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Evaluation of the greenery in historic park in Beladice-Beladice, Slovakia

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Abstract

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The work is a part of broader research of historic parks in the South-western region of Slovakia. Beladice is a small village 20 km from Nitra; composed of 4 former villages; the largest one carries the name Beladice. In each of them there is a manor surrounded by a park. Late baroque styled manor rebuilt at the end of 19th century has had an added functionalistic wing since 20th century. Park laid out on 6.6 ha and 2.4 ha was last time treated by Michal Strnad in 1906-07. In 2012 a plant inventory of the whole park was made using an author's method. 800 trees, 35 shrubs and 65 groups of natural seedlings have been evaluated. Altogether 67 taxa were identified; from which 36 are broad-leaved trees, 23 conifers and 8 shrub species. The result of the stock taking is felling proposal for the ill, dangerous and compositionally unsuitable trees. The average health state of the trees is 3.55; their average compositional value is 3.25 and 50% of the plants should be removed due to the overgrown outplantings and lack of maintenance for over last 20 years.

Keywords

historic park, Beladice-Beladice, plant inventory, Slovakia

Introduction

Historic parks represent a specific art of cultural heritage of mankind; their particularity is based on their vividness, they still grow and without a proper long lasting and never ending maintenance they would decay. In fact decaying of a park is in confrontation with the return of the nature. It would overrule the human made composition, sometimes artificial, sometimes demanding, but usually culturally valuable and always intentional. So keeping up of a historic park can be considered as a fight against but still with the nature itself (Supuka et al., 2008).

Tree inventory methods are being developed for many purposes which affect their characteristics, parameters or even profundity and accuracy. As it is very human demanding and time consuming work which can only be done by professionals equipped by botanic and other scientific skills, it is not very common and widely used tool. Its importance on the other hand is broadly recognized, still not sufficiently well financially covered. There is significant difference between American and European approach. As Americans (DiSalvo, 2011) are oriented more on species, genus and families identification; size (defined by diameter in breast height), condition (fair, good, poor and dead), stocking level (potential planting spaces), replacement values (full cost of replacing trees in their current condition) and aesthetic and environmental benefits (Energy savings, Carbon sequestration, Air quality improvement, Storm water processing); European methods differ in separate countries, but are more or less more scientifically oriented (all parameters are measured or qualified by points). English tree stock taking method resembles more American ones (Ciesielski, 2011) as they are oriented similarly just on tree size (diameter in breast height), species composition, tree diversity and vulnerability, tree mortality (wood condition,

leaves condition, percentage of deadwood), new outplantings withstanding and pests infestation. Similar to continental approach is presence of maintenance recommendation and remark on sidewalk damages or overhead wires.

We would like to present our approach to tree stock taking methods and their application in praxis. Tree inventory methods used in our region are based more on scientific assessment. Result of the work would be valuable information about dendrological composition of a hundred-year-old park.

Material

As the material of this work can be considered the complete 6.6 ha area of the historic park in village Beladice, local part Beladice (48°20′21″N, 18°17′55″E; 48.339167°, 18.298611°) together with the area of former agricultural school situated in the manor house with 2.4 ha park; finally the area of a cooperative farm neighbouring with the area of the school was not included although in the past it was a part of the manor just with economic use (stables, vegetable garden and so on). According to *Atlas Slovenskej republiky. Landscape atlas of the Slovak Republic*, Miklós, 2002, the village Beladice-Beladice is in warm climatic region, moderately dry with mild winter. Mean annual precipitation is 550–600 mm; mean annual air temperature is 9–10 °C. There are brown soils, phytogeographically area belongs to Žitavská pahorkatina and potential vegetation is *Carici pilosae-Carpinetum* and partially *Ulmenion*; in shorter words – hardwood alluvial forest.

The material itself were just woody plants growing in these two parts which are separated by a fence, owner and also by use. Historic park serves as a free public village area for short term recreation; also it has a transitional character as it is situated between two parts of the village (Beladice and Pustý Chotár). Second part of the park belonging to the school is completely fenced with no access to the public; it is little bit decayed as it has already been abandoned for several years with pure maintenance; it has a private owner.

Originally a renaissance manor house built in 1620, was in 18th century replaced by a late baroque styled manor house; this was at the end of 19th century reconstructed to mostly today's appearance. Also a Szentivanyi family mausoleum situated in the school park was built at this time but in romantic neo-renaissance style. Manor is also equipped with yard with an agricultural function, interesting terrace with pergolas and a glasshouse. During socialistic times a functionalistic wing was added to the manor house needed for school purposes (Kubišta, 2004).

Park itself was probably founded like formal garden with a parterre, but at the end of 19th century was re-stylized and enlarged into romantic landscape park. It still keeps the composition of its gardener Michal Strnad from Topolčany, but after last 20 years with no or very low village maintenance it is already overgrown, with plenty of naturally seeded trees (natural seedlings) aged exactly 10 or 20 years. These trees are already endangering the old ones planted in a composition of an English park. As it was fashionable in 19th century the park was enriched by exotic trees as *Ginkgo biloba* L., *Phellodendron amurense* Rupr., golden pine (*Pinus sylvestris* L. just with yellowish needles), *Liriodendron tulipifera* L. or *Gymnocladus dioicus* (L.) K. Koch. But the most interesting tree was till recent years over 300-year-old *Tilia platyphyllos* Scop.; unfortunately surviving now only like a torso of formerly the hugest tree in the park, this title is now carried by a *Platanus hispanica* Mill. A massive trunk of dead *Fraxinus excelsior* L. overlies a small lake creating a natural bridge. Since 1982 the park has been proclaimed as a Protected Area (Kubišta, 2006).

Methods

The stock taking was done in February 2012, in a dry and cold weather; it was following the geodetic survey using digital gages which needed the deciduous plant without foliage because of high density of plants in inventoried area. As a main method for woody plants inventory, author's method developed for historic greenery was chosen – Kubišta (2008), which is developed out of Machovec (1982) plants inventory methods. Stock taking is conditioned with exact geodetic survey of items position. To each item a set of information expressing their parameters is collected. According to used inventory method can be collected information divided to four types: identification data, characterisation data, evaluation data and operation data.

Identification data is especially the Item Code (IC) consisting of a letter expressing a kind of inventoried plant (T, tree; B, bush, shrub; S, natural seedling…) and a number expressing order of inventoried item (T01, B02, T03…). These Item Codes are marked not just in inventory tables but also in inventory maps to present a real position of the inventoried item. The most important part of identification data is the Name of inventoried item consisting of Latin genus, species and possibly also cultivar name of the plant (for example: *Picea pungens* Glauca).

Characterisation data concerns two types of data; first type is a professional guess of the age of inventoried plants in years set in categories (0–10, 10–20, 20–40, 40–60, 60–80, 80–100, 100–150, 150–200,…). Age guess results from an assumption that average tree ring gain is 0.5 cm per year, so in diameter 1 cm on average stand of medium growing tree (Table 1). According to

this assumption also other stand and tree growth groups can be guessed. Second type are dendrometric data as the height of the plants in meters set in categories each 2 and later 5 m high (0–2, 2–4, 4–6, 6–8, 8–10, 10–12, 12–14, 14–16, 16–18, 18–20, 20–25, 25–30, 30–35, 35–40,…), the trunk diameter in centimeters set in categories each 20 cm wide (0–10, 10–20, 20–40, 40–60, 60–80, 80–100, 100–120, …) and finally the crown diameter in meters set in categories each 2 wide (0–2, 2–4, 4–6, 6–8, 8–10, 12–14, …). All dendrometric data can be measured precisely. The height can be guessed or measured with hypsometer or digital gage. Trunk diameter can be guessed or precisely measured with forestry calliper usually in 1.3 m trunk height (so called breast height). Crown diameter is measured in two orthogonal measurements with a measuring tape; the result is always an average value of these two measurements. The accuracy of measurements is sufficient for the historic park renewal projects, as the number of inventoried items is very high and necessary time always short.

Evaluation data is the most scientific part of the plant inventory; it needs long lasting experiences and is not easily describable. There are just two parameters, first is Compositional Value and second is Health State. Although their name seems to be easily recognizable, they are not. Compositional Value logically presents a value of the plant in particular composition, this concerns characteristics like originality of the tree in the composition, location, suitability, proportionality, usability and in some cases also connectivity and inclusiveness (Table 2). All these parameters have 6 degree values (0, 1, 2, 3, 4, 5) representing the percentage of monitored characteristics at each inventoried item. Finally the compositional value is an average value of all these monitored parameters rounded to the closest whole number (0–5).

Compositional value depends on following characteristics of inventoried items:

- *Originality* traces whether the item belongs to the original composition, when it became a part of the composition, or how it fits with its style.
- *Location* checks whether the items position was changed, whether it was moved or removed.
- *Suitability* checks whether the item is suitable in existing composition, whether it fits in there, whether it disturbs or whether it is suitable for the specific use.
- *Proportionality* checks whether the elements have its composed dimensions, whether they are not overgrown or whether their size was set correctly.
- *Utizability* traces whether the particular item is legitimate in the composition, whether there is a reason for its preservation.
- *Connectivity* observes in relevant cases overlap of tree crowns or bushes.
- *Inclusiveness* checks missing items in alee, in bosquets, or in hedges etc.

Health state values are set similarly like Compositional value (0, 1, 2, 3, 4, 5); they show the real condition of the plant item. The parameters of the Health state are the size, typicalness, viability, damage, safety and sustainability. There can also be set other ones according the needs of stock taking (Table 3). Health state is then an average value of all these monitored parameters rounded to the closest whole number (0–5). They are usually the same degree like Compositional value; just in several cases they can be completely opposite. For example very old tree connected with a legend or standing solitarily in formal parterre can have very high Compositional value but the Health state could be very low because of high age.

Health state monitors condition characteristics of inventoried items:

- *Size* shows items of environmental conditions; whether it is flourishing there or declining.
- *Typicalness* is also an expression of environmental conditions during items ontogenesis or human impacts. In bad conditions plants do not achieves typical habitus or growth.
- *Viability* checks health problems like diseases, dry branches, illness changes, pest occurrence. It also monitors the vitality of growth, leaves size, plant growth increase and so on.
- *Damage* checks wounds, inclination, bad human interventions and environment exposition causing the lowering of health state.
- *Safety* evaluates safety risks of items presence in particular composition for visitors.
- *Sustainability* checks the perspective of items endurance in particular composition, its endangerment and resistance.

Operational data set the future of inventoried items following the evaluation data. They are the most important data in stock taking; divided to data influencing the restoration budget (arrangement) and explanation data (comments). Arrangement is an act proposal; it sets the best suitable solution for each inventoried item. There are several acts like felling in 1st phase, felling in 2nd phase, chemical treatment, trimming or other. All of them have a specific price in the budget; according to inventory the preparatory costs can be completely set. Comments do not influence the budget, they just explain the reasons of felling (compositional, health, safety), or display specific growth characteristics of a plant (inclination, trunk disposal and so on), or specify disease, pest or damage (fracture, cavity, decay, fungus and other). Also the compositional position can be displayed closer (solitaire, alee, hedge, vegetation border, vegetation); or mutual influence between plants (incline because of another tree, common crown of more plants); also importance of the plant in composition (dominant) or just interesting undergrowth vegetation which can be used in composition (perennials, bulbs).

Table 1. Age guess according to plant and trunk diameter

Stand / Plant growth	Fast growing plants	Medium growing	Slow growing plants	Dwarf growing plants
Nourishing stand	X – 2	X – 1	X	X + 1
Average stand	X – 1	X	X + 1	X + 2
Poor stand	X	X + 1	X + 2	X + 3

X, measured trunk diameter category (0–10, 10–20, 20–40, 40–60, 60–80, 80–100, 100–120, …); +/–, lowering or increasing of age categories about 1, 2 or 3 categories, just when it is possible, in higher age categories (100–120 and over) is age guess disputable.

Table 2. Compositional value

Parameter / Degree	0	1 (0–20%)	2 (20–40%)	3 (40–60%)	4 (60–80%)	5 (80–100%)
Originality	Naturally grown plants	Unoriginal composition, planted	Close to original composition	Original composition	Identical species in original composition	Original plant from original plantings
Location	Missing item, stump…	Unoriginal location	Expected unoriginal location	Approximately original location	Assumed original location	Original location
Suitability	Completely unsuitable item	Unsuitable item	Rather unsuitable item	Mostly suitable item	Suitable item	Ideally suitable item
Proportionality	Unpreserved	Rather unpreserved	Suppressed	Almost preserved	Preserved	Ideally preserved
Utizability	Illegitimate	Unnecessary	Almost unnecessary	Rather necessary	Necessary	Legitimate
Connectivity	Unconnected	Almost connected, 0–20% overlap	Mostly connected, 20–40% overlap	Connected, 40–60% overlap	Connected, 60-80% overlap	Connected, 80-100% overlap
Inclusiveness	Completely missing item	0–20% rate	20–40% rate	40–60% rate	60–80% rate	Complete, 80–100% rate
…	Resultant Compositional value is an average of all parameters values rounded to closest whole number (0, 1, 2, 3, 4, 5)					

Table 3. Health state

Parameter / Degree	0	1 (0–20%)	2 (20–40%)	3 (40–60%)	4 (60–80%)	5 (80–100%)
Size	None, extremely unsuitable conditions	Minimal, very unsuitable conditions	Substandard, unsuitable conditions	Standard, suitable conditions	Extraordinary, very suitable conditions	Exceptional, extremely suitable conditions
Typicalness	None	Very low	Low	Average	High	Very high
Viability	None	Very low	Low	Average	High	Very high
Damage	Dead	Dying	Strongly damaged	Damaged	Slightly damaged	Undamaged
Safety	Emergency state	Very high risk	High risk	Average risk	Low risk	Very low risk
Sustainability	None	Very short	Short	Average	Long	Very long
...	Resultant Health state is an average of all parameters values rounded to closest whole number (0, 1, 2, 3, 4, 5)					

Results and discussion

Plants inventory in altogether 9.0 ha historic park in village Beladice in its local part Beladice has shown existence of 800 trees, 35 shrubs and 75 natural seedlings (naturally grown groups of young trees or shrubs). Using author's method of plant inventory these parameters of plants have been shown: Number, Name, Age, Height, Crown diameter, Trunk diameter, Compositional value, Health state. For practical purposes Operational and Comment data were set too.

Species analysis has shown existence of 36 broad-leaved trees, 23 conifers, 8 shrubs species or cultivars. For compositional value and health state formulas for arithmetic average were used (Tables 4, 5 and 6). As there is no known plant analysis of this park, result can not be compared with older situation.

Table 4. Plant evaluation analysis

	Age [years]	Height [m]	Crown diameter [m]	Trunk diameter [cm]	Compositional value (0–5)	Health state (0–5)
Trees (800 items)						
Average	62.88	16.31	7.80	47.25	3.25	3.55
Shrubs (35 items)						
Average	36.86	4.69	4.06	–	3.40	3.86
Natural seedling (75 items / 240 subitems)						
Average	13.29	5.71	2.84	–	1.19	4.86

Table 5. Tree species analysis (800 trees**)**

No.	Species, cultivars	Number [specimen]	Percentage [%]
	Broad-leaved trees		
1	*Acer campestre* L.	118	14.8
2	*Acer platanoides* L.	43	5.4
3	*Acer pseudoplatanus* L.	11	1.4
4	*Aesculus hippocastanum* L.	16	2
5	*Alnus glutinosa* (L.) Gaertn.	14	1.8
6	*Betula pendula* Roth	9	1.1
7	*Carpinus betulus* L.	1	0.1
8	*Castanea sativa* Mill.	1	0.1
9	*Crataegus monogyna* Jacq.	1	0.1
10	*Fraxinus angustifolia* Vahl.	1	0.1
11	*Fraxinus excelsior* L.	183	22.9
12	*Fraxinus excelsior* ´Pendula´	3	0.4
13	*Gymnocladus dioicus* (L.) K. Koch	10	1.3
14	*Juglans nigra* L.	3	0.4
15	*Juglans regia* L.	16	2
16	*Liriodendron tulipifera* L.	1	0.1
17	*Magnolia* × *soulangeana* Soul.-Bod. ex Thunb.	4	0.5
18	*Malus pumila* Mill.	2	0.3
19	*Negundo aceroides* Moench	28	3.5
20	*Ostrya carpinifolia* Scop.	2	0.3
21	*Padus avium* Mill.	4	0.5

Table 5. Tree species analysis (800 trees**)** – continued

No.	Species, cultivars	Number [specimen]	Percentage [%]
	Broad-leaved trees		
22	*Phelodendron amurense* Rupr.	1	0.1
23	*Platanus hispanica* Mill.	8	1
24	*Populus alba* L.	2	0.3
25	*Populus nigra* ´Italica´	11	1.4
26	*Prunus domestica* L.	2	0.3
27	*Prunus spinosa* L.	19	2.4
28	*Quercus robur* L.	5	0.6
29	*Quercus robur* ´Fastigiata´	1	0.1
30	*Rhus typhina* L.	1	0.1
31	*Robinia pseudoacacia* L.	26	3.3
32	*Salix alba* L.	2	0.3
33	*Salix alba* ´Tristis´	2	0.3
34	*Sophora japonica* L.	3	0.4
35	*Sophora japonica* ´Pendula´	1	0.1
36	*Tilia platyphyllos* Scop.	56	7
	Conifers		
37	*Abies alba* Mill.	2	0.3
38	*Abies concolor* (Gordon & Glend.) Hildebr.	2	0.3
39	*Abies procera* Rehder	1	0.1
40	*Ginkgo biloba* L. (femina)	1	0.1
40	*Ginkgo biloba* L. (mas)	1	0.1
41	*Chamaecyparis lawsoniana* (A. Murray bis) Parl.	4	0.5
42	*Chamaecyparis pisifera* (Siebold & Zucc.) Endl.	2	0.3
43	*Juniperus* × *media*	8	1
44	*Juniperus chinensis* ´Pfitzeriana Glauca´	3	0.4
45	*Picea abies* (L.) H. Karst.	13	1.6
46	*Picea pungens* ´Glauca´	5	0.6
47	*Pinus nigra* J. F. Arnold	48	6
48	*Pinus sylvestris* L.	2	0.3
49	*Pinus sylvestris* Aurea	1	0.1
50	*Platycladus orientali*s (L.) Franco	4	0.5
51	*Pseudotsuga menziesii* (Mirb.) Franco	13	1.6
52	*Pseudotsuga menziesii* ´Glauca´	1	0.1
53	*Taxus baccata* L. (tree growth)	9	1.1
54	*Thuja occidentalis* L.	1	0.1
55	*Thuja occidentalis* ´Globosa´	6	0.8
56	*Thuja occidentalis* ´Malonyana´	56	7
57	*Thuja plicata* Donn ex D. Don	2	0.3
58	*Thuja plicata* ´Zebrina´	1	0.1
59	*Tsuga canadensis* (L.) Carriere	3	0.4
	Total	800	100%
	Broadleaf trees – 36 species	611 specimen	76.4%
	Needle trees – 23 species	189 specimen	23.6%

Table 6. Shrub species analysis (35 shrubs)

No.	Species, cultivars	Number [specimen]	Percentage [%]
	Broad-leaved shrubs		
60	*Buxus sempervirens* L.	13	37.1
61	*Buxus sempervirens* Bullata	3	8.6
62	*Sambucus nigra* L.	1	2.9
63	*Berberis thunbergii* DC.	5	14.3
64	*Philadelphus coronarius* L.	4	11.4
65	*Rhamnus cathartica* L.	1	2.9
	Coniferous shrubs		
66	*Taxus baccata* L. (bushy growth)	5	14.3
67	*Taxus baccata* Repandens	3	8.6
	Total	35	100%
	Broad-leaved trees – 6 species	27 specimen	77.1%
	Conifers – 2 species	8 specimen	22.9%

Tree evaluation has shown average age of trees which is 62.88 years which is caused by new plantation during socialistic times, natural sowing of trees and decay of the park. In ideal conditions much more plants would survive from the times when the park was founded (19th century) or from the times of the last treatment (the beginning of the 20th century). However the average age of the trees is still impressive. The average age of shrubs is much lower as they live much shorter time, which is just natural. The average age of natural seedlings shows exactly the time when the park lost continual maintenance which happened after the revolution, so approximately 20 years ago.

Average height of the trees 16.31 m shows average to good environmental conditions of the park. Some of the trees in the lowest part of the park reach the height up to 25 m because of stream flat in this part of the park. Upper part of the park is occupied by black pines (*Pinus nigra* J. F. Arnold) which also reach the same height as they like drier conditions. Average height of shrubs is 4.69 m, which is still sufficient. Average height of natural seedlings is 5.71 m which is influenced by the species, ashes (*Fraxinus excelsior* L.) reach 10 m and bushes are much lower.

Crown diameter shows that the overlap of tree crowns is very high, average diameter reaches 7.8 m. As we have 4 ha of areas with trees, bushes and natural seedlings and approximately 4 ha of open spaces and built area, then 800 trees grow on 3 ha of areas together with natural seedlings. Their overlap is then 27% as the average cover of one tree is 47.8 m so together 3.8 ha on area of 3 ha makes a 1.27 multiple overlap. Shrubs have average 4.06 m crown diameter, but they usually grow under the trees and natural seedlings have average 2.84 m crown diameter as they are young. Natural seedlings were not counted in pieces; just the areas they are growing in were digitally measured with result of approximately 4 ha.

Trunk diameter was categorized just on trees and was 47.25 cm which shows again good environmental conditions.

The most important parameter is compositional value which shows the quality of plants in whole composition. Final compositional value of all trees in the park is 3.25; for shrubs it is 3.4 and of natural seedlings only 1.19. Weighted average of compositional value for trees is 3. These values offer a possibility for expressive improvement after making compositional felling in the park.

Health state is little bit better at trees 3.55 and shrubs 3.86 and much better at natural seedlings 4.86 which refer to low age of natural seedlings. Felling of ill trees, damaged and dangerous ones will certainly improve the health state of trees and shrubs. Certain amount of naturally sown trees (natural seedlings) could remain in a composition after a positive selection.

To reach historical look of the park the reconstruction proposal counts with removing of all other natural seedlings (not selected individual trees and shrubs) and felling of 400 trees in two phases (60% in the first step, 40% in the second one). Comparison of a present state and proposed one is visible in Figs 1 and 2. Also approximately 240 new trees are planned to be planted out, 3,000 new shrubs and approximately 6 ha of new lawns.

Krásny et al. (2008) have made similar evaluation of woody plants in historic park in Piestany (Slovakia) where they have come to similar conclusions. Although their work was made in spa park, it has similar use of woody plants as it was grounded mainly in 19th century

Fig. 1. Present State of the Park.

Fig. 2. Felling Plan.

like Beladice historic park. Total number of trees was 1,704 in 82 taxa, 56 broad-leaved trees and 26 conifers; average age was mostly in categories 10–20, 20–40 and 60–80; average compositional value using Machovec method (1982) it was 2.9 and average health state (tree health index) was 3.75; both average values similarly like in Beladice historic park.

Also Feriancová and Štepánková (2006) have evaluated trees in spa park Brusno using Machovec (1982) method combined with other ones oriented on pests and damages. There were 892 trees evaluated; 2/3 of autochthonous and 1/3 of allochthonous taxa. Their average health condition was 3.3 and their compositional (landscaping) value was 3.34, similarly like in Beladice historic park.

Comparison with a historic park tree evaluation can be made with Oravcová (2005) research where she used the same Machovec (1982) method. The results of 684 trees inventory have shown average compositional value 3 and most trees' age in category 40–60 years.

Conclusion

Evaluation of greenery in historic park Beladice, part Beladice, has shown average health state and compositional value of trees and shrubs. There were recognized 67 plant species altogether in 900 specimens (800 trees, 35 shrubs and 65 groups of natural seedlings). This situation can be considered as not suitable for the park condition. That is why compositional outcuttings are necessary. Especially in case of already too overgrown natural seedlings, just several trees can be selected for further use in composition of the park. Also health state of half of trees (400 specimens) causes the need for their outcuttings. As this is not possible in one step two ones are needed, second one following the first one after 20 years (60% in the first step, 40% in the second one). Just after these cleanings it is possible to grow new plants and laws in the park.

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