*Ecological Questions* 19/2014: 35 – 43 http://dx.doi.org/10.12775/EQ.2014.003

# Variability of green biomass content in plant communities along selected traffic routes in Białystok

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**Abstract.** Variability of green biomass quantity in plant communities found in study transects established along selected traffic routes in Białystok was studied. The study was conducted in a total of four transects including three in non-forest plant communities and one in a forest community located in the vicinity of Białystok's main outbound roads. The effect of different distance of the study fields from the traffic routes (4-5 m, 14-15 m and 24-25 m) was taken into account. Results obtained for biomass variability in city transects were then compared to the biomass values recorded in both forest and non-forest communities in two standard transects in the centre of Knyszynska Forest, located away from traffic routes.

The study demonstrates that total green biomass of plants collected from the study fields depends primarily on the floristic composition of the plant communities under study rather than on the distance of the study fields from traffic routes. As for the city transects, greater total green biomass was recorded in non-forest plant communities (1457.33 g – 3161.65 g) than in the forest community analysed (255.39 g), which is mainly attributable to high green biomass content identified in the floristically richest group of meadow species from the class *Molinio-Arrhenatheretea.* Total green biomass in non-forest and forest plant communities in the city is greater than outside the municipal area (233.43 g and 134.69 g, respectively), which is predominantly a consequence of higher diversity of plants.

**Key words:** vegetation biomass, non-forest plant communities, forest plant communities, floristic composition, traffic routes, Podlaskie Province.

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## 1. Introduction

Road maintenance and traffic have many adverse effects on the vegetation of road verges and they tend to favour species which are able to adapt to disruptive factors of a different nature. As compared with adjacent habitats, the physical environment is characterised by increased windiness and changes in temperature, soil density and water content (Trombulak & Frissel 2000). Exhaust emissions, particles and fluid leaks from vehicles, dust from the pavement materials, and de-icing salts all alter the chemical environment (Günthardt-Goerg et al. 2000; Viskari et al. 2000). In addition, the environmental conditions in road verges and their role as corridors promote the dispersal of many grassland plants, making the survival of native flora even more difficult (Trombulak & Frissel 2000).

Disruption of the chemical environment along roads is a factor affecting plant growth, species diversity and composition (Trombulak & Frissell 2000; Cape et al. 2004). Many authors studying roadside vegetation indicate a strong relationship between the spread of non-native plant species and soil nutrient levels (Forman 2000; Johnston & Johnston 2004). Vegetation allocation reflects a balancing strategy of plants in response to the supply of environmental resources (Enquist & Niklas 2001, 2002). Changes in biomass allocation affect the survival, growth and reproduction of individual plants (Maherali & DeLucia 2001) as well as biogeochemical cycle processes of terrestrial ecosystems (Bird & Torn 2006; Litton et al. 2007). Biomass allocation reflects the effects of the most important factors restricting plant growth in ecosystems (Chapin III et al. 2002). Changes in environmental conditions produce rapid and profound effects on vegetation biomass (Maherali & DeLucia 2001). In order to understand mechanisms of plant adaptation and response to environmental changes, it should be established first how variations in environmental factors affect vegetation biomass.

A number of authors have reported that plants intercept air pollution and are very useful for the biomonitoring of environmental contamination (Aksoy et al. 2000; Alfani et al. 2001). This role is especially important in highly urbanized areas because of increased levels of contamination caused by vehicle traffic.

The present study is focused on the variability in green biomass content caused by anthropogenic factors. The measurements were carried out in selected non-forest transects and one forest transect established in the vicinity of traffic routes in Białystok. Differences in the distance from traffic routes of varying levels of traffic volume were duly taken into account. The aim of this study was to describe the changes in green biomass as a function of the type and floristic composition of plant communities (non-forest, forest) and the distance from a busy traffic route.

## 2. Study area

The study was conducted in north-eastern Poland, in the central part of the Podlaskie Province, along four traffic routes selected in the city of Białystok: T1 – regional road no. 669, Białystok – Ełk (Narodowych Sił Zbrojnych street); T2 – national road no. 8, Białystok – Warsaw (Andersa street), T3 – regional road no. 676, Białystok – Krynki (Raginisa street), T4 – regional road no. 678, Białystok – Wysokie Mazowieckie (Ciołkowskiego street) (Fig. 1). In 2012, the intensity of traffic on the streets analysed in the study was determined as very high. The traffic volume in Narodowych Sił Zbrojnych street was 439 vehicles per hour; in Andersa street – 964 vehicles per hour, in Raginisa street – 501 vehicles per hour and in Ciołkowskiego street – 860 vehicles per hour (Kuklewicz, unpublished data).

## 3. Material and methods

The study was conducted in August 2010, assuming that it is the period of the greatest abundance of plant biomass. Green biomass was collected from non-forest plant communities (T1, T2, T3) and one forest plant community (T4). Transects (25 m long and 1 m wide) were marked perpendicularly to the roadway, starting from a distance of 4 m from the verge, taking into account their floristic and habitat similarities. At the distances 4-5 m, 14-15 m and 24-25 m, study plots of 1 $m^2$ were outlined. Localisation of study plots was made taking into regard the report by (Sheng-Lan Zeng et al. 2010) according to which the most pronounced changes in the species diversity related to the disturbances caused by the effects of the road take place at distances up to 30 m from the road and in particular up to 10 m from the road and decrease with distance from the source of disturbance. In the study plots of 1 $m^2$ and in the area of 100 $m^2$ (4 m x 25 m) with transects, the phytosociological relevés were made by the Braun-Blanquet method, using the 6-grade quantitative scale.

Using lists of all species growing in 1 $m^2$ plots made on the basis of the phytosociological relevés, the green biomass of all species was collected from a given plot down to the level of soil. For trees and bushes, biomass was collected in the form of green plant parts. Collection of biomass from 1 $m^2$ plots was performed separately for different species (biomass from different species were collected to different sacks), taking into account the life forms (leaves, needles of trees, blades of herbal plants, moss and lichens) of plants in particular layers of habitat. Biomass collected from the area was transferred to the laboratory, where the material was dried at ca. 80°C for 48 hrs. Dry mass was weighed with an accuracy of 0.001 g. Results obtained for biomass variability in city transects were then compared to biomass content determined in two standard transects (T5 – a non-forest transect, T6 – a forest transect) set up in the centre of Knyszyńska Forest, located away from traffic routes. In this

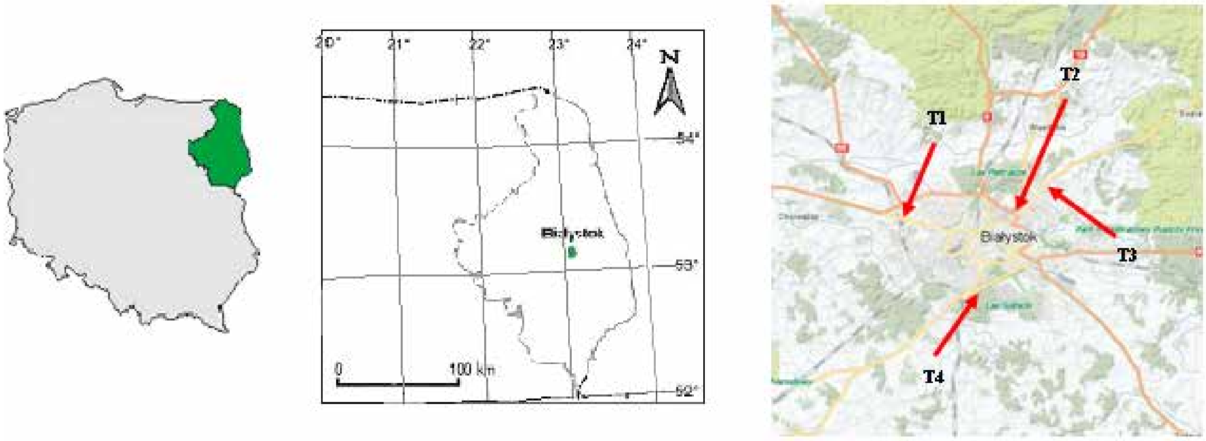

Figure 1. Location of the study area in the Podlaskie Province (NE Poland)

way from the reference transects, both forest and non-forest, three replicates were obtained (4-5 m, 14-15 m, 24-25 m) from three zero study plots from the areas with traffic undisturbed variation in biomass from plant communities.

The correlations between the traffic volume, PM10 dust emissions from linear sources (Bartocha 2008), distance from the traffic route and green biomass content were determined at the significance level α=0.05 using the Statistica 9.0 package (StatSoft 2006).

# 4. Results

## 4.1 Phytosociological description of plant communities in marked transects

Plant communities growing in the transects under study represent forms disturbed by anthropogenic pressure. The most numerous were the species representing the classes *Molinio-Arrhenatheretea*, *Querco-Fagetea* and *Artemisietea vulgaris*.

Plant communities in the non-forest transects delimited within the city limits consisted of a fully developed herbal layer, characterised by 100% cover and dominated by meadow species of the class *Molinio-Arrhenatheretea* including *Rumex acetosa and Festuca rubra* (T1), *Festuca rubra* (T2), *Dactylis glomerata, Lotus corniculatus* and *Calamagrostis epigejos* (T3). The moss layer in the transects under analysis was weakly developed, and comprised *Eurhynchium angustirete*. The plant community in the forest-type transect delimited in the city (T4) was found to have a major proportion of the *Querco-Fagetea* class species including *Corylus avellana* and *Carpinus betulus,* and those from *Vaccinio-Piceetea* including *Pinus sylvestris*. The herb layer was dominated by the following species: *Agrimonia eupatoria, Rubus saxatilis* and *Festuca ovina.* The moss layer was poorly represented, consisting mainly of *Eurhynchium angustirete* and *Plagiomnium affine* (Table 1).

The plant community identified in the standard non-forest transect was represented by a well developed herb layer dominated by *Poa annua*. The plant community in the standard forest transect, on the other hand, was largely dominated by *Pinus sylvestris*, *Quercus robur* and *Corylus avellana*. The herb layer was composed mainly of *Oxalis acetosella* and *Vaccinium myrtillus.* The moss layer in the standard transects was represented by *Eurhynchium striatum*.

## 4.2. Green biomass in plant communities in the study transects

Analysis of plant communities in the non-forest transects reveals the greatest green biomass content in the study plot in Raginisa street (3161.65 g), which is attributed to the fact that the groundcover is mainly composed of meadow species representing the class *Molinio-Arrhenatheretea.* Considerably smaller green biomass quantities were collected from the plots in Andersa street and in Narodowych Sił Zbrojnych street, 1868.85 g and 1457.33 g, respectively. The smallest green biomass content (255.39 g) was recorded in the plant community growing in the forest transect in Ciołkowskiego street. Such a low green biomass quantity is a consequence of the shadowing caused by a compact tree stand in the area and shadowing oriented towards the compact forest canopy.

Statistical analyses fail to demonstrate any statistically significant relationship between the traffic volume, PM10 dust emissions from linear sources and green biomass content in transects selected within the city limits. Total green biomass content depends on the structure and species composition of a given community of plants. In line with the correlation coefficient, there is a very strong positive correlation between the floristic composition of the plant communities under study and the total content of green biomass (r=0.96) (Fig. 2).

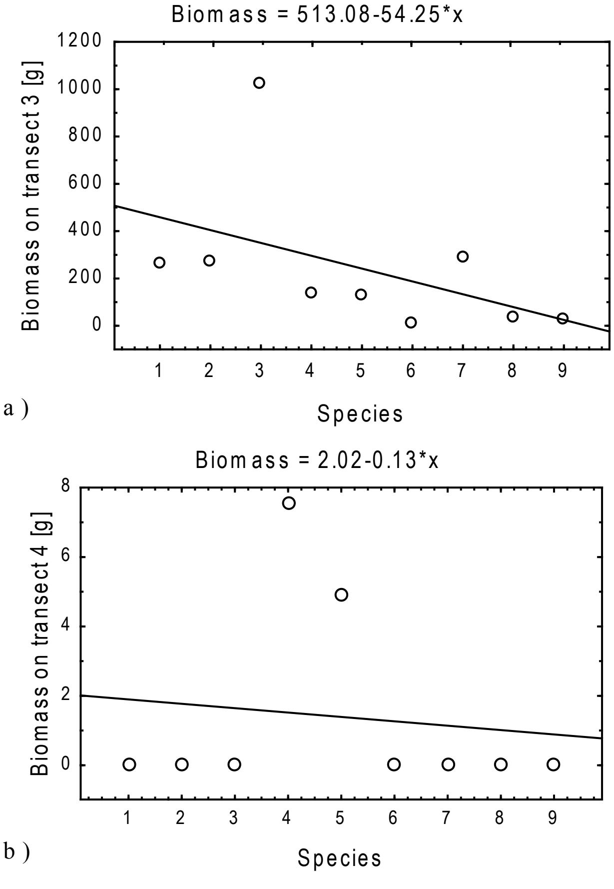

Figure 2. Correlation between the species composition of the plant communities under study and the green biomass content in (a) transect 3 (maximum biomass) and (b) transect 4 (minimum biomass) (1 – *Festuca rubra*, 2 – *Dactylis glomerata*, 3 – *Poa pratensis*, 4 – *Eurhynchium angustirete*, 5 – *Veronica chamaedrys*, 6 – *Plantago lanceolata*, 7 – *Lotus corniculatus*, 8 – *Carex hirta*, 9 – *Elymus repens*)

Table 1. Floristic diversity of plant communities in the studied transects

1. T1 – transect marked in Narodowych Sił Zbrojnych street
2. T2 – transect in Andersa street
3. T3 – transect in Raginisa street
4. T4 – transect marked in Ciołkowskiego street
5. T5 – non-forest standard transect
6. T6 – forest standard transect

| Number of transect | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Number of relevés | | 1 | 1 | 1 | 1 | 1 | 1 |
| Area of relevés ($m^2$) | | 100 | 100 | 100 | 100 | 100 | 100 |
| Date | | 30.08.2010 | 30.08.2010 | 30.08.2010 | 26.08.2010 | 11.08.2009 | 11.08.2009 |
| Cover of tree layer a1 (%) | | 10 | - | 20 | 20 | - | 40 |
| Cover of tree layer a2 (%) | | - | - | - | 60 | - | 60 |
| Cover of shrub layer b (%) | | 50 | 20 | 10 | 40 | - | 60 |
| Cover of herb layer c (%) | | 100 | 100 | 100 | 70 | 90 | 50 |
| Cover of moss layer d (%) | | - | 20 | - | 20 | 60 | 30 |
| Number of species | | 49 | 34 | 45 | 50 | 15 | 39 |
| **Cl. *Molinio-Arrhenatheretea*** | | | | | | | |
| *Rumex acetosa* | | 3 | + | + | + | + | - |
| *Dactylis glomerata* | | 2 | + | 3 | - | 2 | - |
| *Poa pratensis* | | + | 2 | + | - | - | - |
| *Festuca rubra* | | 3 | 4 | + | - | - | - |
| *Poa annua* | | - | + | - | - | 3 | - |
| *Plantago lanceolata* | | - | - | + | - | 2 | - |
| *Lotus corniculatus* | | - | + | 2 | - | - | - |
| *Festuca ovina* | | - | - | - | 1 | - | - |
| **O. *Fagetalia sylvaticae*** | | | | | | | |
| *Tilia cordata* | a2 | - | - | - | - | - | 2 |
| *Tilia cordata* | c | + | - | - | - | - | 2 |
| *Carpinus betulus* | a2 | - | - | - | 2 | - | - |
| *Carpinus betulus* | b | - | - | - | 2 | - | + |
| *Carpinus betulus* | c | - | - | - | 1 | - | - |
| *Eurhynchium angustirete* | d | + | 2 | + | 1 | 4 | 2 |
| **Cl. *Querco-Fagetea*** | | | | | | | |
| *Acer platanoides* | a1 | - | - | 1 | - | - | - |
| *Acer platanoides* | a2 | - | - | - | 1 | - | 2 |
| *Acer platanoides* | c | + | + | - | 1 | - | + |
| *Corylus avellana* | b | - | - | - | 2 | - | 2 |
| *Corylus avellana* | c | - | - | - | - | - | 2 |
| *Euonymus verrucosa* | c | - | - | - | 1 | - | + |
| *Poa nemoralis* | | - | - | - | 1 | - | - |
| *Hepatica nobilis* | | - | - | - | - | - | 2 |
| **Cl. *Vaccinio-Piceetea*** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Pinus sylvestris* | a1 | 1 | - | - | 2 | - | 3 |
| **Cl. *Artemisietea vulgaris*** | | | | | | | |
| *Cichorium intybus* | | - | - | 1 | - | - | - |
| *Oenothera biennis* | | - | 1 | + | - | - | - |
| *Linaria vulgaris* | | 1 | - | - | - | - | - |
| **Cl. *Agropyretea intermedio-repentis*** | | | | | | | |
| *Agropyron repens* | | 2 | + | + | - | - | - |
| *Convolvulus arvensis* | | + | 1 | - | - | - | - |
| **Cl. *Trifolio-Geranietea sanguinei*** | | | | | | | |
| *Agrimonia eupatoria* | | + | - | - | 1 | - | - |
| **Cl. *Stellarietea mediae*** | | | | | | | |
| Silene vulgaris | | + | 1 | + | - | - | - |
| Calamagrostis epigejos | | - | - | 4 | - | - | - |
| **Cl. *Koelerio glaucae-Corynephoretea canescentis*** | | | | | | | |
| *Rumex acetosella* | | - | 1 | - | - | - | - |
| Associated species | | | | | | | |
| *Quercus robur* | a1 | + | - | - | - | - | 2 |
| *Quercus robur* | a2 | - | - | - | 2 | - | 2 |
| *Quercus robur* | b | - | - | - | + | - | 2 |
| *Populus tremula* | a2 | - | - | - | 1 | - | - |
| *Malus sylvestris* | a1 | - | - | 1 | - | - | - |
| *Betula pubescens* | b | 2 | - | - | - | - | - |
| *Betula pendula* | b | 1 | - | - | - | - | - |
| *Prunus domestica* | b | 2 | 2 | + | - | - | - |
| *Prunus domestica* | c | 1 | + | + | - | - | - |
| *Acer negundo* | b | - | + | 1 | - | - | - |
| *Equisetum sylvaticum* | | - | - | - | 1 | - | - |
| *Convallaria majalis* | | - | - | - | 1 | - | - |
| *Artemisia campestris* | | + | - | 1 | - | - | - |
| *Rubus saxatilis* | | - | - | - | 1 | - | - |
| *Plagiomnium affine* | d | - | - | - | 1 | - | - |
| *Oxalis acetosella* | | - | - | - | - | - | 2 |

Sporadic species (+):
*Achillea millefolium* 1, 3, 4, 5; *Knautia arvensis* 1, 3, 4, 6; *Taraxacum officinale* 1, 2, 3, 5; *Agrostis stolonifera* 1, 2; *Carex hirta* 1, 2, 3, 4; *Vicia cracca* 1, 2, 3; *Arrhenatherum elatius* 2; *Daucus carota, Potentilla reptans* 2, 3; *Plantago major, Scirpus sylvaticus, Trifolium hybridum* 3; *Ranunculus repens* 1, 5; *Trifolium pratense* 1; *Equisetum palustre, Prunella vulgaris* 5; *Angelica sylvestris* 6; *Padus avium* (b, c), *Tilia cordata* (b), *Milium effusum, Dryopteris filix-mas* 6; *Viola reichenbachiana* 4, 6; *Polygonatum multiflorum* 4; *Acer platanoides* (b), *Fraxinus excelsior* (c) 1, 4; *Acer campestre* (c) 1; *Lonicera xylosteum*, *Melica nutans* 4, 6; *Carex digitata, Anemone nemorosa* 4; *Campanula persicifolia*, *Euonymus verrucosus* 6; *Pinus sylvestris* (c) 1; *Vaccinium myrtillus*, *Hypnum cupressiforme* 4; *Pleurozium schreberi* 4, 6; *Equisetum sylvaticum* 6; *Artemisia vulgaris, Melilotus officinalis, Solidago canadensis* 3; *Capsella bursa-pastoris, Hypericum perforatum, Medicago lupulina* 1, 2, 3; *Cirsium arvense, Euphorbia cyparissias* 2, 3; *Cirsium arvense, Potentilla argentea* 1; *Anthriscus sylvestris, Geranium robertianum* 4; *Geum urbanum, Veronica chamaedrys* 1, 3, 4; *Urtica dioica, Geum rivale* 6; *Melandrium album* 2; *Bromus inermis* 3; *Melampyrum nemorosum* 4; *Trifolium medium* 1, 2, 3, 4; *Centaurea cyjanus, Myosotis arvensis* 1; *Stellaria media* 4; *Conyza canadensis* 1, 3; *Lapsana communis* 5; *Fragaria vesca* 4; *Verbascum nigrum* 2; *Rubus idaeus* 4, 6; *Humulus lupulus* 2; *Sorbus aucuparia* (c) 6; *Potentilla erecta* 1; *Hieracium pilosella* 5; *Galium verum* 6; *Ribes spicatum*, *Plagiomnium affine* 6; *Quercus robur* (c), *Pyrus communis* (c), *Populus tremula* (c), *Ajuga reptans, Calamagrostis arundinacea, Luzula pilosa, Pteridium aquilinum* 4; *Populus tremula* (b), *Sorbus aucuparia, Crataegus monogyna* (c), *Juglans regia* (c), *Pimpinella saxifraga* 1; *Malus sylvestris* (c), *Pyrus communis* (a1), *Acer negundo* (c), *Rumex conglomeratus* 3; *Crataegus monogyna* (b) 1, 2; *Equisetum pratense* 2; *Hiperniania gabra, Trifolium medium* 5; *Veronica chamaedrys* 5, 6; *Luzula pilosa*, *Equisetum fluviatile* 6.

As for plant communities inhabiting non-forest transects, the green biomass content is mainly dependent on the green biomass present within the groundcover. The less abundant the groundcover in the vertical structure of the community, the smaller the quantity of green biomass. In plant communities located in forest transects the green biomass content depends on the tree and shrub cover.

### 4.3. Variability of green biomass content with account made for distance from the traffic route

The total green biomass of plant communities in the city, analysed with consideration for distance from the traffic route, varies considerably. The greatest green biomass quantity was found at a distance of 4.0-5.0 m from the traffic route in the non-forest community in Raginisa street (1,430.73 g) and in Andersa street (702.86 g) – and in the forest community in Ciołkowskiego street (189.26 g). In the transects delimited in Raginisa and Andersa streets a reduction in total green biomass was observed with growing distance from the traffic route, being the most pronounced at a distance between 24.0 and 25.0 m. The correlation analysis, however, did not reveal a relationship between the distance of the study plots from traffic routes and the quantity of green biomass recorded in the transects. The quantity of green biomass at a distance of 4.0-5.0 m from the traffic route is thus closely related to the number and composition of species and biomass of species growing in the plant communities in the transects.

### 4.4. Comparative analysis of green biomass content against standard transects

Analysing plant communities in the non-forest transects under study, the content of green biomass was found to be the lowest in the standard non-forest transect (T5): 233.43 g. With regard to plant communities in forest transects, the green biomass content was also the lowest in the standard forest transect (T6): 134.69 g (Fig. 3).

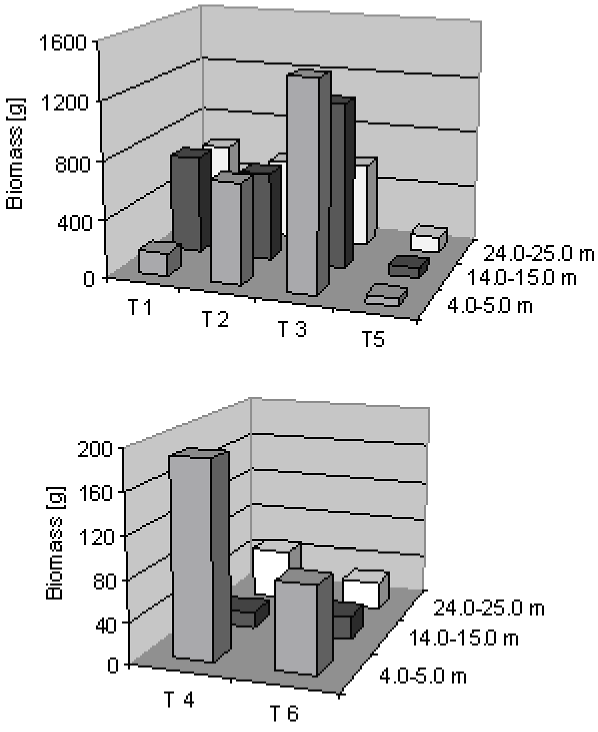

Figure 3. Variability in green biomass in plant communities in a) non-forest transects (T1 – transect marked in Narodowych Sił Zbrojnych street, T2 – transect in Andersa street, T3 – transect in Raginisa street, T5 – standard transect) and b) forest transects (T4 – transect marked in Ciołkowskiego street, T6 – standard transect), with account made for distance from the traffic route

## 5. Discussion

Roads are considered to be the most widespread form of anthropogenic modifications made over the last century (Wang & Zhou 2000). One of major changes associated with this type of modification is the fragmentation of habitat, which may be a significant barrier preventing the migration and dispersal of species (Spooner et al. 2004). However, as well as being a typical anthropogenic disturbance, roads are also corridors serving as conduits which can increase habitat connectivity and ultimately sustain and enhance the population viability of some species (Davies & Pullin 2007). Flory and Clay (2006) claim that if a road functions as an important dispersal corridor and roadside verges provide a good habitat for plant growth, plant diversity is predicted to decrease with increasing distance from the road. Similar evidence was gathered by other researchers as well (Saunders et al. 2002; Theoharides & Dukes 2007).

The increase in bare ground and ruderal species towards the edge of the road verge indicates that both direct and indirect pressure exerted by traffic is an important factor in determining the structure of plant communities along road verges. Disturbance to the edge of the verge by vehicles, combined with the deposition of grit, creates gaps for the invasion by ruderal and weedy species (Truscott et al. 2005). The present study showed that the total green biomass of plant species depends largely on the floristic composition of plant communities under analysis rather than on the distance of the study plots from traffic routes. In city transects, greater total green biomass was found in non-forest plant communities (1,457.33 g – 3,161.65 g) than in the forest-type community (255.39 g), which is mainly attributed to the high green biomass content in the floristically richest group of meadow species of the class *Molinio-Arrhenatheretea* including *Festuca rubra*, *Dactylis glomerata*, *Poa pratensis*, *Rumex acetosa* and *Lotus corniculatus,* and considerable shadowing in forest transects. The biomass values found for the types of plant communities analyses correspond to the mean values determined for them, e.g. the biomass of the forest herbal layer in the middle of summer is from 430 to 1075 kg d.m./ha, while the biomass of meadow in the middle of summer is up to 4000 kg d.m./ha (pdf presentation, www.staff.amu.edu.pl, 2010). The findings of the present study are in line with Truscott et al. (2005) who reported that ruderal plant species, including *Festuca rubra*, *Poa annua* and *Elymus repens*, dominated roadside verges in Scotland. The most abundant weeds, *Taraxacum* ssp., *Cirsium arvense*, *Elymus repens*, *Artemisia vulgaris*, were found in more than 50 out of the 85 sites studied along roads in Finland (Jantunen et al. 2006). The species composition in road verges may be strongly influenced by the period elapsed since road construction, the presence of a seed bank, propagule supply from adjacent habitats and the initial composition of the seed mix (if used). Road verges are often planted with a mix of *Lolium perenne* and *Festuca species*. Roadside verges with coastal influences, with poor soils or along roads that are subject to winter salting, may also contain *Festuca ovina* and *Agrostis stolonifera* (Truscott et al. 2005).

The study also helped establish that total green biomass in non-forest communities within the city is greater than outside the city's limits, which is attributed mainly to the higher proportion of meadow species of the class *Molinio-Arrhenatheretea*. An increase in the amount of green biomass along the traffic routes is related to the influence of the road, which is also evidenced by a greater contribution of synanthropic flora and ruderal species than in the communities undisturbed by the effect of traffic. As far as the foreign species are concerned, only one North American neophyte – *Acer negundo* – was found. A similar clear difference in plant species composition between the roadside habitats and semi-natural grasslands emerged in the studies conducted by Tikka et al. (2000) and Norderhaug et al. (2000). Results of the study by Truscott et al. (2005) add further weight to the growing body of evidence that roadside plant communities are being altered as a result of the use of salt and grit, which is particularly evident close to the edge of the verge. There may also be an interaction between salt and nitrogen deposition, with salt potentially increasing the availability of nitrogen to plants from $NO_x$.

Taking into account the distance of the study plots from traffic routes, the area close to the road had an abundant cover of synanthropic species and robust herbaceous plants, with a higher number of vascular plant species, and a lower cover of mosses. As the distance from the road increased, vegetation became dominated by less competitive stress-tolerant species. The biomass of individual plants was significantly lower in comparison with that of the specimens found closer to the roadway. The observed shift in species composition reflects both nutrient enrichment and level of disturbance along roads. The border between natural and roadside vegetation was sometimes wide, with unstable transitional vegetation of both categories. Watkins et al. (2003) noted that the roadside (up to 5 m) supported a vegetation community different from that of the forest interior. In particular, 25% of all species occurred more frequently within 5 m of the roadside, and plant species were much more prominent near roads both in terms of frequency and abundance. Other studies of edge effects have yielded similar results in that edges cause shifts in plant community composition (Baker & Dillon 2000). Roadside verges have a lower canopy cover allowing more light to reach understory plants, which often results in differences in species composition compared to the forest interior. For example, plants are more abundant along roads with a higher availability of light (Parendes & Jones 2000). Lower litter cover and higher proportion of bare ground also favour those plants that are able to withstand disturbance. Plant communities in which severe environmental stresses test the survival of plants, typically have a smaller number of highly persistent species, however where environmental factors are not strongly limiting, inter-plant competition usually reduces the number of species (Grime 1973). A common finding of other edge studies, though, is an increase in total species richness near the road verge (Euskirchen et al. 2001).

Statistical analyses of the results of this study have not revealed statistically significant relation between the intensity of traffic, emission of PM10 dust from linear sources and the amount of green biomass in the study plots delineated in the city. No correlation has been also found between the distance from the road and the amount of biomass in the transects established near this road. However, the amount of green biomass was found to be dependent on the type and species composition of a given plant community. It is a direct consequence of a positive and very strong correlation between the floristic composition of the study plots and the total amount of green biomass collected from them.

In floristic terms, the vegetation structure of the Białystok city, as compared to non-urbanized areas, has a greater share of synanthropic flora. Indigenous species are declining, particularly in the forests, aqueous communities, marshlands and peatbogs, as well as xerothermic grasslands. Observations demonstrate that vegetation found along traffic routes in Białystok may act as vegetated buffer strips improving the overall functioning of the municipal ecosystem, and play a major role in environmental biomonitoring. Therefore, municipal green areas should be viewed as a crucial biological barrier hindering the spread of air pollution in urbanized areas caused by growing road transport intensity and a major increase in car exhaust gas emissions.

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