*Aplinkos tyrimai, inžinerija ir vadyba, 2009. Nr. 4(50), P. 44 - 50* *ISSN 1392-1649*
*Environmental Research, Engineering and Management, 2009. No. 4(50), P. 44 - 50*

# Changes in Abundance Degree of Biological Key Elements in Woodland Key Habitats of Kaunas Region

**Sigitas Urbonas**
*Vytautas Magnus University, Department of Environmental Sciences*

*(received in November, 2009, accepted in December, 2009)*

This paper focuses on one of the most important issues on environmental protection – biodiversity protection in woodland key habitats. Experimental data were collected from 184 Kaunas region woodland key habitats in the years of 2008 and 2009. 922 biological key elements (BKEs) were evaluated. High hump around tree, hollow tree, fall tree, and stubs were considered as BKEs. Experimental data were compared to the data of a project "Inventory of woodland key habitats in Lithuania". It was established that the abundance degree of BKEs was unchanged in 59 % of cases, significantly increased – in 41%, reduced - in <1 %. The "qualitative" BKEs, showing suitability of the territory, almost unchanged only "*signs of beaver activity"* were newly recorded in 7 woodland key habitats (WKHs).

Key words*: biodiversity, abundance degree of biological key elements, woodland key habitat.*

## 1. Introduction

The Biodiversity Conservation Strategy and the Action Plan of the Republic of Lithuania (1997) as well as the National Sustainable Development Strategy (2003) foresee conservation and rational use of the biological and landscape diversity of our country, promoting natural regeneration of damaged natural elements and components.

Long-term objectives of the strategy aim:

- to conserve landscape and biological diversity as well as originality of the country and its ethnographic regions;
- to develop the network of protected territories and natural framework, to increase the area of Lithuanian protected territories up to 14–18 % of the country's territory;
- to increase public awareness concerning protected territories; to disseminate information on the importance and aims of such territories.

The number of species of different organisms in natural forest ecosystems may remain almost constant for a long period of time. Especially rare species may vanish due to adverse environmental factors. At the same time, other rare species of the region may immigrate, consequently, the total number of species remains almost the same. Besides, locally observed disappearance of certain species in the natural forest is most often a temporary phenomenon – rare species in the natural forest disappear only for a certain time, because this is related not to the changes of habitat conditions, but to other factors (Kurlavičius 2003).

Biodiversity in an unaffected or slightly affected by anthropogenic activities forest undergoes changes, but for a long time it remains rather stable. Primeval forests differed from the current ones not only by the area or the abundance of animals. Trees attaining natural maturity and diversity of dead wood used to be usual phenomena in such forests. Many species of organisms were adapted to such conditions. In natural conditions pine trees may attain the age of 300 years, oak – twice more, even spruce may exceed the limit of 200 years. When a stand attains biological maturity, it contains ecological niches suitable for the organisms of vulnerable and demanding species (Andersson 2003). Natural forest, as compared to the commercial one, contains considerably older (by about 33 times) or averagely-aged dead trees comparing to intensively exploited forests. This is especially important to birds living in hollow trees and small mammals, invertebrates and wood-destroying fungi living in deadwood (Tucker 1997).

Fallen trees left in the forest, thinning residues, stumps and roots as well as forest litter are of tremendous importance to biodiversity. Fallen dead trees, left after felling, stumps of trees provide substratum for establishing and spreading of rare spore plants, most species of fungi and micro-organisms, thus being an important indicator of biodiversity.

By the spring of 2005, in state and private forests of Lithuania the inventory of woodland key habitats (WKHs) was carried out and WKHs as well as the potential woodland key habitats (PWKHs) were singled out. WKH is defined as a forest area with a high probability of the non- accidental occurrence of endangered, vulnerable, rare or care demanding species (Andersson et al 2002). Most of them were allocated on the basis of key forest elements and indicator species. The condition of biodiversity in WKH is indicated by the abundance of biological key elements (BKEs).

The aim of this research has been to ascertain and assess the changes of the abundance degree of biological elements in WKHs in the region of Kaunas.

Biodiversity is of great importance to humanity by conserving our environment, sustaining clean waters and preventing soil degradation. On the species level, biodiversity comprises different forms of domestic and wild animals, plants and micro-organisms, providing an abundance of products, raw materials, services. Some values of biodiversity still have not been sufficiently studied, thus they must be conserved for future generations as potential values (Stattersfield et al 1998).

Biological diversity covers the diversity of different forms of life – genes, species and ecosystems. This term applies to the diversity and variation of living organisms, genetic differences and ecosystems where they live or develop (Gaston, Spicer 2004). According to the Law of Protected Territories of the Republic of Lithuania (2001), biological diversity is the diversity of all species of living organisms, their communities, habitats, ecosystems, as well as their genetic diversity.

In a natural, virgin forest natural biodiversity is formed. It is admitted that in major naturally developing forest ecosystems the changes of biodiversity are rather slow (Kurlavičius 2006).

Biodiversity can be assessed on several levels. During the WKH inventory most relationships were ascertained on the level of both the species diversity and the total number of species (plants, fungi and lichen). The level of the genetic diversity of species and populations is lower, while that of the ecosystems diversity is higher. The general biodiversity may be assessed only having assessed each level separately.

The terms of biodiversity and biodiversity values are applied to characterize biodiversity and peculiarities of the territories where special protected species may be detected. Most often WKHs are singled out on the basis of forest key elements and indicator species.

Most researchers point out that some mosses and lichen partially contain mort mass. According to the substratum, mosses and lichen are divided into epiphytic (growing on live woody plants), epigeic (growing on the surface of soil or forest litter) and epiclisic (growing on deadwood). As compared to the pH of live tree bark medium, decaying wood is more acid, thus mort mass is colonized by a lot of specialized species of mosses and lichen (Humphrey et al 2002).

## 2. Material and methods

The object of the study is BKEs of WKHs in Kaunas region.

BKEs along with other indices allowed to ascertain whether the studied territory is considered as WKHs or not; the WKH territory was also described as based on BKEs. The abundance of BKEs differs greatly among different WKHs. Key elements undergo the permanent changes during development of the forest ecosystem. BKEs were recorded only if they met certain requirements (Andersson et al 2005).

To assess the changes in BKE abundance, five BKEs may be considered as "quantitative" and the abundance of elements based on them is assessed:

*High humps around tree stems* occur in waterlogged areas. Humps are found in damp areas and their size may show how long the forest has been growing in the area. Humps also create additional ecological niches, e.g. for specialized species of mosses. Humps and similar structures may remain after drainage and then they are not considered to be the sign of certain constant living conditions. If grass cover contains no signs of periodical flooding or permanent water logging, or usual forest mosses prevail in the moss cover, it is most probable that high humps are only the relict of earlier times.

*Hollow trees* are required by most rare species, especially insects. Hollows only deeper than 5 cm are recorded. Big hollows of broadleaved trees may be the only suitable habitat for certain specialized species in the region. All hollows containing bird nests as well as the ones suitable for bats and small mammals were recorded.

*Fallen trees* are divided as follows:

- fallen tree with bark – bark covers more than a half of the tree;
- fallen trees without bark – bark covers less than a half of the tree.

If the diameter of the biggest tree stub is greater than 25 cm, such a stub is attributed to one of the types of fallen trees. A fallen and disrupted into separate pieces tree is recorded as one fallen tree.

*Stub* – dead tree with a broken top. A stub is considered to be a key element if it is higher than 50 cm and thicker than 15 cm.

The above mentioned elements were used to assess the abundance of BKEs. They were marked in different columns estimating their amounts. The amount of these key elements estimated to a corresponding degree is provided in Table 1.

*Table 1. Abundance degree of BKEs*

| Amount of BKEs, unit/ha | Degree |
|---|---|
| 1-5 | 1 |
| 6-10 | 2 |
| > 10 | 3 |

The BKEs of different tree species are evaluated as separate elements. It is recorded to what tree species one or the other BKE belongs, pointing out its degree of abundance. In cases when it is impossible to point out accurate tree species, it is recorded either as belonging to broadleaved (Kl), coniferous (Ks) or an unknown tree species (Ne).

Location of the investigated WKHs is provided in Figure 1.

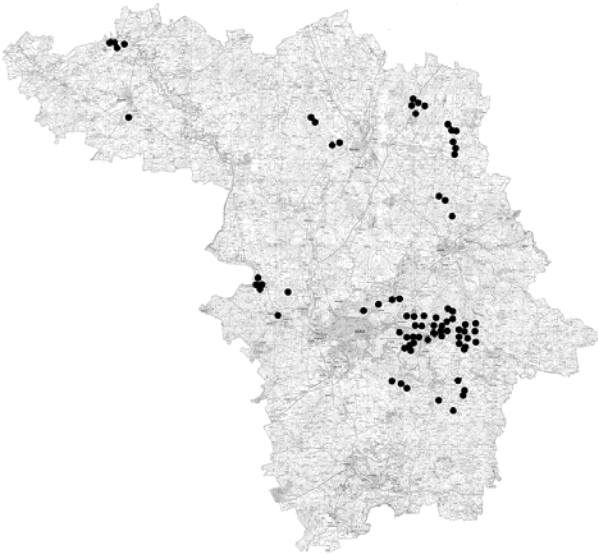

*Fig. 1. Location of investigated WKHs in Kaunas region (black points show the location of the investigated WKHs)*

Location of investigated WKHs and (P)WKHs is shown by black points on the map of Kaunas region. The study of WKHs and (P)WKHs was organized in whole territory of Kaunas region. WKHs and (P)WKHs were selected for the study incidentally. Study method – collection of experimental material, analysis of abundance, comparison to the data on WKHs collected by the State Forest Survey Service and data generalization, a precise Chi-square test applied to the comparison of frequencies. In 2008 and 2009, the studies of 184 WKHs in Kaunas region were carried out during which 922 BKEs and their abundance degree changes were ascertained.

"Statistica" and "Microsoft Excel" software were used for data analysis (Vencloviené 2000). Differences in an abundance degree of biological elements were considered statistically significant when $p<0.01$.

## 3. Results and discussion

*Changes in BKE abundance degree.* In 2008 and 2009, the studies of 184 WKHs in Kaunas region (Kaunas, Kaišiadorys, Kėdainiai, Jonava, Raseiniai districts) were carried out.

Types and amount of the investigated WKHs and (P)WKHs are presented in Table 2.

*Table 2 Types and amount of investigated WKHs*

| No. | codes of types | WKHs and (P)WKHs types | amount |
|---|---|---|---|
| 1. | A1 | spruce and mixed spruce forests | 8 |
| 2. | A2 | pine and mixed pine forests | 19 |
| 3. | B1 | broad-leaved forest | 64 |
| 4. | B2 | other deciduous forest | 14 |
| 5. | C1 | black alder wetland forest | 20 |
| 6. | C2 | spruce and mixed spruce wetland forest | 4 |
| 6. | C3 | pine or birch wetland forest | 2 |
| 7. | D1 | slope of watercourse | 1 |
| 8. | D2 | slope of lake | 1 |
| 9. | D3 | stream bank | 12 |
| 10. | H2 | ravine | 5 |
| 11. | F3 | surrounding of calcareous fen or moist meadow | 1 |
| 12. | J1 | overgrown wooded grassland | 15 |
| 13. | K1 | giant tree | 10 |
| 14. | K2 | group of giant trees | 6 |
| 15. | L | old park | 2 |
| | | total | 184 |

Percentage of WKHs types repartition in the investigated habitats is presented in Fig. 2.

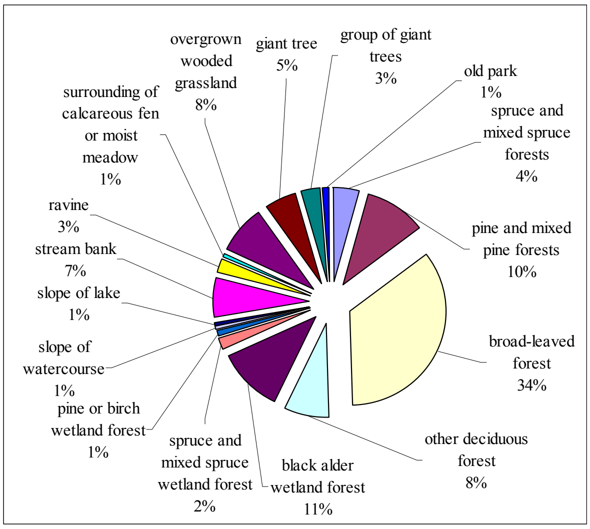


Fig. 2. *Percentage of WKHs types repartition in investigated habitats*

As it can be seen, most of the investigated habitats were "*broad- leaved forest*" (34 %), *"black alder wetland forest"* (11%), *"pine and mixed pine forests"* (10%), *"other deciduous forest"* (8%), *"overgrown wooded grassland"* (8%), the other types registered less amount.

Studies of the investigated WKHs, (P)WKHs have shown the following "quantitative" BKEs changes presented in Table 2.

*Table 4. Abundance degree change in "quantitative" BKEs*

| Biological key element | Group | Abundance degree | Amount of BKE, in 2001-2003 | Amount of BKE, in 2008 | Abundance degree of BKE | | | p |
|---|---|---|---|---|---|---|---|---|
| | | | | | Decreased | Not changed | Increased | |
| High humps around tree stems | 1 | 1 | 7 | 7 | 0 | 23 | 0 | not significant |
| | | 2 | 8 | 8 | | | | |
| | | 3 | 7 | 7 | | | | |
| Hollow trees | 2 | 1 | 125 | 97 | 0 | 112 | 28 | <0.001 |
| | | 2 | 13 | 39 | | | | |
| | | 3 | 2 | 4 | | | | |
| Fallen trees with bark | 3 | 1 | 184 | 79 | 1 | 118 | 108 | <0.001 |
| | | 2 | 31 | 99 | | | | |
| | | 3 | 13 | 49 | | | | |
| Fallen trees without bark | 4 | 1 | 194 | 106 | 1 | 134 | 137 | <0.001 |
| | | 2 | 42 | 91 | | | | |
| | | 3 | 36 | 75 | | | | |
| Stubs | 5 | 1 | 192 | 118 | 2 | 144 | 97 | <0.001 |
| | | 2 | 25 | 69 | | | | |
| | | 3 | 27 | 56 | | | | |

The data in Table 4 show that *high humps around tree stems* were detected 23 times; the degree of their abundance has not changed (compared to the inventory data). It may be explained by the fact that the formation of these biological elements requires a sufficiently long time, meanwhile the time span since their assessment during the WKH inventory in the project period is only from 4 to7 years.

*Hollow trees* were assessed in 140 BKEs, the change in their abundance degree was recorded in 28 BKEs, 4 BKEs of that type were newly recorded, the positive abundance change comprised 20 %. It shows that living conditions for specialized species requiring hollow trees have improved. Change abundance of hollow trees is presented in Figure 3.

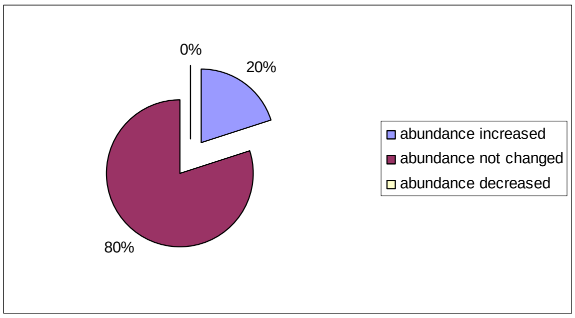


Fig. 3. *Abundance change of hollow trees*

The distribution of hollow trees by tree species is given in Figure 4.

As it can be seen, most of hollows are in linden trees, almost in half of the investigated BKEs, followed by pines and black alders.

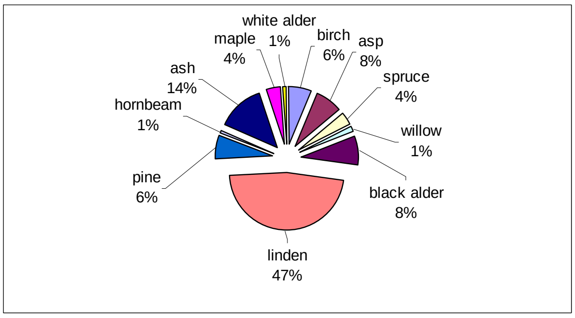


Fig. 4. *Species composition of hollow trees*

Abundance change in *fallen trees* was the most significant. It was registered in almost all BKEs except the groups of *giant trees* and *trees giants*. *Fallen trees with bark* and *fallen trees without bark* are assessed as separate BKEs. An abundance degree of *fallen trees with bark* in 108 (48%) increased, in 1 (<1%) out of 227 BKEs decreased.

Abundance change in *fallen trees with bark* is given in Figure 5.

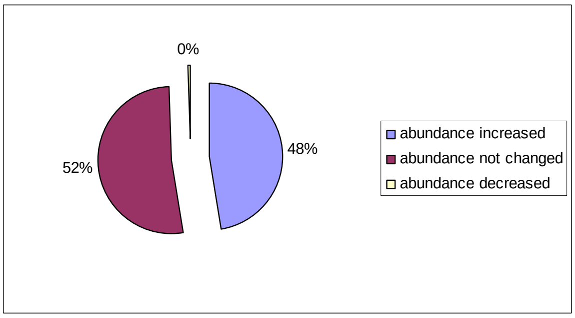


Fig. 5. *Abundance change in fall trees with bark*

Species composition of fallen trees with bark is presented in Figure 6.

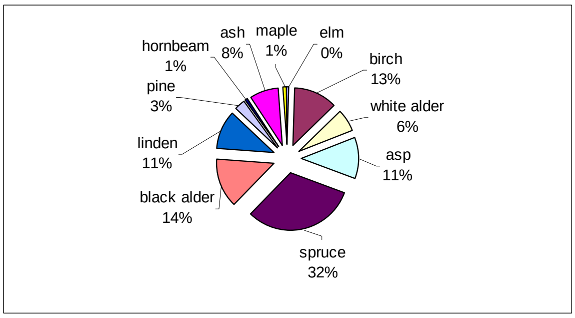


Fig. 6. *Species composition of fall trees with bark*

Abundance degree of *fallen trees without bark* in 137 (51 %) increased, in 1 (<1 %) decreased from the assessed 272 BKEs. An increase in the abundance of the elements is predetermined by natural factors and restricted human activities, by leaving in the forest deadwood mass (mort-mass) which provides specific living conditions for most specialized and WKH indicator species. Abundance change in fallen trees without bark is given in Figure 7.

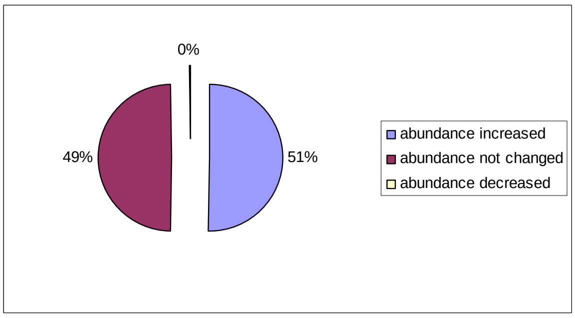


Fig. 7. *Abundance change of fall trees without bark*

Species composition of fallen trees without bark is presented in Figure 8.

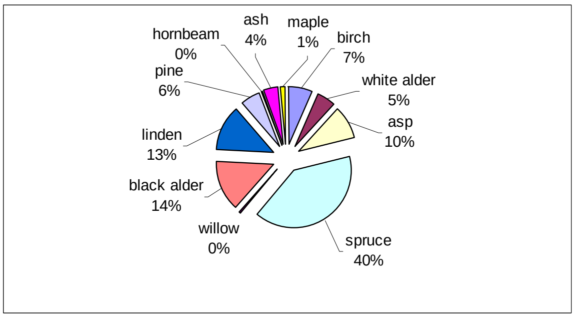


Fig. 8. *Species composition of fall trees without bark*

Fallen spruce trees make even 40 % of this type of BKEs. A big portion, almost one-fifth may be attributed to fallen black alder trees.

*Stubs.* BKE abundance degree of this type increased in 83 (41 %), decreased in 2 (1 %) from the assessed 157. Abundance change in *stubs* is presented in Figure 9.

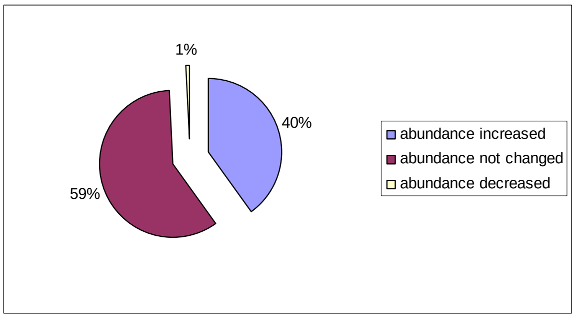


Fig. 9. *Abundance change in stubs*

Species composition of stubs is presented in Figure 10.

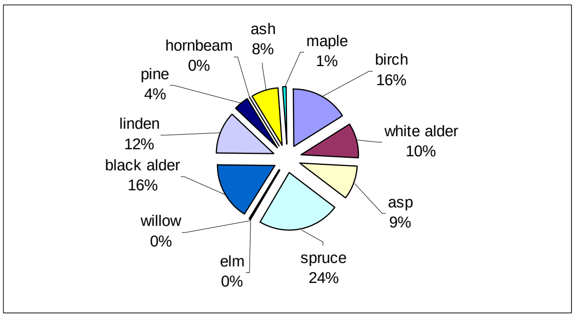


Fig. 10. *Species composition of stubs*

Although fallen trees and stubs are the structures of dead wood, they are assessed as a separate BKE. A stub provides an ecological niche of different moisture regime, differing from that of fallen trees and at the same time providing specific conditions for different species.

The general change in abundance degree of “quantitative” BKEs in WKHs of Kaunas region is presented in Figure 11.

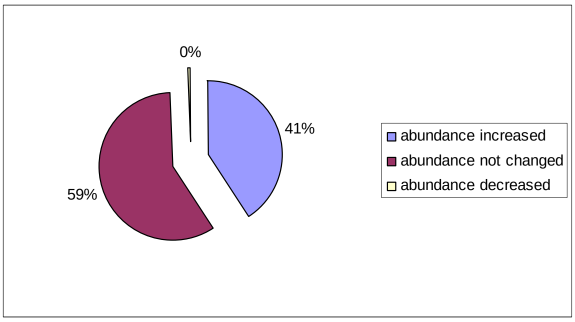


Fig. 11. *Abundance degree change of BKEs in WKHs s of Kaunas region*

In the period from 2001 to 2009, the abundance degree of BKEs in 41% of all **“**quantitative” BKEs in Kaunas region changed.

The “qualitative“ BKEs, showing the suitability of the territory, almost remained unchanged only “*signs of beaver activity”* were newly recorded in 7 WKHs. BKEs should be considered as continuously changing together with the forest development(Anderson 2002).

“Qualitative“ BKEs are presented in Table 4.

*Table 4. "Qualitative" BKEs registered in WKHs,(P)WKHs of Kaunas region*

| | BKE codes | Biological key elements | amount |
|---|---|---|---|
| 1. | 11 | Stand with trees of varying age in the first storey | 113 |
| 2. | 12 | Uneven structure and density | 131 |
| 3. | 13 | Lying deadwood in a few decomposition stages | 51 |
| 4. | 14 | Lying deadwood of many stages of decomposition | 91 |
| 5. | 15 | Many wood inhabiting fungi/conks | 24 |
| 6. | 21 | Many old hazel bushes | 34 |
| 7. | 22 | Four different species of broadleaved trees | 21 |
| 8. | 23 | Three essential tree/bushes species | 8 |
| 9. | 25 | Signs of beaver activity | 15 |
| 10. | 26 | Large nest | 6 |
| | | | 494 |

Percentage of "qualitative" BKEs repartition in the investigated habitats are presented in Figure 12.

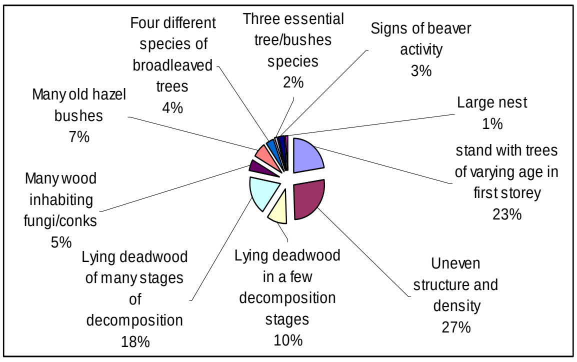


Fig. 12. *"Qualitative" BKEs of WKH,(P)WKHs in Kaunas region*

"Uneven structure and density" - (27%), "Stand with trees of varying age in the first storey" - (23%), "Lying deadwood of many stages of decomposition" - (18%) comprised the largest amount of registered "qualitative" BKEs. The "qualitative" BKEs, showing the suitability of the territory, almost unchanged only "*signs of beaver activity",* were newly recorded in 7 WKHs.

## 4. Conclusions

1. In the period from 2001 to 2009, the abundance degree of BKEs changed in most WKHs in Kaunas region, precise Chi-square test $p<0.001$.
2. Out of the assessed 922, the BKEs were accredited in 184 WKHs, their abundance degree remained unchanged in 59 %; BKEs increased in 41%; BKEs decreased in <1 %.
3. An increased amount of hollow trees indicates the growth of suitable habitats for specialized species.
4. The highest increase in BKE abundance was recorded for fallen trees with bark and without it in 48 % and 51 %, respectively, of all BKEs of this type.
5. An increase in an abundance degree of BKEs indicated the created additional ecological niches and new habitats for specialized species.

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**MSc. Sigitas Urbonas** – PhD student at Vytautas Magnus University, Department of Environmental Sciences.
Main research area: ecology, environmental bioindication, environmental engineering, biodiversity.
Address: Vileikos str.8, Kaunas
LT–44404, Lithuania
Tel.: +370 7 32 79 04
E-mail.: s.urbonas@gmf.vdu.lt

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# Kertinių biologinių elementų gausumo laipsnio pokyčiai Kauno apskrities kertinėse miško buveinėse

**Sigitas Urbonas**
*Vytauto Didžiojo universitetas, Aplinkotyros katedra*

*(gauta 2009 m. lapkričio mėn.; atiduota spaudai 2009 gruodžio mėn.)*

Straipsnyje aptariami Kauno apskrities kertinėse miško buveinėse (KMB) registruoti kertiniai biologiniai elementai (KBE) ir nagrinėjamas jų gausumo laipsnio pokytis. Pateikiami 2008 ir 2009 m. vasarą 184 Kauno apskrities kertinėse miško buveinėse surinktos eksperimentinės medžiagos analizės rezultatai. Tirtose KMB buvo aptikti 922 „kiekybiniai“ kertiniai biologiniai elementai (aukšti kupstai aplink medžių kamienus, drevėti medžiai, virtėliai su žieve, virtėliai be žievės, stuobriai), įvertintas jų gausumo laipsnis ir palygintas jo pokytis, palyginant su projekto „*Kertinių miško buveinių inventorizacija Lietuvoje*“ vykdymo metu surinktais duomenimis. Nustatyta, kad 59 % tirtų kertinių biologinių elementų gausumo laipsnis nepakito, 41 % – patikimai padidėjo, o <1 % – sumažėjo. Taip pat buvo registruoti 494 „kokybiniai“ kertiniai biologiniai elementai, palyginti su „*Kertinių miško buveinių inventorizacija Lietuvoje*“ vykdymo metu surinktais duomenimis, naujai 7 kertinėse buveinėse registruotos - „bebrų veiklos žymės“. Didėjantis kertinių biologinių elementų gausumo laipsnio pokytis rodo aplinkos kokybės gerėjimą biologinės įvairovės išsaugojimo ir naujų ekologinių nišų specializuotosioms rūšims sukūrimo požiūriu.

DOI: 10.5755/j01.erem.50.4.45