. University of Ulster, Northern Ireland

Kuo, F, E (1997) *Trees, Aggression and Urban Violence*. City Trees - The Journal of The Society of Municipal Arborists Vol 33 no 6 November/December 1997

Lonsdale, D (1999) *Principles of Tree Hazard Assessment and Management*. HMSO publications ISBN 0117533556

Miller, R, W (1997) *Urban Forestry, Planning and Managing Urban Greenspaces*. Second ed, Prentice hall, inc ISBN 0134585224

Municipal yearbook directory (2002), Hemmingway Information Services ISBN 0707970318

Olig, A, G and Miller, R,W (1997) *A Guide to Street Tree Inventory Software*. USDA forest Service Urban Forestry Centre for the Midwestern States <http://www.na.fs.fed.us/spfo/pubs/uf/streettree/toc.htm> (accessed 11/2002)

Pauleit, S and Duhme, F (2000) *GIS Assessment of Munich's Urban Forest Structure for Urban Planning*. Journal of Arboriculture 26:3 pp133-140

Reeder, E, C and Gerhold, H (1993) *Municipal Tree Programs in Pennsylvania*. Journal of Arboriculture 19:1 pp13-19

Shigo, A, L (1991) *Modern Arboriculture*. Shigo and Trees Associates, Durham, New Hampshire, USA. ISBN 0943563097

Smiley (1989) *Computer Software for Urban Forest Management: A Buyers Guide*. Cited in: Moll, G and Ebenreck, S (Eds) *Shading our Cities* Washington DC Island Press. Cited in: Miller, R W 1988 *Urban Forestry, Planning and Managing Urban Greenspaces* Second ed, Prentice hall, inc ISBN 0134585224

Smiley, E, T and Baker, F,A (1988) *Options in Street Tree Inventories*. Journal of Arboriculture 14:2 pp36-42

Thurman, P, W (1983a) *The Management of Urban Street Trees using Computerised Inventory Systems*. Arboricultural journal 7 pp101

Thurman P, (1983b) *Computerisation of Tree Inventories*. (edited by Bickmore and Hall), A B Academic Publishers ISBN 0907360092

Tree sourcebook (2002) Published by Treesource, Stillingfleet, York. ISBN 0954359402

Wager, A and Smiley, E T (1990) *Computer assisted management of urban trees*. Journal of Arboriculture 16:8 pp209-215

Warrick, R B and Williams, C, F (1993) *A Computerised Tree Inventory System for Small Cities using Lotus 1-2-3*. Journal of Arboriculture 19:3 pp39-142

Widdicombe, R, C and Carlisle, B (1999) *Geographic Information and Global Positioning Systems of Tree Management*. Journal of Arboriculture 25:3 pp175-178

Zwingle, E (2002) *Megacities*. National Geographic Magazine Vol. 202 No5 November 2002

Bibliography

Case history of

- Chapman v Barking & Dagenham London Borough Council. 1997
- Cunliffe v. Bankes. 1945
- Kent v Marquis of Bristol. 1947

Available at http://www.aie.org.uk/resources/aie_db_law.html (Accessed 18/2/2003)

CITYgreen A powerful GIS application for land-use planning and policy-making. The software conducts complex statistical analyses of ecosystem services and creates easy-to-understand maps and reports. CITYgreen calculates dollar benefits based on your specific site conditions.

- <http://www.americanforests.org/productsandpubs/citygreen/> (Accessed 19/2/2003)

Oultwood Local Government (LG) web index <http://www.oultwood.com/index.html>
(Accessed 02/2003)

Glossary of Terms

CAD	Computer Aided Design
Conservation Area	An area protected under English Law, primarily to ensure building preservation but also affects trees.
DBH	Tree Diameter at Breast Height (1.4m)
‘field’	In computerised inventories a refers to a specific type of recorded information such as a trees or many trees height or location.
Galileo	A proposed European version of the American GPS system
GIS	Geographical Information System
GPS	Global Positioning System
TPO	Tree Preservation Order

Appendix 1. Statistical Tests

Test 1. Area by Likelihood of having a computerised system

Chi-Square Test

Expected counts are printed below observed counts

	yes	no	Total
1	13	10	23
	9.50	13.50	
2	6	17	23
	9.50	13.50	
Total	19	27	46

$$\text{Chi-Sq} = 1.289 + 0.907 + 1.289 + 0.907 = 4.394$$

$$\text{DF} = 1, \text{P-Value} = 0.036$$

Appendix 1. Statistical Tests (continued)

Test 2. LA type by likelihood of a computerised system.

Chi-Square Test

Expected counts are printed below observed counts

	Yes	No	Total
1	11 5.96	3 8.04	14
2	3 4.68	8 6.32	11
3	3 2.13	2 2.87	5
4	1 1.70	3 2.30	4
5	2 5.53	11 7.47	13
Total	20	27	47

$$\text{Chi-Sq} = 4.268 + 3.162 + 0.604 + 0.447 + 0.358 + 0.265 + 0.290 + 0.215 + 2.255 + 1.670 = 13.533$$

DF = 4, P-Value = 0.009

5 cells with expected counts less than 5.0