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Article

Transit *verus* Nature. Value Depreciation of Road Alleys. Case study: Gamerki-Jonkowo, Poland

Marzena Suchocka [1] *, Magdalena Błaszczyk [1], Adam Juźwiak [2], Joanna Duriasz [3], Adam Bohdan [4], Jerzy Stolarczyk [5]

[1] Department of Landscape Architecture, Faculty of Horticulture, Biotechnology and Landscape Architecture, Warsaw University of Life Sciences - SGGW, Ul. Nowoursynowska 159, 02-776 Warsaw, Poland; magdalena_blaszczyk@sggw.pl
[2] Muzeum Zamkowe w Malborku, Dział Przyrody-Muzeum w Kwidzynie, Starościnska 1, 82-200 Malbork, Poland, adamjuzwiak@gmail.com
[3] Ad Natura Joanna Duriasz, Tęczowy Las 2A, 10-687 Bartąg, adnatura@wp.pl
[4] Fundacja Dzika Polska Teremiski 12, Białowieża 17-230 Poland, adam.bohdan@wp.pl
[5] Eko-trek Jamnik 1, 55-140 Żmigród, js@eko-trek.pl
* Correspondence: marzena.suchocka@interia.pl; Tel.: +48-506-650-607

Abstract: Road alleys, especially on areas of Warmia (north-east Poland), are multifunctional features in open landscapes. They serve as ecological corridors connecting habitats and play an important role in sustaining ecological stability. However, multiple road authorities claim that tree-lined routes are a threat for traffic safety and therefore should be removed. The aspect of safety seems to be crucial to them, significantly overwhelming alley benefits. The vitality problems of the trees (which are mainly mature and aging) deliver arguments to cutting them down. The aim of this paper is examination of environmental and natural value of the road alleys (based on a 14 km long-distance of the Gamerki – Jonkowo road), and verification of the degree of hazard posed by trees designated for cutting because of safety reasons. The six-examination framework for the research was developed. Tree risk assessment and vitality evaluation, pulling tests, examination of protected beetle species - hermit beetle, the lichens species, and examination of bat fauna were performed. The results revealed no trees in the resignation phase and confirmed that the alley is a unique natural and landscape habitat with protected species of lichens, a few bats species and valuable insect species, among others hermit beetle (*Osmoderma barnabita*) existing there. The environmental value of the alley is, therefore, hard to overestimate and cannot be perceived only as a component of the road infrastructure. The maintenance of the trees seems to be essential when taking into account environmental stability of the region.

Keywords: road alleys; protection of road trees; tree cutting; roadside trees management

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1. Introduction

An alley is defined as two rows of trees along both sides of a road, which provide both benefits for people and environment [1,2]. Suburban development, and the popularization of automobiles have caused the importance in the growth of alleys [3]. Alleys have the potential to serve as green infrastructure and to enhance urban sustainability [1,4], but they are often a reason for public complaint. Road users are afraid of fallen trees, broken branches and leaning tree trunks which eventually causes pressure to cut trees down along the roads and streets [5,6], although the benefits of trees outweigh the annoyances they pose on the whole [7]. Anthropogenic changes in landscape have bilateral character and they can lead to its impoverishment (simplification) or enrichment (diversification) [8]. Alleys are a type of buffer strip which rise the esthetic of roads [9], safety and natural values (increase of biological diversity) [10,11,12]. They increase ecological capacity and stability, and alleviate the climate, often being the symbol of cultural identity of region as well [13,14]. The benefits of alleys (including roadside trees) are hard to overestimate. Trees

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increase the capacity of the soil to store water and contribute to carbon sequestration, enhanced local air quality the removal of PM (particulate matter), local climate regulation, noise interception when planted in dense strips, improve aesthetic quality and enhance biodiversity [1,15,16].

And although they are multifunctional objects, some of their functions cannot be realized due to other landscape components. One of them being the creation of special ecological corridors to connect habitats surrounded by agricultural landscape (fragment of the forest, buffer strips, parks, cemeteries, and countryside). Migration of many animal species is related to existence of "connectors" covered by trees and shrubs. Alleys are used as dispersive trails by different animal species, such as insects [17] and birds [18]. Alleys are also ecological corridors for migration of the protected saproxylic beetles and bats which need them for flight navigation [19,20], and for forest species as for example rare and protected species of the dormouse mammals as well [21]. Old trees are habitats of endangered and protected lichens [22-26].

Moreover, alleys can be an important "link with the past" [27] or a component of green infrastructure and take part in a social–ecological resilience of urban and rural areas [1,2,28]. Alleys are an inseparable component of the culture in Polish agricultural landscape. In some cases (Warmia, Mazury and Powiśle), the road alleys are even considered as landmarks [29].

Valuing green infrastructure is not only an important need in planning for rapidly urbanizing city areas but also in rural areas [30-32]. In the context of construction and modernization of road systems, alleys are the component of the landscape that is the most exposed to the effects of human actions and frequently management decisions concerning roadside trees are taken precipitately and come down to their felling [33]. Tree management could increase maintenance costs of roads but potentially contributes to savings due to provision of a wide range of ecosystem services [34]. Diverse functions like environmental protection, economic development, and social equity – might be an integral part of alleyway management systems [1]. Despite the important contribution to ecosystem services and general positive attitude to trees by people (i.e. urban dwellers often declare their willingness to pay higher taxes for investment in green infrastructure [7,34]), trees are not always accepted because of the safety considerations or proximity to infrastructure [15,35].

The pressure for the removal of trees along the roadsides has become a serious problem which can threaten their existence in the Polish landscape. Free rules from The Nature Conservation Act of 2004 gave road managers large amount of freedom in the decision-making process. The consideration of tree removal has led to impoverish of the environmental value of many areas. Tree removal is ostensibly justified by taking into consideration the safety of road users by removing the possibility of collision with infrastructure. In Poland, tens of thousands of road trees were cut down as a result of such an approach. During road modernization, protection of trees is rarely implemented, which often causes their decay which sees many trees later needing to be felled. Moreover, road alleys are destroyed even along the roads that are no longer used or along farmland (aggregation of agricultural plots related to the extra charge for farmers) where a threat of collision does not exist. Many trees are felled for reasons which lack environmental sense. Road supervisors, who should also take care of tree alleys, do not use transparent methodology of evaluation nor tree classification. Selection of trees to be cut is often inconsiderate and without support of reliable health condition analysis or risk evaluation. Meanwhile, researchers point out, that there is a possibility for avoidance of cutting old road alleys and ensuring traffic safety at the same time [36-38].

Proper roadside tree management could lead to the reduction of hazards through inspection and mitigation, maintaining the level of hazard at an acceptable level with the need to keep large, beautiful trees in situ [39]. It is worth noting, in Poland only 5,1 % of road accidents happen due to collision of vehicles with trees. The main reason for accidents is the exceeding of speed limits by drivers [40]. In fact, many researchers point out that trees alongside streets and roads contribute to increase of safety level [41-44]. Trees are responsible for causing "an immunization effect" and being a stress inhibitor for drivers [45,46]. They help them regain a balance after a stressful reaction to a situation stimulus and provide higher frustration tolerance, making road users driving slower and more carefully [47,48].

The above mentioned facts and circumstances have contributed to the conducting of research concerning validity of removal of road alleys. Verification of the degree of hazard posed by road trees designated for cutting due to safety concerns and the assessment of their environmental values was set as the aim of the paper. It is assumed that it is possible to reconcile the safety requirements to nature protection by application of objective methods for management of road trees.

2. Materials and Methods

2.1. Study area

In this study a section of road planted with trees, which in the opinion of the road manager should be cut due to risk and lack of value, was examined. Analyses was developed in order to verify the necessity of the planned cutting of 31 trees that was unsubstantiated by reduction of traffic threats. There was also a plan to remove the whole alley in the future in order to modernize the above-mentioned section of the road. The survey was executed on the Gamerki - Jonkowo section, county road number 26124 (Jonkowo district, warmińsko - mazurskie province, north - east Poland). This fragment goes within and connects several areas of conservation. On the Gamerki-Kawkowo Stare section of road it crosses OSOP Dolina Pasłęki PLB280002 and it runs nearby OOS Dolina Pasłęki PLH280006 where the beetle species - *Osmoderma barnabita* was indicated as a protected species. In Jonkowo Kolonia town the road is located just next to the OOS Buczyny Warmińskie PLH280033 and Kamienna Góra nature reserve. Within the reserve, there lies a natural beechwood old-growth forest [49] that became the potential habitat for *Osmoderma barnabita*. The area of research crosses the ecological corridor of Dolina Pasłęki on the road section Gamerki - Kawkowo Nowe (Figure 1). Morover, Gamerki – Jonkowo alley has been "a bone of contention" between Poviat Road Services (Powiatowa Służba Drogowa) who have "sentenced" the alley of trees to be cut down and local activists trying to protect them.

Discussed linear tree plantations are present in 7 segments with a total length of ca. 12,4 km along the road that counts ca. 14 km. At the same time this road trees segments account for ca. 25% of all alleys in the area of the whole Jonkowo district. The old-growth forest occurs in whole space in between a traffic lane and a ditch. The appearance of lichens on the counterscarp is the result of the natural succession. The distance between tree segments in the alley is ca. 7 m and distance between trees in segment is ca. 6-8 m. The tree alley is dense with gaps but there are some sections which have been thinned (Figure 2).

Modernization works on the area of interest have been planned in order to improve standards of traffic safety (including surface modernization). Cutting of the 28 trees was planned because of the modernization. The road supervisor planned the removal of the whole alley (more than 1500 trees) in the future. In their opinion, trees threaten traffic safety and the value of the alley is low. Such an attitude to trees, however, raises many doubts when taking into consideration actual knowledge concerning the potential benefits trees alleys, and directly contributed to starting the research.

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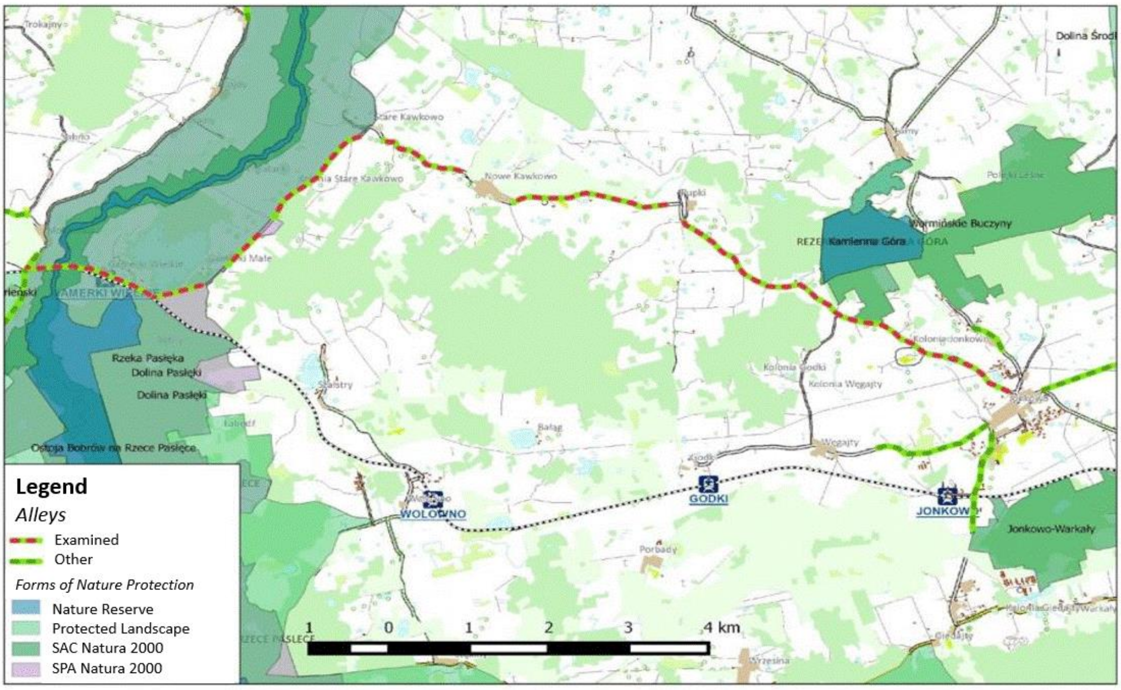

Figure 1. Research area. Gamerki-Jonkowo road alley with neigburing forms of nature protection.

Figure 2. Gamerki-Jonkowo road alley.

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2.1. Methods

Alleys serve as ecological corridors, and therefore their value must be estimated taking into account both "flora as fauna". As linear objects, alleys are particularly important for two species: bats and hermit beetles [50,51]. They use alleys as places for living, breeding, feeding, resting, hiding, navigating etc. Continuity of the alleys is crucial for maintaining of local populations of the species. For the purpose of the research a framework consisting of six examination methods was developed:

1. Risk assessment, verifying the statistics from the VTA method (*Visual Tree Assessment*) was used for 28 trees chosen for removal. Trees were examined by visual evaluation and segregated into different risk classes, according to Quantitative Risk Assessment typology formulated by ISA (*International Society of Arboriculture*). According to ISA recommendation each tree could be categorized into one of the 5 classes indicating risk: insignificant (A), low (B), moderate (C), high (CD), extreme (D) [52].

2. Vitality evaluation was done for each tree according to Rollof's classification [53] that is based on distal crown parts liveliness. 28 trees chosen for removal were segregated into 4 groups: 0 'exploration'; tree in the phase of intensive offshoot growth, 1 'degeneration': tree with slightly delayed offshoot growth, 2 'stagnation': tree with visibly delayed offshoot growth, 3 'resignation': tree is dying, without regeneration possibility nor returning to second class.

3. Pulling tests of two trees from the group designated to cut down by road engineer's, which were designated as posing a risk, on the basis of the results of VTA method. The pulling test was conducted according to TSE methodology (Tree Stability Evaluation), ITEG group (Independent Tree Expert Group). Among the other tests there were also measurements of fracture resistance and evaluation of root stability in the soil.

4. The lichens species were examined on the 28 selected trees chosen for removal. Examination was conducted in the middle of November 2015 according to the inventory. Species were defined on the basis of morphological traits. Trunk surface and tree branch to the height of 5 m above the ground were chosen for investigation. In order to detect the lichens 3,5 m high ladder was used.

5. The bat fauna was examined along the whole tree alley section. The examination was conducted using an ultra sound detector between 25.08 - 16.09.2015. The research took place along the whole alley from the bridge on the Pasłęka River, Gamerek Wlk. neighborhood, as far as the rail crossing at Wiliamów. The research was conducted during peak evening hours of bat activeness, starting approximately. 30 minutes after sunset and lasting around 4 hours. Recordings were made from within a car driving at ca. 4, 5 km/h. The detections were carried out by Petersson D230 and Petersson D240 x detectors. Recorded material was analyzed by computer analysis (Bat sound program, Petersson Electronic Company). In addition to the evening reading, the bats sounds were also recorded during the morning on 25. 08. 2015. The alley was observed in order to determinate the occurrence of breeding colonies. As within the alley, there were also recognized trees which are known to support bat habitats.

The alley was divided into a number of section, depending on a unified landscape type and presence of certain structures and bat habitats. The length of sections varied form 350 m to 1000 m (Table S1). Bat activity index was calculated for every section according to the following formula:

$Ix = Lx * 60 / T$

where:

Ix – activity index for a group of species „x";

Lx – a number of all the recorded bat activities in sections

T – time of all the records (in minutes)

The index describes the number of bat fly-overs in every section within an hour. Following activities levels where assumed:

0-20 signals per hour – low activity

21-40 signals per hour – medium activity

41-60 signals per hour – high activity

above 60 signals per hour – very high activity

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6. Inventory of hermit beetle (*Osmoderma barnabita*) on the whole road section. The examination was conducted according to standard methodology that is recommended for this species inventory [17,54] by:

- searching for larval excrements and remains of hermit beetle imago's shells within trees (hollow and surroundings): 19.08 - 13.11.2015;
- imago stage using pheromones traps**:** 19 - 30.08.2015;
- observation of adult beetles in the tree cavities surroundings: 19-30.08.2015;
- observation of imago in the tree hollow interior with usage of endoscopic camera connected to the computer: 19 - 20.08.2015.

Conclusions from the survey were used to estimate the value of Gamerki- Jonkowo road section and the validity of tree removal. The above mentioned tests were conducted within the 'Maple alley in the landscape of Jonkowo community' project through subsidy by National Fund for Environmental Protection and Water Management.

3. Results

3.1. Risk assessment

The tree alley is created by the following species: norway maple (*Acer platanoides* L.) - 60%, small-leaved lime (*Tilia cordata* L.) – 28%, silver birch (*Betula pendula* L.) - 6%, horse-chestnut (*Aesculus hippocastanum* L.) – 3%, European ash (*Fraxinus excelsior* L.) – 3%, English oak (*Quercus robus*) – 1 %. There also exists additional species in old-growth forest composition: common aspen (Populus tremula), sycamore maple (*Acer pseudoplatanus*) and apple tree (*Malus domestica*). The avenue consists of ca. 1900 trees in total.

In addition, there are also seedlings of the aformentioned species and additionally: scots pine (*Pinus silvestris*), goat willow (*Salix caprea* L.), european elder (*Sambucus nigra*), common hazel (*Corylus avellana*), rowan (*Sorbus aucuparia*), common hornbeam (*Carpinus betulus*), blackthorn (*Prunus spinosa* L.), black cherry (Prunus serotina), single-seeded hawthorn (*Crataegus monogyna*), rose (*Rosa* sp.), common snowberry (*Symphoricarpos albus*), white pine (*Pinus strobus*), northern white-cedar (*Thuja occidentalis*), staghorn sumac (*Rhus typhina*), european spindle (*Euonymus europaeus*), scots elm (Ulmus montana) and common lilac (*Syringa vulgaris*).

Trunk circumference was measured at the height of 1,3 m and are 100-350 cm. The average trunk circumference is 190 cm. There are also specimens of small-leaved lime which trunk circumferences meets the criteria for being considered as a monument of nature.

28 trees which were selected by road services to be removed because of the threats and lack of liveliness prognosis were evaluated additionally. The trees are: 13 norway maples (*Acer platanoides*), 10 small-leaved limes (*Tilia cordata*) and 5 English oaks (*Quercus robur*). The evaluation indicated occurrence of 25% trees in B class, 29% of trees in C class and 46% of trees in CD class. Part of trees in C and CD class demanded risk minimization by tree crown stabilization (11 trees) and dry branches removal (8 trees) (Table 1).

3.2. Vitality evaluation

According to the Rollof's classification there were no trees in the resignation phase (3rd class) in the evaluated group. 29 % of the trees were qualified to the exploration phase (0 class). Percentage distribution of trees in others groups (degeneration and stagnation) amounted respectively 57% and 14%, what demonstrate that 86% of examined trees were in good health (Table 1).

Table 1. Dendrological examination of trees dedicated to cut because of safety reasons VTA on the Gamerki Wielkie-Nowe Kawkowo road section with safety recommendation.

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No	Species	Trunk circum-ference at 130 cm height	Classes of risk tendency	Rollof's classification	Safety recomendations	Inventory of hermit beetle (*Osmoderma barnabita*)
1	**2**	**4**	**3**	**5**	**6**	**7**
1	*Tilia cordata*	340	C	0	binding of stems	presence
2	*Acer platanoides*	137	C	1	deadwood cutting	
3	*Tilia cordata*	238	B	0	-	presence
4	*Tilia cordata*	317	CD	0	pulling test – 583%	
5	*Tilia cordata*	298	CD	1	pulling test – 264%	
6	*Tilia cordata*	316	CD	0	binding of stems	
7	*Tilia cordata*	336	C	0	-	
8	*Acer platanoides*	272	B	1	-	
9	*Acer platanoides*	270	CD	1	binding of the branch, retrenchment pruning	
10	*Acer platanoides*	272	CD	0	binding of three codominant stems, retrenchment pruning	
11	*Acer platanoides*	197	B	1	-	
12	*Acer platanoides*	149	B	1	-	
13	*Acer platanoides*	300	CD	1	binding of the branch, deadwood cutting	
14	*Acer platanoides*	170	C	0	-	
15	*Tilia cordata*	368	CD	0	binding of the codominant stems	
16	*Acer platanoides*	237	CD	1	deadwood cutting	
17	*Quercus robur*	315	CD	2	binding of the codominant stems	
18	*Tilia cordata*	458	C	1	binding of the branch	
19	*Acer platanoides*	210	C	1	binding of the codominant stems	
20	*Acer platanoides*	250	CD	2	binding of the branch, deadwood cutting	
21	*Acer platanoides*	207	B	1	-	
22	*Acer platanoides*	224	B	1	-	
23	*Acer platanoides*	184	CD	2	deadwood cutting	
24	*Acer platanoides*	277	CD	1	binding of the codominant stems	
25	*Acer platanoides*	205	C	2	deadwood cutting	
26	*Acer platanoides*	195	B	1	-	
27	*Acer platanoides*	253	CD	1	deadwood cutting	
28	*Quercus robur*	324	C	1	-	

3.3. Pulling tests

There were two trees which after preliminary testing appeared unsafe. These trees were verified by conducting a pulling test. Tree statics examinations were conducted according to loading method and trunk fraction resistance. The survey concerned a small-leaved linden (*Tilia cordata* Mill.) No. 4 (Figure 3) and a small-leaved linden (*Tilia cordata* Mill.) No. 5 (Figure 4).

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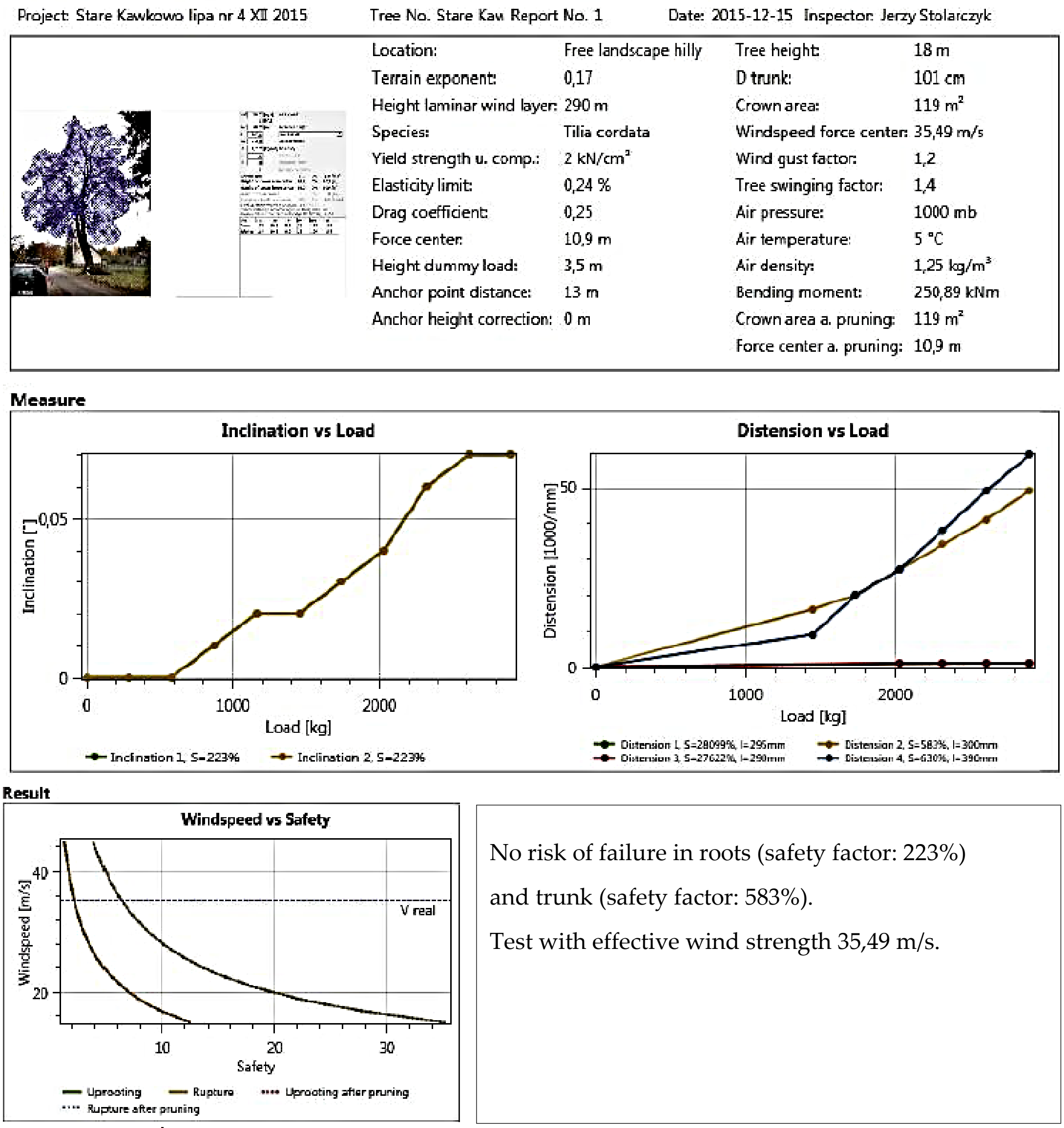

Figure 3. *Tilia cordata* no. 4/13 – pulling test report

The loading test was conducted on selected small-leaved lindens. It proved that the trees demonstrated over-regular stability in the ground. Inclinometers placed on the trunk describing tree stability showed the level of: linden No. 4 - 223%, linden No. 5 - 347% (safety level is considered as higher than 150%). Elastometers indicators were verified. On the weakest parts of the trunks (with the biggest defects) sensors indicated following results: linden No. 4 - 583%, linden No. 5 - 264%. This proves sufficient breaking resistance for the trees to remain insitu.

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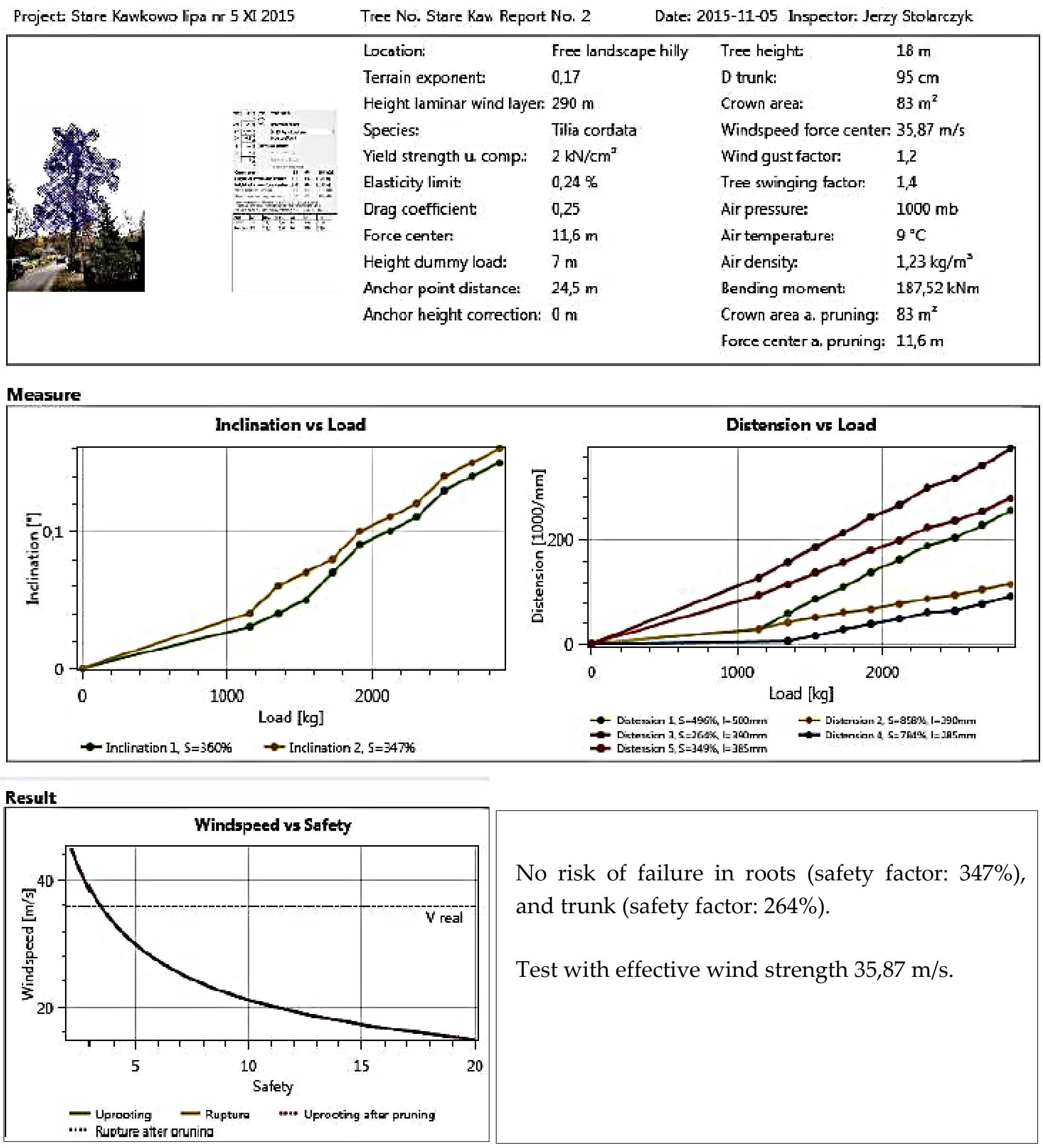

Figure 4. *Tilia cordata* no. 5/13 – pulling test report.

The occurrence of species which are protected was confirmed on almost all of the examined trees (Figure 5). Registered species composition is typical for valuable tree alleys in the area of north - east Poland [55] and distinctive to the species described in other parts of the region [23-26,56]. Many species of epiphytic lichens are sensitive to air contamination, which particularly indicates the need to preserve a matured and senescent trees as valuble habitats of protected species across the entire country.

3.4. Examination of lichen species

The survey which was conducted on lichens which are under species protection was done on the sample of 28 trees. It demonstrated the occurrence of 3252 specimens of epiphytic lichens of 10 different species (Table 2, Table 3).

Table 2. Species of lichens observed on studied tree. EN – dying; VU – exposed.

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Name	**Protection status**	**Status in the Red List of extinct or threatened lichens in Poland (Cieśliński et al., 2003)**
Usnea hirta	partial protection	
Melanohalea elegantula	strict protection	
Melanohalea exasperata	strict protection	
Ramalina pollinaria	partial protection	VU
Ramalina fraxinea	strict protection	EN
Ramalina fastigiata	strict protection	EN
Ramalina farinacea	partial protection	VU
Pleurosticta acetabulum	partial protection	EN
Parmelina tiliacea	strict protection	
Hypogymnia tubulosa	partial protection	

Table 3. The number of lichen species on proven trees growing on trees in the 14 km road lane of the Gamerki Wielkie - Jonkowo route: 3 678 individuals belonging to 8 species of lichens subject to legal protection (Ap - *Acer platanoides*, Qr - *Quercus robur*, Tc – *Tilia cordata*, A - 40% on a dry branch, B - 15% on a dry branch, C – on a dead wood, L – left, R - right).

No.	***Site of the route***	***Tree number***	***Tree species, trunk circumference (cm)***	***Hypogymnia tubulosa***	***Melanohalea elegantula***	***Melanohalea exasperata***	***Parmelina tiliacea***	***Pleurosticta***	***Ramalina farinacea***	***Ramalina fastigiata***	***Ramalina fraxinea***	***Ramalina pollinaria***	***Usnea hirta***
1	L	1/13	Tc340						2				
2	R	2/13	Ap137					8	30	10	80		
3	L	3/13	Tc238										
4	R	4/13	Tc317		15	15	5						
5	R	5/13	Tc298						4		1		
6	L	6/13	Tc316		30			5	20		5	15	
7	L	7/13	Tc336			30		3	1		1		
8	L	9/13	Ap272	5					40	15	40	100	
9	R	10/13	Ap231						150	30	30	70	
10	L	11/13	Ap197						40	20	100 **A**	30	
11	R	12/13	Ap149					15	50	60	120 **B**		
12	L	8/13	Ap272						180	3	12		
13	L	21/13	Ap207						180	15	20	4	60
14	L	13/13	Ap300					5	15	10	80		
15	L	14/13	Tc170					25		50			
16	R	15/13	Ap368						10	20	2		
17	R	16/13	Qr237					3	20	10	30		
18	L	17/13	Tc315					12	130	7	10		
19	L	18/13	Ap458			10			3	2	1	4	
20	L	19/13	Ap210	1					150	20	25		
21	L	20/13	Ap250					2	15	30	15	10	
22	R	22/13	Ap224						30	16	10		
23	R	23/13	Ap184						50	15	30		

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24	L	24/13	Ap277		3	80 **A**	10 **B**	15	50 **C**
25	L	25/13	Ap205		15	30	30	15	30
26	R	26/13	Ap195	5			15	15	
27	R	27/13	Ap253		20	9	10	25	10
28	L	28/13	Qr324		17	100		1	200

Figure 5. Example of protected lichenes species; *Melanohalea exasperata* (strict protection), on one of the alley trees.

Research has shown colonization and dispersion of propagule of some macro lichens, such as *Evernia prunastri* and *Ramalina farinacea*, occurred over distances of 30 m [57]. Therefore a minimum distance between groups of trees should be preserved during tree removal, replacing removed trees in order to maintain this distance [26].

3.5. Examination of bat fauna

At least 9 bat species out of the 26 existing in Poland were recorded on the road alley. All of the detected species are under species protection, three of them on the Red list of extinct and threatened animals in Poland [58] (Table 4). As a result of the survey, the occurrence of potential hiding places within most of trees along the road alley on the section of Wilimowo - Gamerki Wielkie was verified. The survey indicates that Gamerki Wielkie - Jonkowo section is especially valuable place for local bat population. Detectors along the alley confirmed the existence of 9 species of bats. In the analyzed period, *Pipistrellus sp*. was dominating in the chiropterofauna of the alley and its surrundings, constituting almost 50% of all the recorded fly-overs. A significant number of fly-overs belonged also to *Nyctalus noctula* (21%), *Eptesicus serotinus* (13%), and other unidentified bat species (*Myotis sp*.) (Figure 6).

Table 4. Species of bats observed on studied area. NT – near threatened; LC – least concern ; VU – vulnerable.

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Scientific name	Status of protection	Status on the Red List of extinct and threatened animals
Pipistrellus nathusii	strict protection	
Pipistrellus pipistrellus	strict protection	
Pipistrellus pygmaeus	strict protection	
Eptesicus serotinus	strict protection	
Eptesicus nilssonii	strict protection	NT
Vespertilio murinus	strict protection	LC
Nyctalus noctula	strict protection	
Nyctalus leisleri	strict protection	VU
Plecotus auritus	strict protection	

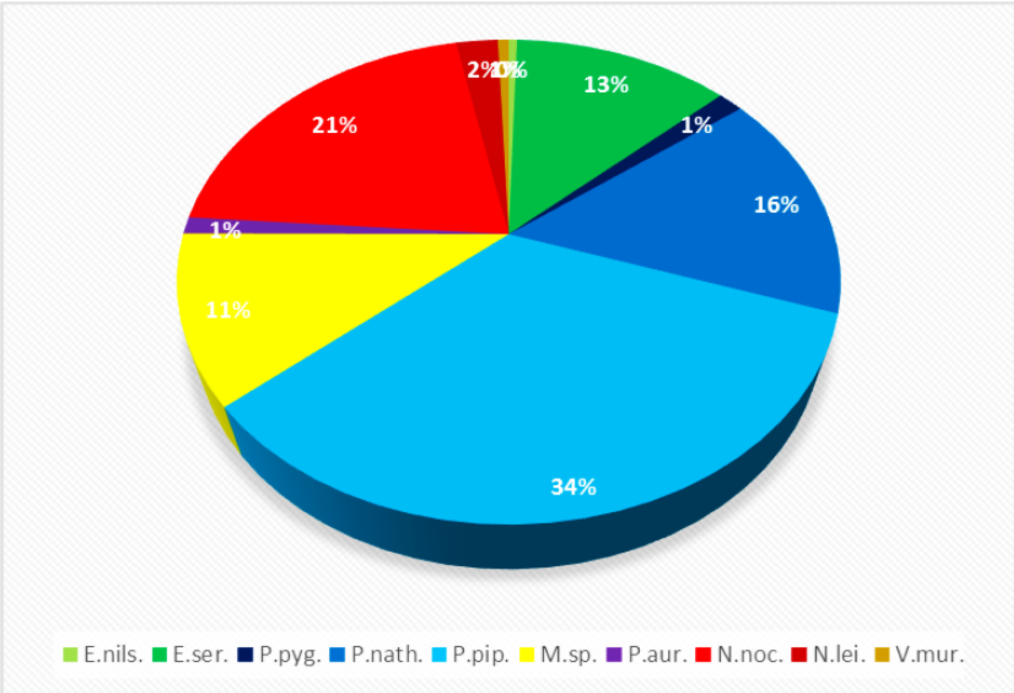

Figure 6. Species composition of the chiropterofauna of the analyzed avenue during the dispersion of breeding colonies at the beginning of autumn migration. E.nils. - *Eptesicus serotinus,* E.ser. - *Eptesicus serotinus,* P.pyg. - *Pipistrellus pygmaeus,* P.nath. - *Pipistrellus nathusii,* P.pip.- *Pipistrellus pygmaeus,* M.sp. - *Myotis sp.*, P.aur.- *Plecotus auritus,* N.noc. - *Nyctalus noctula,* N.leis. - *Nyctalus leisleri*, V.mur. - *Vespertilio murinus.*

A number of feeding buzzes were recorded on 13 sections of the alley. Parts of the alley, in which the signals were recorded (Table 5), should be therefore valued as significant bat feeding places. Moreover, social sounds of *Pipistrellus sp.* were recorded on 7 sections of the alley. The sounds are made by territorial males during breeding seasons. This proofs the sections of the alley are particularly important for bat reproduction.

Table 5. The chiropterofauna - characteristics of the avenue sections.

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Number of the road section	Description of the section	Bats activity	Feeding sounds	Social sounds
1	Bridge on Pasłęka river – Gamerki Wielkie	very high	X	X
2	Gamerki Wielkie	high	X	X
3	Gamerki Wielkie- edge of the forest	low	X	
4	Forest next to the Gamerskie Lake	high	X	
5	Gamerki Małe	low		
6	Gamerki Małe – brake in the alley	low		
7	brake in the alley	moderate		
8	Alley till Kolonia Stare Kawkowo	low	X	
9	Kolonia Stare Kawkowo	low		X
10	Kolonia Stare Kawkowo – Stare Kawkowo	moderate		
11	Stare Kawkowo	low		
12	Stare Kawkowo – Nowe Kawkowo	high		
13	Stare Kawkowo – Nowe Kawkowo sector without the buildings	moderate	X	
14	Nowe Kawkowo – west part	moderate	X	
15	Nowe Kawkowo – east part	very high	X	
16	Nowe Kawkowo – power line	low	X	
17	power line - Pupki	low		
18	Pupki	low	X	
19	wetlands	low		
20	wetlands-edge of the forest	moderate		X
21	Edge of the forest – road to Węgajty	moderate	X	X
22	road to Węgajty – Ostoja Warmińskie Buczyny	moderate		X
23	Ostoja Warmińskie Buczyny – Jonkowo	high	X	
24	Kolonia Jonkowo	high		
25	Kolonia Jonkowo – cementary	moderate	X	X
26	Jonkowo – build section	low		
27	Jonkowo dispersed housing	low		
28	Jonkowo till the edge of the forest	low		
29	Till Mątki	low		
30	Mątki – Wilimowo	low		
31	Wilimowo till railway crossing	low		

3.6. Inventory of hermit beetle

There were confirmed habitats and specimens of protected beetle species - hermit beetle (*Osmoderma barnabita*). Within the hollows of the trees observed the occurrence of hermit beetle's imago, along with a large amount of the species excrements were documented. Their settlement was also confirmed on two trees. There is a possibility of settlements in further trees in addition to the trees examined (Figure 7). The hermit beetle prefers trees with hollows with a trunk circumference larger

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than 70 cm [53] are especially significant for this species. The existence of these trees within 2000 m radius of each other is required to maintain continuity of settlement on the trees.

Figure 7. A hermit-beetle hollow in one of the alley trees.

Large trunk circumferences, many hollows, small distance between trees and occurrence of hermit beetle habitats within a few kilometers from each other proved the fact that the examined alley is an optimal habitat for the hermit beetle. The existence of active habitats of this species indicates fauna wealth of trees standing where they exist [59]. Therefore, the hermit beetle is an indicator species on the list in attachment II of the "Habitats Directive". The places of occurrence of this species are potential locations for Nature 2000 protection.

4. Discussion

Within the examined group only one tree was found to be dangerous for road users' safety and indicated for removal. The loss of only one tree allowed the habitat and landscape value of the avenue to be maintained. In the instance of the other trees there were proposed treatments to improve their stability and safety. The risk level was minimized by implementation of treatment recommended by experts. Dry branches were removed from the crowns of 11 trees. 8 trees were protected by elastic ties. Parts of trunks or branches which could cause traffic threats were marked by fluorescent bands. All the safety treatment effects were noticeable for dwellers and travelers. This in turn allowed for the spread of knowledge about safety improvement methods around the trees.

Trees which were indicated for removal by the road supervisor were checked and the risk was minimized to the accepted level. All the planned actions regarding the avenue were projected according to the assumption to not worsen actual condition of the protected species habitat. The basic assumption is the number of trees which are potential habitats for hermit beetle should not be reduced. Moreover, in the case of the examined alley it is necessary to plant new trees in the empty

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sections between mature trees in order to improve the future migration capacity between existing and potential habitats. Alleys are a key component able to enhance connectivity and facilitate movements of organisms between green patches such as woodlands, forests or urban green infrastructure [60]. Tree maintenance is possible by the evaluation of tree condition and risk estimation, this in turn will enable preservation of the landscape value and improved whole natural system function. It should be emphasized that the typical approach, assuming that mature trees can be felled and replaced with seedlings of young trees, is not shown from the loss of biodiversity and ecosystems which cannot be compared to the small contribution of recently created habitats connected with new plantings [61,62]. Ecosystem services provided by trees are dependent on tree size and biomass [63,64]. In example, trunk diameter is positively related to presence of decay-cavities. Tree-cavities are generally an important ecological factor as a number of animals living in woody habitats are cavity users and in case of our study that kind of trees have been selected for removal. What's worth mentioning, decay-cavities occur as a result of removal of large branches. Decay-cavities are featured more often in trees of low vitality and with woodpecker-cavities than in trees of high vitality or without woodpecker-cavities [65]. From another site presence of saproxylic beetles in the cavities is positively associated with tree height and a high degree of damage at the root collar, what could be a factor increasing risk level, and negatively with the presence of hole-nesting birds [66]. In the case of necessity to eliminate a tree that creates a risk, constituting at the same time a habitat of protected species (especially lichens and beetles colonizing the cavities), a certain compromise may be cutting the tree at a height of several meters and leaving the bottom part of the trunk. Although it should be remembered that such a solution will not be fully effective due to the change of the temperature and humidity conditions within the trunk, which may be exposed to over drying and flooding.

The rich diversity of bat species and numerous registered signs of their existence showed the immense significance of examined alley for the local bat population. Due to the fact of using road trees by some of the bats as ecological corridor during migration [19] retaining spatial continuity of road trees is significant criteria for alley management.

The survey results indicated the necessity of special protection of the old tree alley. The use of tree risk assessment methods prevents unjustified felling of trees and maintains the legally required low level of risk. However, some studies show clearly that protected species are at risk of removal from urban environment because of the clash of interests between biodiversity conservation and public safety assessed on the basis of Visual Tree Assessment Procedure (VTA) [66]. This indicates the necessity of implementation of risk management taking into consideration both of the priorities. The alley has a unique habitat and landscape values, maintaining these values will support biodiversity and it can increase touristic potential and educational function. There are fewer and fewer rich ecosystems like this one, that function in the rural and urban areas. The existence of the alley is a big advantage for the region and its preservation will bring ecological and economical profits to the local government and inhabitants by touristic popularization. This indicates a justified need of reconstructing old alleys and creating new ones.

The results also confirmed the necessity to value alleys taking into consideration both "flora and fauna". In Poland, it is still a common practice to examine trees only referring to their vitality. Such an approach seems to be insufficient, especially when a tree is a part of a bigger structure like an alley. Therefore, certain standards should be set for their valuation, including accurate methods adjusted to the landscape and habitat type, as well as to its surroundings.

5. Conclusion

The six-examination framework for the research – dendrological examination with tree risk assessment and vitality evaluation, loading tests, examination of protected beetle species - hermit beetle, the lichens species, and examination of bat fauna – guided a comprehensive measures

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approach that shows the value of the examined road alley. The study demonstrates that responsible assessment of the avenue requires consideration of all these important factors. The study has revealed in detail multifunctional benefits of road trees and proved them to be a significant ecological element of a rural landscape. Therefore, alleys cannot be perceived only as a part of the road system, in which they cause threats for road users. Especially since professional risk assessment has not confirmed the need for tree removal. In this case the level of risk was possible to reduce by safety recommendations. For these reasons an expanded resource management should become a common practice. This approach has become an increasingly important, as dendrologists continue highlight the utilitarian relationship residents have with local alleys, and the apprehensions they have about these spaces [1,28]. Further studies should be made in order to implement full procedures (risk and natural value assessment) into decision making processes concerning road management.

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