A METHODOLOGY FOR ASSESSING AND MANAGING BIODIVERSITY IN STREET TREE POPULATIONS: A CASE STUDY

by Michael F. Galvin

Abstract. As a consequence of compacted soils, impervious surfaces, heat irradiation, pollution, and other stresses, urban trees have an average expected service life of 10 to 25 years. Most public agency budgets for street tree replacement and maintenance are declining. Public tree managers need tools to prolong the service life of street tree populations while reducing the need for maintenance activities (including pruning and pest management). Many jurisdictions rely on "approved tree" lists, but these often contain large numbers of species generally unavailable in a given area, and filters for diversity are seldom part of these documents. To avoid catastrophic losses and pest outbreaks associated with virtual monocultures, the Maryland Department of Natural Resources has developed a methodology for assessing biodiversity in existing populations. An inventory is taken. The results of the inventory are broken down taxonomically by family, genus, and species; The results are then analyzed, with target levels established as follows: no more than 30% of any one family, 20% of one genus, or 10% of one species should be present. Based on the results of the assessment, recommendations are made as a tool for use in future replacement contracts to bring about the desired species composition.

Key Words. Biodiversity; street tree populations; street tree inventory.

The benefits of trees in urban or populated areas are well documented. They are variable and far reaching, including improving urban aesthetics, improving wildlife habitat (Schwaab et al. 1995), sequestering carbon and removing pollutants from the atmosphere (McPherson et al. 1994), reducing building energy use for cooling and heating (Akbari et al. 1992), mitigating the "heat island" effect through evapotranspiration and shading (United States Department of Energy 1992), and reducing domestic violence (Sullivan and Kuo 1996). However, as a consequence of compacted soils, limited rooting volume, impervious services, heat irradiation, pollution, and other stresses, urban trees have an average expected service life of 10 to 25years (Urban 1989). Though this situation would indicate a need for significant maintenance and replacement funding to maintain street tree canopy in urban areas, the average municipal tree budget has dropped from $4.14 per capita in the year 1986 to $2.49 per capita in 1994 (amounts have been adjusted for inflation for the period described), a 40% reduction (International Society of Arboriculture 1995). With increased management needs and reduced funding available for management, public agency tree managers need tools that will allow them to prolong the service life of public street tree populations while reducing the amount of tree maintenance, tree removal, and tree replacement needed.

The problems encountered when street tree Populations consist of monocultures or virtual monocultures have been demonstrated by the major losses experienced by jurisdictions that over planted American elm *(Ulmus americana)* or 'Bradford' pear (Pyres *calleryana* 'Bradford'). In the case of American elm, huge losses were experienced with the spread of Dutch elm disease *(Ophiostoma ulmi)* (Nannini et al. 1998). 'Bradford' pear was bred for a number of characteristics, including disease resistance; however, the tree tends to grow with a structural defect whereby multiple primary branches originate from a single point on the main stem, resulting in included bark, multiple codominants, and large limb or whole tree failure as the tree matures. This cultivar became a maintenance problem in many areas (W L. Ackerman 1995, personal communication; Sissini et al. 1995).

These cases, and others like them, have shown that as most serious pests or problems are specific to certain families, genera, or species of plants, a key to sustainability in urban forests lies not in the selection of any single cultivar with a particular set of characteristics but in biological diversity within populations in order to minimize plant maintenance needs and losses.

METHODS

Methods for applying models for urban forest sustainability have been described (Clark et al. 1997; Clark and Matheny 1998). Urban forest management plans have also been generated in some jurisdictions (McPherson and Luttinger 1998), but the methodology is not as standardized as is that for traditional forest management plans.

In the spring of 1996, the Maryland Department of Natural Resources-Forest Service began an effort to establish a procedure for generating urban forest management plans in Maryland. Using the United States Department of AgricultureForest Service's *An Ecosystem-Based Approach to Urban and Community Forestry* (USDA-Forest Service and Center for Urban Forestry 1994) as a foundation, the process of identifying components to incorporate into the overall plan was undertaken These items included a public tree inventory, along with a street tree biodiversity analysis and integrated pest management recommendations based on the inventory data.

SITE SELECTION

Mount Rainier, Maryland, was selected as the pilot site for the program. The city has an established and active tree commission; the city's mayor, town administrator, and public works director are all involved with and supportive of the city's urban forestry programs. They have demonstrated their commitment by the city's recognition by the National Arbor Day Foundation and the State Forester as a Tree City USA since 1989.

Mount Rainier is a municipality in a highly urbanized area in eastern metropolitan Washington, DC, directly abutting the District of Columbia. Located in Prince George's County (population approximately 750,000), Mount Rainier's population is 7,950. The jurisdiction maintains approximately 11 mi (18 km) of roadway, on which the street trees described in the inventory are found. The area is predominantly residential and is dominated by detached single-family homes; most streets have threephase utility lines with cross-arm construction on at least one side of the street and tree lawn widths of from 3 to 4 ft (0.9 to 1.2 m). These factors limit the suitable species for much of the city's potential street tree planting sites to small scale trees, or mediumscale trees with decurrent branching.

SITE INVENTORY

The trees were inventoried between June 12 and June 21, 1996. The inventory was conducted by an intern under the supervision of a Maryland DNR Forest Service Chief Ranger. The following information was recorded: street name, address, tree type, tree dbh, tree condition (good, fair, poor, dead), presence of overhead utility lines, presence of sidewalks, presence of stakes requiring removal, and comments. The jurisdiction later obtained a copy of TreeKeeper Jr.® tree management software for managing the data obtained in the inventory.

DATA ASSESSMENT

Frank Santamour has previously described a method for managing diversity in urban plantings; this is referred to as "the 10-20-30 formula"(Santamour 1990). The formula states that for maximum protection against pest outbreaks, the urban forest should contain no more than 10% of any single tree species, no more than 20% of any tree genus, and no more than 30% of any tree family.

The data collected in the inventory were broken down and tallied by species, genus, and family. The results are shown in Figure 1 and Table 1. Recommendations were then made for future species composition, and pest management recommendations were provided based on present species composition.

RECOMMENDATIONS

The analysis showed, with one notable exception, a fairly well-balanced population. Use of red maple *(Acer rubrum)* should be suspended until population

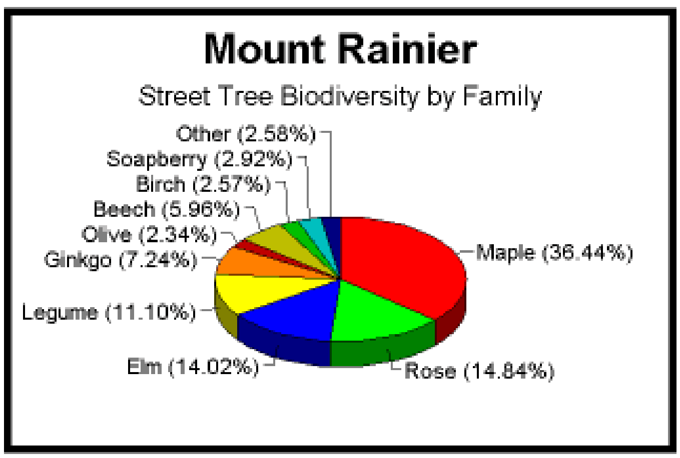

Figure 1. Street tree diversity by family.

Table 1. Street tree population by family, genus, and species.

Family	% of total	Genus	% of total	Species	# of trees	% of total
Aceraceae		*Acer*		*rubrum*	293	34.23
Aceraceae		*Acer*		*saccharinum*	14	1.64
Aceraceae		*Acer*		*saccharum*	2	0.23
Aceraceae		*Acer*		*palmatum*	1	0.12
Aceraceae	36.45	*Acer*	36.45	*platanoides*	2	0.23
Rosaceae		*Pyrus*	9.46	*calleryana*	81	9.46
Rosaceae		*Prunus*		unknown	44	5.14
Rosaceae	14.84	*Prunus*	5.37	*cerasifera*	2	0.23
Ulmaceae		*Ulmus*	11.80	*americana*	101	11.80
Ulmaceae	14.02	*Zelhova*	2.22	*serrata*	19	2.22
Leguminosae		*Sophora*	2.80	*japonica*	24	2.80
Leguminosae		*Gleditsia*	7.71	*triacanthos*	66	7.71
Leguminosae	11.10	*Cercis*	0.58	*canadensis*	5	0.58
Ginkgoaceae	7.42	*Ginkgo*	7.24	*biloba*	62	7.24
Fagaceae		*Quercus*		*rubra*	22	2.57
Fagaceae		*Quercus*		*phellos*	25	2.92
Fagaceae		*Quercus*		*palustris*	3	0.35
Fagaceae	5.96	*Quercus*	5.96	*rubra borealis*	1	0.12
Sapindaceae	2.92	*Koelreuteria*	2.92	*paniculata*	25	2.92
Betulaceae	2.57	*Carpinus*	2.57	*caroliniana*	22	2.57
Oleaceae		*Fraxinus*	1.40	*pennsylvanica*	12	1.40
Oleaceae	2.34	*Syringa*	0.93	*reticulata*	8	0.93
Hamamelidaceae	1.17	*Liquidambar*	1.17	*styraciflua*	10	1.17
Malvaceae	0.35	*Hibiscus*	0.35	*syriacus*	3	0.35
Platanaceae	0.35	*Platanus*	0.35	*x acerifolia*	3	0.35
Bignoniaceae	0.23	*Catalpa*	0.23	*bignonioides*	2	0.23
Cornaceae	0.12	*Cornus*	0.12	*florida*	1	0.12
Cupressaceae	0.12	*x Cupressocyparis*	0.12	*leylandii*	1	0.12
Nyssaceae	0.12	*Nyssa*	0.12	*sylvatica*	1	0.12
Salicaceae	0.12	*Salix*	0.12	*alba*	1	0.12

levels account for a maximum of 50% of all maples (currently 94%) and 10% of total street trees (currently 33%). Maples should account for no more than 20% of the total street tree population. When the maple population dips below these levels, replacement should be undertaken with a variety of species rather than continue over-reliance on A. rubrum.

Current callery pear (Pyrus calleryana) levels should not be exceeded. This is a known problem species and is present at the maximum recommended level. Purpleleaf plum (Prunus cerasifera 'Atropurpurea') may be increased to up to 10% of total population.

As American elm levels decline, they may be replaced with resistant hybrids, zelkovas (Zelkova serrata, or lacebark elms (IJlmus parvifolia), while maintaining Mmus levels at no more than 20% of the total population and zelkova populations at no more than 50% of U1mus population.

Honeylocust (Gleditsia triacanthos) (7.52%) and ginkgo (Ginkgo biloba) (7.06%) may be increased moderately to 10% of the total population. There is a

Table 2. Recommended species for future street tree plantings in Mount Rainier.*

Family	Genus	Species
Aceraceae	*Acer*	*buergerianum*
Aceraceae	*Acer*	*ginnala*
Aceraceae	*Acer*	*palmatum*
Betulaceae	*Ostrya*	*virginiana*
Cornaceae	*Cornus*	*alternifolia*
Hippocastanaceae	*Aesculus*	*pavia*
Leguminosae	*Maachia*	*chinensis*
Leguminosae	*Cladrastis*	*lutea*
Magnoliaceae	*Magnolia*	*virginiana; various* cultivars
Oleaceae	*Chionanthus*	*virginicus*
Oleaceae	*Syringa*	*reticulata*
Rosaceae	*Amelanchier*	*arborea; canadensis;* various cultivars
Rosaceae	*Crataegus*	various cultivars
Rosaceae	*Malus*	various cultivars w/ persistent fruit
Rosaceae	*prunus*	*x yedoensis*

*Note: All types listed to be incorporated into current populations within the constraints of the 10-20-30 filter.

noticeable lack of oaks (5.81 %) in the inventory. This is likely due to the small tree lawns (3 to 4 ft [0.9 to 1.2 m]) on most streets and the presence of overhead utility lines. Oaks may be planted in any locations where space allows (minimum 4-ft [1.2-m] tree lawn; no overhead utility lines), to a maximum of 20% of the total population.

Some replacement types not found in the inventory, which are small to medium in scale and will increase diversity, are listed in Table 2.

SUMMARY

To insure the sustainability of urban forests, management and replacement costs must be minimized. "Approved tree" lists normally have no numerical restrictions; virtually all users could, and in some places do, plant only a small number of the cheapest, most readily available species from such lists. The model provided here requires no special software or equipment other than a reference that includes information on taxonomy. Spreadsheet programs do make the analysis easier; however, this can easily be performed on any of the commonly available spreadsheet packages.

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