

Game Management State and Topicalities in the Context of Small-Scale Forestry in Lithuania

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Abstract

There are some specific features of the Lithuanian game management dating back to ancient times, and the hunting traditions built through the centuries while humans have settled the territory of present Lithuania. Plenty of archaeological remains, historic metrics and folklore all proclaim the honour-founded relations of the ancient Lithuanian people with nature including wildlife. The initial notions of wildlife use and protection formed mostly because of the influence of nature worship. The function of hunting depends on the historical socio-cultural state. In the primitive society the hunting was source for subsistence. The next its character related to the mentioned nature worship and assumed a part of lifestyle based on the spiritual aspects. Further agricultural development of Lithuania has formed a game management as a source of additional food and need to protect human prosperity against damage caused by game. The development of game management was different from other countries because of quite specific history through last centuries. The game management assumed the features of leisure, pleasure, and passion in social life, of a contribution to the nutrition system as well as takes social and economic ground. Presently, changes in the use of natural resources including hunting are one of six EU and Lithuanian national priorities. The total common area of production (hunting area) constitutes 4,178,362 hectares including 1,931,651 hectares of the forest area. The total hunting area involves 897 hunting units, where hunters – users of game resources number 25,000 (FACE 2005). The area of production slightly decreases in comparison with last hunting seasons owing to the changes in an area of the new-formed and re-formed hunting units. The last national legal acts and ratified international conventions and directives defined the game management. Hunting competence, regulation rights, control of the orderliness are validated and divided on the ground of the *Hunting Law* (IX-966, 2002). There are a lot of ambiguous articles on the game management in the small-scale forestry. The main actualities and challenges of game management are discussed in conformity with differences between social groups, property rights, qualitative, quantitative and territorial regulation of game populations, forest damage, benefits of game management and development of the ecological and hunting tourism.

Key words: game management, hunting rights, legal acts, forest owner

Introduction

In the last decades forests have gained new functions in society in Lithuania. Forests provide not only timber but also a wide range of multifunctional benefits as non-wood products and services. One of following is hunting, whereas game management is not only hunting as an activity that pointed to use game by seeking, lurking, stalking and shooting. Game management is oriented to sustainable use and conservation of wildlife resources including the system of arrangements and economic measures to protect wildlife and their habitat, and improve habitat carrying capacity. Game management combines entitlements and obligations of involved parties. The main objects of game management are game and their habitats. Game embody animals, by the valid legal acts, which were hunted before, are hunted presently and could be hunted in future (*The Hunting Law* 2002). Game in-

clude just half number of wild animals. There are a great deal of the legal and post-legislative acts that regulate game use and their habitat protection.

The policy of game management would be to discourage unsustainable use of game resources. It aims to regulate the use of wildlife resources managing their populations qualitatively, quantitatively and territorially, maintaining diverse and healthy wildlife populations and decrease damage caused by game to forest and other lands. Game population qualitative parameters (as age and sex composition), potential useful affect to nature, and further, use of the well-chosen census methods (Munch 1978, Grubešič, 1998, Padaiga 1996, Belova 2001, 2002). S. Shvarc (Shvarc 1980) assumed that productivity of game population should be obtained through the optimal composition and structure of their populations that is the basis of game management. Game management has to be compatible with the needs of wildlife considering the complex

forestry, agriculture and environment protection interests. New legislations and restrictions are implemented in Lithuania to target game management including hunting on the new level consistent with EU nature conservation legislation (*Council Directive 92/43/EEC, Council Directive 79/409/EEC, CITES, Bonn Convention 82/461/EEC, etc.*). Management for wildlife could provide a wide range of benefits for small - scale forestry. Numbered local game populations could provide recreational opportunities (such as ecological and hunting tourism). Forest owners could receive additional income through the development of ecological tourism, outdoor classroom for education *etc.* As concerns the hunting tourism, this field of non-wood products and services is difficultly negotiated for many forest owners as well as the main action as hunting. The present legislation on hunting is not suitable in small-scale forestry for the further development and sustainable use. The study aims to analyse the condition and challenges of game management and its main activity as hunting.

Material and methods

The data for analysis were collected using statistical yearbooks, hunter organizations’ and environmental sourcebooks, sources of historical evidences, scientific and special publications, and inquiring, n=175. The calculations were based on officially published

data, and data on the monitoring of game and their habitats and sustainable use of game resources on 20,765 hectares of total area within the established research network. The method of comparative analysis has been used. The determination of the history of game management in Lithuania and its present condition including changes in hunting grounds, harvesting level, hunters’ and responsible organizations, general legal basis, involvement and share of small-scale forestry other related items are presented. I have separated natural and legal stakeholders involved into the game management course including their user and processor position and place of the private forest owners. On the ground of analysis, the recommendations and proposals are submitted.

Results

Hunting traditions and further game management have built through the centuries since earliest inhabitants have settled on present-day territory of Lithuania 10,000 BC. Afterwards, archaeological remains, historic metrics and folklore all proclaim the honour-founded relations of the ancient Lithuanian people with nature including wildlife. The historic formation of game management encompasses seven main stages as follows (Table 1).

The initial notions of wildlife use and protection formed mostly because of the influence of nature

Table 1. Development of game management and changes in landowners’ rights in the territory of Lithuania

Development stage/precedence	Character	Landowners’ rights	Legal basis	Notes
I. Initial: - Game management/ hunting	substantial spiritual	before social stratification	nothing	Pre-civilization, Pleistocene Era
II. Game management/ hunting - game management in embryo	additional food source, defence of lands; soldiery training	traces of proprietary rights	indeterminate	Cooper Age and later; husbandry
III. Game management/ hunting	additional food, pleasure, leisure, recreation	proprietary rights	Casimieras’s Statute-Book, Valakai Law, Lithuanian Statutes	first sanctuaries; defence of large landowners’ rights; large game under State property; start of licence hunting
IV. Game management	luxury, leisure, recreation, household economy	proprietary rights	Hunting Law, 1892	Game under property of prosperous landowners; Russian Empire period
V. Game management	recreation, leisure, food industry, household economy	proprietary rights, leasehold	Hunting Law, 1925, 1935 Hunting rules, 1937	Hunting Fund, CIC membership;
VI. Game management	leisure, recreation, addition for food industry	state property	Hunting rules 1947; Law of Nature protection 1959; <i>etc.</i>	Soviet period, Soviet legal acts. No private property
VII. Game management	recreation, leisure, addition for food industry; hunting tourism, ecological tourism	state property rights; large landowners’ rights	Hunting Law 2002, Hunting rules 2002, Law of Wildlife 2001, <i>etc.</i>	Post-soviet period, EU membership. By Constitution, game <i>res nullus</i> ; By Hunting law, game are under state property

worship. On the dawn of human existence, hunters of primitive society used harvested animals to meet human vital demands and initiated the growth of sociality. Use of wildlife was pointed for survival, none for leisure or pleasure. Afterwards, man started to domesticate wildlife. This fact decreased hunting demands for subsistence. However, it promoted defensive function of hunting whenever game caused damage to human property. Traces of proprietary rights have emerged. In 9-12 centuries AC, Lithuanian Dukes have owned lands, forests and game resources. Lithuanian Grand Dukes awarded forests and lands together with game resources to nobility. Thus, nobility have proprietary rights to game resources and hunting grounds. At the same time, there were away a great number of saint places where hunting and other use of natural resources was forbidden even the walking was prohibited without special permission. From the middle of the 15th century the long-time traditions were dwindled. Nobility hunted not only for demand to feel passion or nature and feat, but also due to relaxation. They owned the right to use or protect forests with inner resources. In late medieval times the first big game sanctuaries were established, for example, in 1541 for the European Bison *Bison bonasus* (L.). The first embryo of the game regulation rules was occurred in *Casimieras's Statute Book*. In 1588, the order of the use of game and other forest resources was defined in the *Valakai Law*, and rights and obligations as well as fines for breaching the use of these resources were stated in the *Lithuanian Statute*. Hunting for food was a vital activity for ordinary people, though restricted. This period expressed the defence property rights of prosperous landowners' and king (*i.e.* state). There is also quite important feature of this time such as big game were assigned to state property while the rights of ordinary people (peasants) were also defended by the *Valakai Law*. They had full right to use only small game and sell them all alone. Foresters and other forestry staff had right to hunt only with special permit by King. A specialization is characteristic of game management as each forester has his own duties. Game habitats as the large forests were considerably reduced and fragmented under the Russian Empire 1795-1914. Nevertheless, game management has been developed in the large tenure of prosperous landowners. At the same time, the desultory, irregular game management had prevailed in the small households and other hunting grounds. From 1892, game resources were managed by *The Hunting Law* (1892). In time under the reign of Russian Empire, this Law has aimed to confirm the right for nobility and prosperous landowners to game resources. Large landowners had right to hunt all game species all year round without any restrictions. Dur-

ing the period of independence between two World Wars, *The Hunting Law* (1925, 1935) and *Hunting Rules* (1937) have laid the foundation for legal game management; however, populations of big game remained insufficient. Landowners and state rented out their land to hunters. The Hunting Fund was formed aiming to develop game management. The further development of the game management was quite different from many other European countries. In the Soviet time, only state property of game resources and land has run. After World War II, a number of the forest areas were designated as hunting reserves. Hunting was forbidden or strongly restrained to restore populations of game species that were noticeably declined during WWII. The central hunters' association had been freely supported by sovereign power. Because of the great interest of power in hunting as the mean to gain more personal benefits, game management has been developed suitably.

After independence was restored in 1990, the share of private sector has risen importantly even as the process of privatisation and restoration of proprietary rights runs up. The changes had a profound effect on forest ownership and access to resources. Game management becomes important for household economy and private forest owners not only as additional and fancy food but also as benefits from development of ecological tourism and recreational hunting. However, landowners' rights to game management and the course of the hunting access or prohibition contract are unspecified in the present-day legal acts.

Presently, changes in the use of natural resources including hunting became one of the six EU and Lithuanian national priorities. The questions of the day became the use and protection of game resources.

Game management would be integrated in nature conservation, oriented towards sustainable hunting and forest management. Hunting pressure can cause the impoverishment of game species. Humans are the main threat to game. The sound game monitoring and management has to be carried out. Well-regulated use of these valuable natural resources has proven on many occasions to be a better conservation tool than a total ban. Usually a blanket prohibition encourages use less sustainable forms, circumventions because of the absence of a link to the socio-economic aspects. The question of use and protection of game resources is closely linked with forest and game management and environment protection (Belova 2002). The basis of the game management is data of their number on a certain territory. Game number decreases or overpopulates not only because of their direct elimination or regardless of game population parameters through the hunting. It should be underlined that even if game are

hunted intensively, the important reason for undesirable changes in their populations is mistakes related to an impoverishment and destruction of game habitats and food sources, their disturbance through expansive recreation and settlement activities. Therefore, 95% of problems arose because of the above-mentioned reasons. Habitat destruction, escalation of the inter-competition for the vital limiting sources cause essential changes in the interaction between game and environment including a property of forest owners. The restoration of balance grounds on the territorial management by the regulation of game habitats and their distribution throughout, qualitative management by the regulation of the age and sex structure of game populations, and quantitative management by the regulation of game number corresponding with the carrying capacity of habitats. Evaluation of the role of game species and damage caused by game to forest and lands has to be differentiated considering game value to forests, the use of game resources, hunting methods and facilities, forest protection measures and their efficiency. Damage caused by games is often ascertained with the prejudice while the basis of assessment is sample plots where damage is strongest, and further extrapolation of results throughout the total territory. Then, the hunting quotas and recommendations for the maintaining of the optimal density of game populations are based on these results. Here is an example when a local game population could decline because of the overmuch hunting of the adult game while the productivity of young animals is insufficient to renew the population. Game management encompasses some successive steps on any territory ensuring sustainable use of their resources as follows: 1) animal census, 2) assessment of reproduction of their populations, 3) assessment of the environmental factors and definition of their significance, and 4) monitoring of the significant factors of game populations and their habitats. These items have been mentioned as far back as 1933 by the notable author of game management, Aldo Leopold (1933). The goals of today are the management of game populations; determination of their existing, permissible and ecological density; assessment of the interaction between game and forest vegetation; assessment of the carrying capacity and improvement of game habitats; restoration and maintaining of the balance between game and their environment components, delineation of the territory for game. The hunting, namely, is the main way for biological regulation of game populations that is important to manage the renewable resources of wildlife and maintain at the optimal sustainable level. However, sustainable use of game resources is not only hunting and maintain-

ing of the permanent level of use. That is also the increase of endangered, rare and protected species, and decrease of the overabundant species or harmful to environment and human society. This is the way to protect game and maintain the optimal level of their use and management of numbers. Meanwhile, a great while game management has been developed in the unacceptable direction when the numbers of big game were increased while the other game did not catch a sufficient attention and have declined. The resolving of the issues of the optimisation of game management is given trouble because of the changes in property forms, collision between consumer's and non-consumer's standpoints to game resources, misunderstandings in the game legislation, purposes of the hunting to increase numbers of some species up to their spill-over while the conflict between man and game increases.

Today the total common area of production, or hunting area constitutes 4,178,362 hectares including 1,931,651 hectares of the forest area. The total hunting area involves 897 hunting units, where hunters – users of game resources number 25,000 (FACE 2005). The area of production some decreases in comparison with last hunting seasons owing to the changes in an area of the new-formed and re-formed hunting units.

The recent national legal acts of relevance to game management define the game management to a diverse extent. The legal acts contain innovations associated with EU legislation. The legal acts address issues of game protection and management with greater consideration of biodiversity protection. They emphasise more on the management quality, planning and monitoring for the sustainable use of game resources and protection of their habitats. The subject of hunting and game management, hunting competence, regulation rights, and control of the orderliness are validated and divided on the ground of *The Hunting Law* (IX-966, 2002), *Hunting Rules* (2002, 2004) and *The Law of Wildlife* (IX-638, 2002) in Lithuania. Game are defined as the harvested wild animals (hunted, caught alive or unalive animals), for whom the hunting season is set as well as their parts, shed antlers, and other living products. The main (game parts, which are evaluated by special formulas such as deer antlers, mouflon horns, wild boar tusks, carnivores and other skulls, wolf and lynx fur) and secondary trophies go under ownership of the person entitled to hunt (*i.e.* hunter) from a legal point of view. According to the valid legal acts, game belongs to nobody, as part of the land on which it occurs. By the Constitution of the Republic of Lithuania, the State declares concern with the protection of natural environment, its fauna and flora, supervises the sustainable use of natural

The Bodies by chain of order

Rights and obligations

State Government level:



NGO /small-scale forestry level:

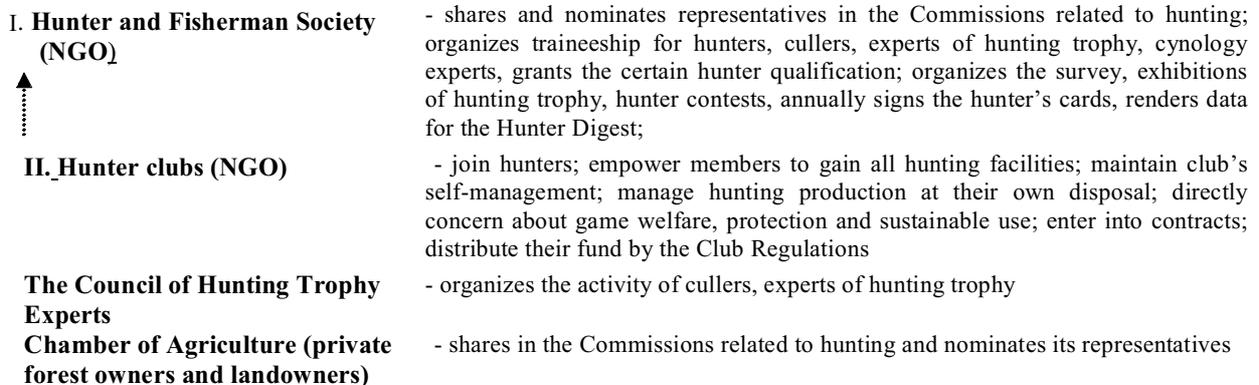


Figure 1. The main rights and hierarchical order of the stakeholders of game management

resources, their restoration and augmentation. Above-mentioned *Hunting Law (2002)* declared that by proprietary game are under State ownership. *The Forest Act (2001)* excludes wildlife from forest resources altogether while the present *Programme of The Government of the Republic of Lithuania for 2004-2008 (2004)* underlined an important task to ensure the implementation of the integrated system of management and protection for game management and forestry (task 7.15). On the ground of recent legal acts the main game resources users are the group of non-associated persons and associated members of different local hunter associations. The members of the Lithuanian Association of Hunters and Fishers constitute 90.8% of hunters and 9.2% of hunters belong to other Hunter organizations.

As game management is historically traditional and related to the social and economic area, a wide variety of interests of different stakeholders arises and should be taken into consideration. The main rights, obligations and interests of various stakeholders are shown in Figure 1.

The share of the private property constituted 31% of the total forest hunting area. The share of private area of production has increased from 25.9% in the previous 2001/2002 hunting season to 31% in the last season 2002/2003. Although the main role of processing of game production as an important part of game management comes to the private sector, it is mainly concentrated in the large closed joint stock enterprises, and only nearly ~10% fall to the small-scale sector. Next source of incomes from game management is the hunting tourism. The private forest professional hunting area has constituted 11,416 hectares in 2002/2003 and increased as compared with 10,507 hectares or 4.2% in 2001/2002. The state forest hunting area designed for the hunting tourism decreased respectively and constitutes 82,643 hectares. The main coordinator of the management and use of these hunting areas is the General Forest Enterprise under the Ministry of Environment that also settles and revises the advisable tariffs for hunting taking into consideration external changes in hunting prices. Special Personal Enterprises "*Felis*", "*Explore Baltija*", "*Hubertus Baltic*", etc. organize and pursue both domestic and external hunting tourism.

What is the role of the small-scale forestry? There are 32 countryside farmsteads that offer domestic hunting tourism facilities as a part of the village tourism. In this case, Nature-Based Tourism becomes a part of game management and is treated as tourism to natural areas promoting knowledge of nature, appreciation and conservation of the native culture and lifestyle, including hunting (active-consumptive tourism),

and hiking and observation (active/non-consumptive tourism). Game watching and photography (passive/non-consumptive) would provide the further enhancing non-traditional activity of the game farming and increase diversification of farms in pursuance with rural development objectives in harmony with nature; hunting ammunition service, development of trade of game production (game meat inc. venison; trophy, fur, skin, pelage, etc), processing, recreation services, feeding network, food safety and health services, forestry activities, household, employment, vocational training and consulting service, technical infrastructure in rural areas such as water supply, road and telecommunication systems as well as cultural heritage protection service. Today, the profit of game management is shared on the ground of valid legal acts. Owners or users of hunting area own the main production and dispose it at their own discretion including personal use and selling. By the valid legislative acts landowners, who have contractual agreements and permitted to hunt on their territory, are recompensed for the damage caused by game to forest and agricultural crops. If they have forbidden to hunt on their territory and made a veto request to the Commission of the Hunting Area Unit (HAU) Formation of the local municipality within 1 month, are not recompensed. Landowners – hunters have right to form the hunting area unit only on the condition that the hunting area unit is not less than 1,000 hectares. In the concrete, it is possible only in cooperation with the not few neighbours – landowners. In this case, landowners dispose hunting area and hunting production at their own discretion. Licences are obtainable in the same way from the Regional Environment Protection Department. Contractual obligations and agreements between landowners and resources managers/users are sound to the *Hunting Law* and followed post-legal acts including the *Regulations of the Professional Hunting Areas*. By *Hunting Rules 2000*, the land users made any amount of contracts with small land/forest owners to use their territories for hunting previously. Contracts between users and land/forest owners or managers, that were signed up to amendments of the *Law of Wildlife* became effective (2001), are valid by the succession right. This way of the entering into contracts had been treated as quite difficult process because of the hundreds of contracts. Today, by the valid legal acts private forest owners must apply to the Commission of HAU (Hunting Area Unit) Formation or local municipality for the veto or have contractual agreements with users of hunting area units that are their property or are adjacent to their land. Unfortunately, there are missing of the necessary post-legal acts rendering the precise set of actions to do it.

The sensitivity, adaptability and vulnerability of the game management in small-scale forestry sector expresses through the analysis of the existing internal Strengths and Weaknesses in combination with external Opportunities and Threats providing the main sets and options for game management.

Strengths:

- Comparatively numbered game populations,
- Advantageous qualitative structure of game populations,
- Species diversity,
- Game habitat diversity,
- Sufficient food supply,
- Forest and adjacent open lands potential for further development of game management,
- Potential of improvement of game habitats and populations,
- Deep historical tradition of game management,
- Development of village tourism in small-scale forestry,
- Increasing of nature-based tourism including active and passive hunting tourism,
- Nature and hunting attractiveness for further development of game management,
- Potential for the development of unconventional enterprises.

Weaknesses:

- Over-consumer standpoint on the game resources,
- Insufficient interest in the sustainable use of game resources,
- Smallholding in forestry and agriculture,
- Smallholders are too much for the formation of HAU,
- Vacancies and indeterminacies in *Hunting Law* definitions and articles related to the forest/landowners rights, and insufficient appropriate post-legislation,
- Uncompleted agrarian reform and uncertainty of the proprietorship of smaller forest/landowners,
- Insufficient game census,
- Illegal hunting,
- Unheeding of the research recommendations.

Opportunities:

- A convenient geographic location between the East and West, the North and South creates favourable conditions for incoming hunting tourism development,

- Potential of an external market of game management production,
- Further improvement and development of game management-based services,
- External collaboration at all stages of the game management chain,
- Increase in the welfare of rural society drawing part of unemployed rural inhabitants into the hunting tourism and related services and stimulate its development, improve living condition in economically and socially underdeveloped regions,
- Increased incomes from nature-based tourism in small-scale forestry,
- Co-operation of different social group of the society,
- Strengthening of internal coherence and increase of international importance of local game resources helping to ensure more effective use and protection of resources.

Threats:

- Uncontrolled and unorganised nature tourism cans poses a serious threat to the wildlife habitats, increases anthropogenic loads on sensitive natural territories,
- Further intensive urban development may escalate conflict of interests among sustainable use of game resources and restoration and protection of their populations and habitats,
- Possible outflow due to insufficient interest of stakeholders and difficulties of start-up enterprises,
- Poaching.

Recommendations, proposals for documentation

On the ground of the SWOT analysis and survey of the game management for small-scale forestry, deep historical traditions and standpoint on game management in Lithuania, recommendations and proposals are consequent on the SWOT analysis. At once, considering the changes in the game management towards the sustainable use of game resources and future development potential of the small-scale forestry some important guidelines would be taken into consideration such as:

- Partnership principle (grounded on the participation and co-operation of different social group of the society from intergovernmental, to private enterprises and persons on equal partnership principle;

- Eco-efficiency principle even as production and services develop faster than consumption;
- Precaution principle when development and implementation of the game management in small-scale forestry are done on purpose to reduce negative impact on game resources and their habitats as well as human health;
- Principle of equal opportunities to development and implementation of activities;
- Flexibility principle when activities are adjusted in a flexible way, considering rapidly changes in the external and internal conditions;
- Responsibility principle;
- Coherence principle when activities must be implemented by interconnecting environmental, economic and social objectives of different economic sectors not only game management;
- Science and knowledge principle taking into consideration the modern scientific achievements, knowledge and experience.

Science and knowledge would become one of the most important guideline of game management. There is no question that sustainable use of game resources depends on the state of game management. It is also evident that the apologia of the natural regulation of game populations is a misconception under present conditions. This is incomparable with retrospective situation, as a numerous populations of the big carnivores had fulfilled their duty as a natural regulator. The use of the population ecological reserve should be considered, *i.e.* population ability to recover the mortality both natural and induced by human activities. This ability determines hunting quotas and its proportion depends on the game living conditions and dynamics stage.

Training and ecological education at all levels will give an opportunity to form an open-minded, creative and self-dependent entrepreneur or other person who feels responsible for the welfare of game, their habitats and nature and preservation of cultural and historical identity. EU membership holds forth more rapid and positive modernization of game management, intensify participation in international knowledge exchange programmes, help to adapt experience of different countries in the design of modern, environment-friendly game management and strengthen its scientific research base in a shorter period of time.

Conclusions

The subsistent hunting that occurred at the dawn of civilisation had transferred through centuries to present-day game management that founded on the recreational hunting and sustainable management of

game resources and their habitats.

The function of hunting depends on the historical socio-cultural state. In the primitive society the hunting was a source for subsistence. Its next character is related to the nature worship and assumed a part of lifestyle based on the spiritual aspects. The development of game management was different from other countries because of quite specific history through last centuries including the period under the reign of Russian Empire 1795-1918, next period of the independent Lithuania between two World Wars, 50-year long Soviet period and last period after independence had been restored. Game management assumed the features of leisure, pleasure, and passion in social life, of a contribution to the nutrition system as well as takes social and economic ground.

Formation of the private game management initiates the development of hunting facilities, game farming and further processing and trading. The total private hunting area constitutes 11,416 hectares and has further uptrend. Joint stock Company *Viltlit* is the main venison processing company while other large meat processing companies "*Utenos mėsa*", "*Nematekas*", "*Agaras*", "*Krekenavos Agrofirma*" contribute fractionally Nature-Based tourism including hunting tourism would be risen as an important branch of the existing and developing small-scale forestry. The hunting tourism is treated as the active consumptive branch that could be combined with non-consumptive passive branch such as game watching and photography and non-consumptive active one as the hiking and watching- photography tour.

Maintaining hunting areas compatible with the needs of game provide several benefits tin small-scale forestry. Numbered game populations and natural habitats provide for the development of recreational activities, village tourism, and coherent services, improve living conditions of indigenes and initiate appropriate opportunities (see SWOT). The main barriers to entrepreneurship related to the indicated weaknesses and threats as well as insufficient dissemination and clear explanation of the up-to-day legal acts and related amendments, initiative of potential entrepreneurs and lack of management practices designed to ensure the ecological sustainability of game management, training of forest/landowners, imprecision and indeterminacies in the main legal acts lacking of the corresponded post-legal acts. The precise and legally defined way to contract for hunting access or prohibition must be conveyed to each private forest owner. The negotiated rates would be done in a manner similar to the determined course for all hunting units. As necessity of game management the item of habitat management may be determined. The circumstances

of payback and possibilities to update to new options depending on the changes in area have been described. Owners would have right to cancel his contract before the contract expires. Unfortunately, the process of contracting is quite ambiguous.

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СОСТОЯНИЕ И АКТУАЛИИ ОХОТНИЧЬЕГО ХОЗЯЙСТВА В КОНТЕКСТЕ МЕЛКОХОЗЯЙСТВЕННОГО ЛЕСОВОДСТВА В ЛИТВЕ

О. Белова

Резюме

Некоторые специфические черты охотничьего хозяйства Литвы, датируемые с древних времен, и охотничьи традиции формировались с времен заселения нынешней территории Литвы. Многочисленные археологические факты, исторические метрики и другие источники указывают на глубокие связи с природой, в том числе дикими животными. В данной работе анализируется процесс развития охотничьего хозяйства и его настоящее состояние, суть в государственном и мелкохозяйственном частном лесном секторе. Функция охоты основана на историческом социально-культурном положении. Первичные понятия о пользовании и охране ресурсов диких животных формировались наиболее под влиянием природоверия. Представлен SWOT анализ, выявляющий критерии нынешнего состояния и актуальности охотничьего хозяйства, важность количественной, качественной и территориальной оценки популяций охотничьих животных. Поставленные вопросы решаются в соответствии с различиями между социальными группами, правами собственности, ведением комплексного лесного и охотничьего хозяйства, вредом наносимым охотничьими животными лесному хозяйству, пользой охотничьего хозяйства и развитием экологического и познавательного туризма.

Ключевые слова: охотничье хозяйство, права охоты, правовые документы, собственник леса

Past and present nest-site requirements of the Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) and their possible conflicts with timber harvesting

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Abstract

Recently, the growing demand for raw timber has resulted in the intensification of forest use in the Baltic countries. The aim of this study was to examine whether the increased timber harvesting during the last decade has influenced the requirements of the Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) for their nest-sites. In 2004, 7% of checked Lesser Spotted Eagle territories were disturbed by forestry operations. The general tendency was that the characteristics of stands used for nesting differed from the average forest stand characteristics in the landscape less than a decade ago. Eagles were found to nest in 19 different forest types, while previously just 13 of such forest types had been recorded. Less productive forests (2nd site class) and normally irrigated stands were not avoided nowadays. The average age of nest stands decreased by 16 years. Though oak remained one of the most preferred nest-trees (20% of all cases), spruce became the most common one (48%). This leads to the assumption, that the eagles are less selective nowadays than in the past. The increased timber harvesting during the last decade might explain why eagles switched to nest in stands, more similar to the surrounding forest landscape than in the past, and why some nest-site preferences remained and others disappeared. It is likely that during the next 30 years forest operations will be one of the most important factors, having an effect on the Lesser Spotted Eagle population in Lithuania.

Key words: Lesser Spotted Eagle, nest-site selection, timber harvesting, disturbance

Introduction

Recently, the growing demand for raw timber has resulted in the intensification of forest use in the Baltic countries. Timber harvesting in Lithuania has always been relatively uneven, especially during the war and occupation periods. State's policy between the World Wars I and II was to tolerate the expansion of the arable land to replace the forests. Significant increase in country's forest resources took place between the 1950s and 1990s, when harvest volumes were reduced and the required timber was taken from outside (Russia) resources (Kairiūkštis 2003). However, after the re-establishment of the independence, followed by the process of restitution of private forests ownership, forest felling started to grow up (*Lietuvos miškų ūkio statistika* 2003).

Unbalanced forestry usually reduces the availability of some structural elements in forests, thus many species, which require such elements as habitats, have suffered declines, become threatened or extinct (Löhmus 2003a). It is well known that harvesting of ma-

ture forest stands is one of the main factors influencing the abundance and regional distribution of forest birds (Virkkala 1987, Avery and Leslie 1991, Haila *et al.* 1994, Edenius and Elmberg 1996, Jansson 1999). There exists a general consensus that many boreal and temperate forest raptors have specific requirements for their nest-sites, which may be in conflict with the intensive forestry (Löhmus 2003a). It is unlikely that the timber harvesting increase during the last 12 years has not had any impact on forest raptors.

Raptor species differ in their tolerance to anthropogenic activity (Krüger 2002), including timber harvesting (Löhmus 2003a). Raptors are influenced by the increased disturbance levels, the alteration of foraging areas and nest-sites (Löhmus 2003a). For this investigation we have selected the Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) - a sensitive forest raptor species which clearly prefers to nest in mature forests and large trees (Löhmus 2003a). Apart from this reason for possible conflict between the Lesser Spotted Eagle (LSE) nest-sites requirements and timber harvesting, this species is sensitive for other reasons

as well: low reproductive rate (Cramp and Simmons 1980, Bergmanis *et al.* 2001, Vali 2003), high first-year mortality - approx. 60% and heavy persecution in migration places (Meyburg *et al.* 2004). LSE has unfavourable conservation status in Europe (Tucker and Heath 1994) and it is included into the EU Birds directive list Annex I (EEC/79/409). Nowadays, forest felling operations are assumed as the main threats for this eagle species (Meyburg *et al.* 2001). Considering the small distribution range, which is concentrated to Eastern Europe (Bergmanis 1999), it is highly probable that the growing forest harvesting in this region might have critical adverse impact on LSE world population.

The aim of this paper is to examine whether the increased timber harvesting during the last decade has influenced the requirements of Lesser Spotted Eagle (*Aquila pomarina* C.L.Brehm) for their nest-sites.

Material and methods

The nests of the Lesser Spotted Eagle were searched for in 18 administrative districts of Lithuania during 2001-2004, though the main material was collected in the central, northern and eastern parts of the country (Fig.1). Two search methods were applied: i) nests, found in winter, were checked during the breeding season and ii) watching of the eagle's behaviour from the elevated points, tree tops, forest edges. The use of two complementary methods was expected to eliminate the sampling bias, nests were found independently of terrain properties, distance from forest edges, breeding success, forest type, *etc.*

Altogether, data on 80 nests (for nest tree – 108)

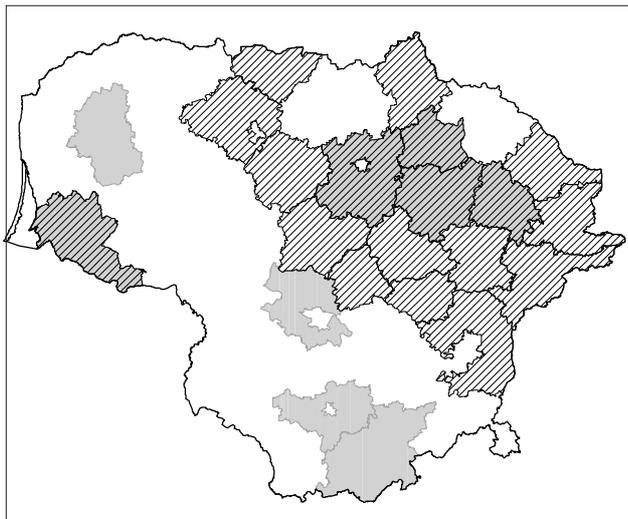


Figure 1. Administrative districts under investigation: grey color - past LSE nest sites (Drobelis 1994), streaked shade – present nest sites

was used in this study. The principle “one territory – one nest” was followed. Only the most recently used nest was accounted if one pair had several nests. Forest stand with a nest tree was considered a nest – site to enable comparison of our data with the historical data (see below). Six parameters were used to describe the nest site: i) forest type, ii) site humidity index, iii) site index (defined according to the stand height at a certain age), iv) stocking level, v) stand age and vi) nest-tree species. State forest cadastre databases served as the data source to provide the forest stand characteristics.

Data published by E. Drobelis (1994) was used as the source of information on the past nest - site characteristics of the Lesser Spotted Eagle. This material had been collected from 127 nests during 1978-93 mainly in 9 administrative districts of Lithuania (Fig. 1). Ten percent difference in the nest - site variables was used as the indicator of possible change in the nest-site use.

To ascertain preliminary change in nest-site selection we also assessed foregone and present preferences of eagles.

The disturbance on the Lesser Spotted Eagle was estimated in 2004 by field checking of 91 nesting areas. The extent of disturbance was expressed as the proportion of areas, negatively affected by timber harvesting. We considered i) any clear cut within 100 m from the eagle nest and ii) any other cutting in the same zone in April - August as a negative effect. This consideration with the official protection rules for eagle nests (*Pagrindinių miško kirtimų taisyklės* 2004).

Results

Seven percent of checked Lesser Spotted Eagle territories were disturbed by forestry operations in 2004. Once, the nest was destroyed only, twice both the nest trees and surrounding stands were felled down. The edge of the clear felling area was 20 m from the nest tree in three cases. The clutches were destroyed in 2 of them, when cuttings were done during the breeding season.

Before 1994, nests of Lesser Spotted Eagle were found in 13 forest types, however 77% of all nests were found in six forest types. Between 2001 and 2004, eagles were nesting in nineteen forest types, but 78% of nests were again found in 6 forest types. However, of the six most frequently used forest types for the two periods only two forest types - *Aegopodiosa* and *Hepatico-oxalidosa* – were the same. Notably, the *Oxalido-nemorosa* forest type was among the most used ones before 1994, whereas since 2001 its importance has decreased. It is obvious, that since 2001

eagles used forest types more similar to what was available in the landscape, than they formerly did (Fig. 2).

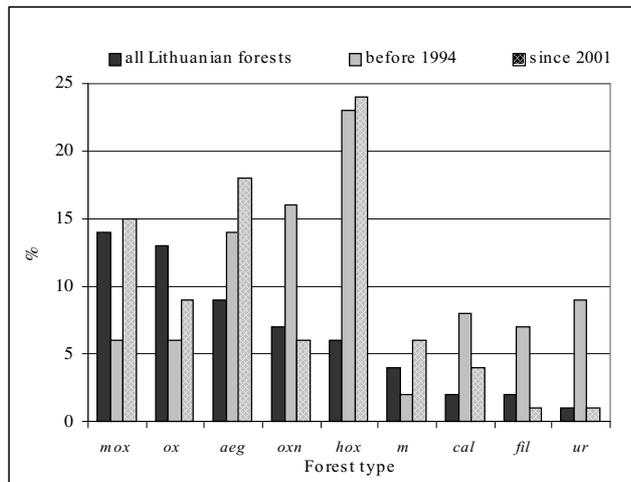
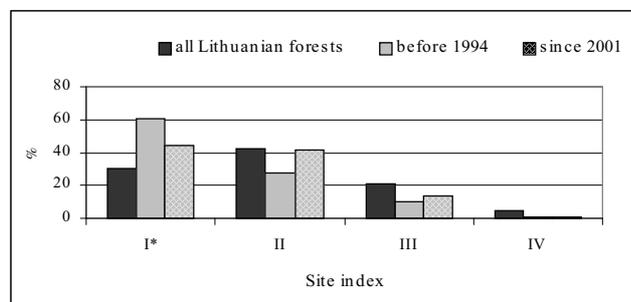


Figure 2. Forest type of stands with past and present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

The average site class of the stands with a nest was 1.51 and 1.73 respectively before 1994 and since 2001. A relatively larger number of nests (by 18%) were found in the 1st site class stands and less (by 15%) in the 2nd class stands before 1994. Average site class in Lithuanian forests is 1.9 (*Lietuvos miškų statistika* 1998) and during the last decades has increased by just one decimal (Kairiūkštis 2003). The preference of an eagle to the productive stands remains at the same level, but the 2nd site class stands are not avoided any more – they seem to be used equally to their share in landscape since 2001 (Fig. 3). The obtained data also reveal a marked (by 18%) decrease in nest sites found on wet soils. Since 2001, eagles have also less avoided normally irrigated stands and slightly more preferred temporarily wet stands (Fig. 4).



* I^a and I site indexes together

Figure 3. Site index of stands with past and present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

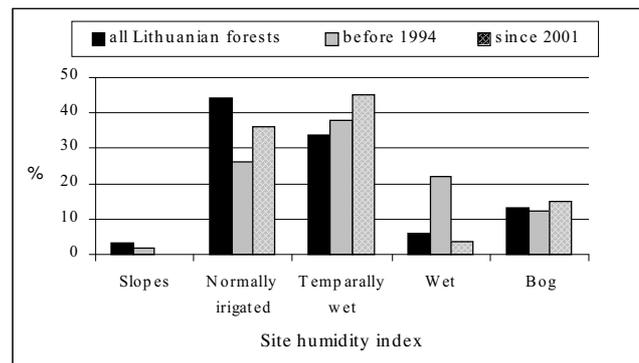


Figure 4. Site humidity index of stands with past and present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

Very diverse stands with respect to stocking level (0.1-0.9) were used before 1994, when the average stocking level was 0.64 ± 0.13 . Since 2001, nests have been found in more uniform stands in terms of stocking level (ranging 0.5-0.1), when the average stocking level was 0.69 ± 0.098 . The difference between stocking levels is statistically significant ($t=3.14$). The share of stands with stocking level 0.5, 0.7 and 0.8 used by LSE is close to the one available in the landscape since 2001. Moreover, the stands with stocking level 0.6 seemed to be preferred as well as the stands with stocking levels 0.9 and stands with value 1.0 - avoided (Fig. 5). Unfortunately, there were no data on the eagle's nests distribution with respect to the stocking level before 1994. However, considering the average stocking level in Lithuanian forests (0.71 during 1978-87 and 0.7 in 2001: *Lietuvos miškų ūkio statistika* 2001, Kairiūkštis 2003), we can assume, that the stands used for nests during the last decades were more similar (in terms of stocking level) to the ones available in landscape since 2001 than before 1994.

The age of stands used for nesting ranged between 40-180 years in the first, and 30-170 years in the second period. The mean stand age differs by 16 years: 94 ± 29 and 78 ± 29 , respectively; this difference is statistically significant ($t=3.87$). In contrast to this decrease, the average age of Lithuanian forests increased from 48 to 53 years. Although the largest number of nests was found in stands of VIII age class before 1994 (26%), the VII age class has been the most common since 2001 (27%) (Fig. 6). Relatively young stands (<70 years) are more often used nowadays than earlier (29% and 14% respectively).

The largest part of the nests was found in oak trees before 1994, whereas the share of this tree species was by 20% less later, when spruce trees were used for nesting much more often (by 23%) (Fig. 7).

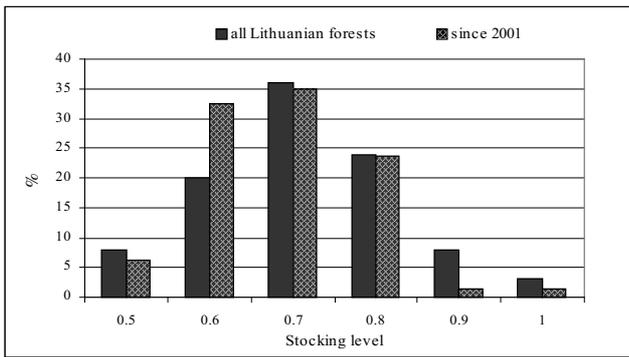


Figure 5. Stocking level of stands with present LSE nest sites as well as the summary characteristic for all Lithuanian forests (after Kairiūkštis 2003)

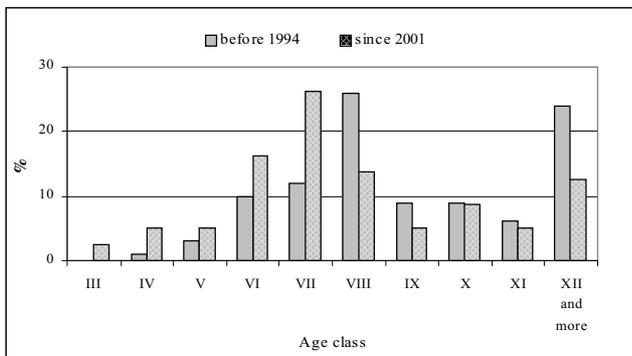


Figure 6. Distribution of stands with past and present LSE nest sites by stand age classes

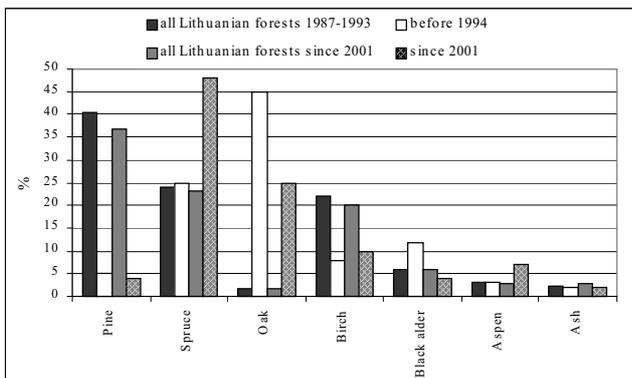


Figure 7. Species of past and present nest tree as well as the prevailing tree species in all Lithuanian forest (after Kairiūkštis 2003; Lietuvos miškų ūkio statistika 2001)

Though spruce became the most common nest tree, oak remains one of the most preferred nest-trees, because its share in the landscape is relatively small (1.8%). Black alder trees seem to be more seldom used as the nest trees since 2001, whereas the aspen trees, on the contrary, more often.

Discussion and conclusions

Considering that i) the information on the majority of checked nests was provided to stakeholders and ii) stakeholders should protect LSE according to the national laws, we suppose, that the 7% disturbance probability is likely to underestimate the real disturbance extent of forestry operations on the Lesser Spotted Eagle in Lithuania. All the recorded disturbance cases were in “well known” nest-sites (stakeholders were informed about the nests of rare species). Two disturbance cases were recorded in special protected areas, designated for Lesser Spotted Eagle protection. Thus, given that even existing protection rules could not protect LSE effectively, and most of the nest sites are not protected even formally (e.g. due to the lack of information on nest sites), we assume that the real pressure of timber harvesting is more heavy than stated in this study, particularly in private forests. We believe that timber harvesting disturbance on LSE in state forests can be minimised implementing better control during FSC certification audits. In private forests, however, we are inclined to rely on compensation for protection of nest-sites.

The most obvious differences in the past and present nest-site preferences are with respect to forest type, stand age and nest tree. The obtained data indicated, that the eagle’s preference to build a nest in spruce trees nowadays is similar to the one reported in other countries: 47% in Belarus (Ivanovsky and Tishechkin 1993), 46% in Latvia (Bergmanis 1999), 71% in Estonia (Vali 2003). The use of wet stands for nesting remained practically the same, what is common in other places of distribution range (Ivanovsky 1996, Langgemach *et al.* 2001). More productive forest stands continue to be preferred, what is most likely related to the faster development of the suitable for breeding conditions (Bergmanis 1999). Though more forest types have been used for nesting now, the preference for two forest types remained. Finally, it is noteworthy that the younger stands seem to be used more frequently for nesting nowadays than a decade ago.

The general tendency observed was that the characteristics of stands used for nesting differed from the overall characteristics of stands in the landscape less now than in the past. This leads to the assumption, that eagles are less selective nowadays than in the past. Possible reasons for the decrease in eagles’ selectivity could be:

1. Differences in the sample. Data on the nests before 1994 was collected mostly in 9, whereas since 2001 in 18 administrative districts. Thus, the larger study area and greater diversity in environmental con-

ditions could have had some influence. For instance, nest – sites are very different in Vitebsk and the Pripyat basin regions in Belarus (Ivanovsky and Tishechkin 1993). The methods, used to search for nests before 1994, are not documented well enough. Using only one method (*e.g.*, searching raptors nests in winter and checking in summer) could introduce some bias in the sample. However, considering the large sample sizes and largely overlapping study areas, we accept that this single reason cannot explain the differences in the past and present nest – site requirements.

2. Selectivity decrease due to the population density. The relationship between raptors' population density and selectivity is well documented: when the population increases, selectivity decreases and *vice versa* (Löhmus 2001). Unfortunately, there is no monitoring of Lesser Spotted Eagles at the national level carried-out in Lithuania. However, fewer LSE pairs or even none were detected to breed in Eastern Lithuanian forests during 2001-2004 (auth. observ.) in comparison with the research carried out in 1990-ies by Mažiulis (1985) and Drobelis (1990). These results are in full agreement with the documented sharp world population's decline in the second half of the eighties (Meyburg *et al.* 2001). Therefore, it is very unlikely that the population of eagles increased during the last decade and the density–selectivity relationship cannot explain the decreased selectivity.

3. Selectivity decrease is related to the intensified timber harvesting. The data by E. Drobelis were collected in the period of the most environment-friendly forestry, when the extent of final felling was low and the share of mature stands was increasing (Kairiūkštis 2003). Only 37% of the volume increment was utilized during this period. In 1978-92, the total cutting amount was small - about 3 mil. m³ per year. This could explain, why the eagles used for breeding relatively older stands, less affected by forestry operations (Drobelis 1994). Since 1993, timber harvesting increased up to 4.5-6 mil. m³ per year (*Lietuvos miškų ūkio statistika* 2002), which makes up to 70-80% of annual increment. The invasion of *Ips typographus* a decade ago influenced over-cuts, especially in spruce forests. Despite the increased timber harvesting, the percentage of mature forest is larger nowadays than in the past, *e.g.*, in 1978-87 – 20.9% and 2000- 32.5% (Kairiūkštis 2003). The increased statistical age of Lithuanian forests does not necessarily mean that eagles have better opportunity to select mature or over-mature stands due to ecological requirements and a variety of interactions, if these stands are disturbed by nearby cuttings or are far from foraging areas or too near to conspecifics.

Though a species which can flexibly respond to the growing timber harvesting pressure and disturbance level by reducing its requirements for nests sites can be considered as not conflicting with timber harvesting, the characteristics of nest - sites might have long-term influence on bird's reproduction (Rauter *et al.* 2002). Recently, oak has been the most used nest tree, with large and strong branches, capable of maintaining large nests (Drobelis 1994), where eagles can breed for 10 years (Vali 2003). Nowadays, spruce became the most used nest tree. It has suitable crown structure for nest building in young age. However, the nest of an eagle, when used for many years, becomes large and heavy. Such a nest may fall down from young trees, the branches of which are not strong enough to maintain it. This opinion is supported with field observations - we found six fallen down nests from such spruce trees in 2001-2004. Thus, the reduction of large-branched trees in economic forest use (Brazaitis and Kurlavičius 2003) and other habitat properties may push eagles to select younger, less suitable stands and nest trees.

We suppose that the seven year period is rather short to analyse the changes in eagle's nest - site selection due to delayed response to quickly changing forest environment. Undisturbed eagles can use the same nest for 10 (Väli 2003) or even 20 years (Šablevičius pers. comm.). So, our sample could possibly include such nests-sites, which were selected before the intensification of timber harvesting and nest-sites, which are located in the protected areas. In spite of this, we are convinced that the differences in past and present nest – site characteristics are associated with the increased timber harvesting. Taking into account the future harvesting perspectives (2001-2010- 6.5, 2011-2020-7.5 and 2021-2030- 8.3 mil. m³ per year: Rutkauskas 2003) we can forecast that during the next 30 years forest operations will become one of the most important factors affecting the Lesser Spotted Eagle population in Lithuania.

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ТРЕБОВАНИЯ МАЛОГО ПОДОРЛИКА (*AQUILA POMARINA* С.Л.ВРЕНМ) К ГНЕЗДОВЫМ МЕСТАМ В НЫНЕШНЕЕ ВРЕМЯ И В ПРОШЛОМ: ВОЗМОЖНЫЙ КОНФЛИКТ С РУБКАМИ ЛЕСА

Р. Трейнис и Г. Мозгерис

Резюме

Возрастающий спрос на сырьевую древесину в последнее время приводит к увеличению лесопользования в странах Балтии. Цель настоящего исследования заключается в проверке имел ли влияние возросший за последнее десятилетие объем сплошных рубок на требования малого подорлика к выбору гнездовых мест. В 2004 году, 7% из проверенных территорий малого подорлика были затронуты лесохозяйственными мероприятиями. Некоторые показатели гнездовых мест потерпели лишь незначительные изменения. Общая обнаруженная тенденция заключалась в том, что характеристики лесных насаждений, используемых для гнезд, менее отличаются от средних характеристик леса в ландшафте в данное время, чем в прошлое десятилетие. Гнездовые деревья найдены на 19 разных типах леса, так как раньше – только на 13. Менее продуктивные леса (2 класс бонитета) и насаждения на сухих почвах в нынешнее время менее избегаются. Средний возраст насаждений с гнездовыми деревьями уменьшился на 16 лет. Хотя дуб остается одной из самых привлекательных пород для гнезд (20% всех случаев), наиболее частой породой (48%) становится ель. Это приводит к идее, что малый подорлик менее селективен сейчас чем в прошлом. Мы полагаем, что возросший объем лесных рубок за последнее десятилетие объясняет почему малый подорлик стал гнездить в насаждениях, более похожих на окружающие лесные ландшафты, чем в прошлом, и почему некоторые предпочтения сохранились, тогда как другие исчезли. Существует большая вероятность того, что в течении последующих 30 лет лесохозяйственные мероприятия будут оставаться одним из наиболее важных факторов, оказывающих существенное влияние на популяцию малого подорлика в Литве.

Ключевые слова: малый подорлик, выбор гнездовых мест, лесные рубки, помеха

BOOK REVIEWS

Publication on the Perception of the Condition of Trees Submitted to Stress

Laima Skuodienė. 2005. Medžių stresas ir jo fiziologinė indikacija [Stress of Trees and their Physiological Indication]. Monograph. Kaunas, ARX Baltica spaudos namai, 224 p., iliustr., bibliogr., Lithuanian, English, German and Russian Summary.

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As a result of obvious climatic anomalies more and more threatening situations are observed in Baltic forests. Different tree species, namely these, that are less typical of our climatic and soil conditions, are found to be in a critical situation. In the middle of the XX century due to elm plague (*Ceratostomella ulmi*) Ulmaceae considerably thinned, at the end of the century mass drying of ash stands occurred. Currently, oak stands dry in many places. Trees that have been submitted to long – term stress dry prior to their natural maturity.

Stress is usually characterized as a state of organism tension, as an entity of protective physiological reactions, which maintain the vitality of an organism: human, live being or plant react to unfavourable factors (stressors).

As to stress of trees, as a primary indication of their death, it must be noted that until recently in Baltic countries the physiological expression of stress was not studied. Therefore appearance of monograph "Stress of trees and their physiological indication" by Doctor of Biomedical Science Laima Skuodienė was appreciated both by foresters and by the society of natural sciences.

In the monograph being reviewed the author presents and generalizes the data of long-term (1978 – 2002) physiological investigations of trees, which have been conducted by her and with collaborators. The effect of different artificial and natural factors on trees is analysed from the standpoint of stress effect as a physiological response of trees. It is merit of the monograph. The second merit is that in the monograph the physiological changes in trees occurring during stress and reversible restoring processes have been successfully applied in the monitoring conducted on the condition of trees. Eventually, the

third merit is that it fills the gap of physiological investigations in forestry of Lithuania and gives hope that the physiological concept of the reaction of trees will be applied in silviculture in choosing economic measures for the growing of more productive and stable forests.

In the book there are 224 pages. It is split into 9 Chapters and consists of abundantly illustrated pictures and the data of experimental investigations. The list of Literature cited attains 200 titles.

The first Chapter encompasses ecophysiological investigations and stress. Here perception of non-specific reaction of an organism, the limits of tolerance of organisms, adaptation and factors (drought, solar radiation, the ozone concentration and other changes) causing stress are set forth. They are presented as a logical assumption for stress-adaptation reactions of trees based on the experiment, which has been carried out by the author.

The second Chapter is devoted to the significance of phytohormone indole-3-acetic acid (IAA) for the processes of the growth and development of trees. The peculiarities of the lateral meristem growth of trees of different classes as well as the role of IAA in the processes of the growth and differentiation of Norway spruce are analysed. The role of phytohormone as an agent decreasing stress tension and strengthening restoring possibilities of a plant is based on the results of original experiments. Different effect of phytohormone, which depends upon the class of tree, is indicated. The author points out that after applying additionally exogenous phytohormone relatively fastest growth of moderately stressed trees of B class was induced. The growth of these trees enlarged 4 times whereas that of well developing trees (A class) and suppressed trees (C class) increased 2 and 0.3 times, respectively. The author conducted analysis on radioactive glycine $1-^{14}\text{C}$ and adenine $8-^{14}\text{C}$ of cell metabolites, which incorporate genetic information as well as on their introduction into the proteins of a cell. Thus the author revealed the essence of the mechanism of phytohormone effect and provided the foundation for the assumption

that differentiation and adaptation of individuals had occurred under the control of genes.

The third Chapter deals with the physiological reaction of trees to the changing conditions of lighting. A response of trees to the stressor of light has been analysed in several respects. After revealing K^+ ion transport via cellular membranes its dynamics in spruce shoots was determined in the process of ecosystem formation. Increased K^+ ion transport via cellular membranes into deionized environment (H_2O) indicated a stress situation in trees. Due to damaged membranes a response of trees had a distinct activity typical of the reactions to stress. Having applied the possibilities (gradually decreasing conditional lighting of trees during coenosis forming and sudden thinning) of the created stationary (1957) in the vicinity of the institute for carrying out biophysical investigations the author revealed the process of the effect of light stressor on a time scale. It was observed that after removal cutting a significant change in lighting occurred. Due to strong light spruce needles got more photochemical energy than it was necessary for photosynthesis. Overloading of the photosynthesis resulted in assimilation of less light, lowering of the level of assimilation and in weakening of the photosynthesis. This statement provided the foundation for tending cuttings of moderate intensity, which had been recommended by us. In the Chapter also a response of trees to changes in light is illustrated according to the accumulation of photosynthesizing pigments in needles. The dynamics of chlorophyll (a,b) as markers of the physiological reaction was shown by abundant experimental data obtained in the stand where the environmental conditions had been changed artificially. It enabled the author to ground the period of stress- reversible reaction of a restoring character.

The fourth and fifth Chapters are devoted to early diagnosis of tree damage and to physiological assessment of stress-adaptation state according to biomarker aminoacid proline. Thorough analysis has been conducted on adaptation of many different provenances of Norway spruce (*Picea abies* (L.) Karst.) and pine (*Pinus sylvestris* L.) in Lithuania. From the standpoint of proline, as a biomarker, the author draws a conclusion that adaptation of trees of different geographical origin is a long process associated with metabolic changes in a cell and with certain production losses. Proline can be used not only for indication of the state of a tree but also for practical purposes in selecting valuable material for propagation.

In the sixth and seventh Chapters physiological differences in the state of trees growing on differ-

ent sites are set forth. While analysing Norway spruce, pine and ash on their natural sites it has been found that stress of trees and physiological damage in forests may be related to hydrotope and tropotope and that in this process meteorological conditions play an important role.

In the eighth Chapter the author dwells upon the bioindicative significance of conifers in investigating the effect of background atmospheric pollution on ecosystems. Here pollution sources are presented concisely, the method of sampling needles and leaves is described in detail. The main chemical elements of nutrition, which have been accumulated in needles in the screen of regional forest monitoring of Lithuania, are presented in a generalized way. On the basis of a long- term simulation experiment of artificial chemical pollution (acid rains) the analysis has been conducted on sensitivity and tolerance of conifers to chemical pollution. An inference is drawn that forest is an enduring and strong biological system in case chemical load causing stress tension increases step by step and in the period of stress tension the feasibility of a reversible physiological reaction remains.

The ninth Chapter encompasses the investigations of heavier chemical pollution. While participating in the state scientific programme "Ecological sustainability in Lithuania in retrospect" the author analysed reactions of forests to stress in some regions (heavily and slightly polluted) of the Republic according to the quantity of proline. Also analysis was conducted on the reaction of plantations to atmospheric pollution in different places of the city of Kaunas. The presented conclusions about tolerance of different tree species to pollution could be applied in projecting plantations in cities.

At the end of the book generalized thorough Summary of the results of the research is presented in Lithuanian, English, German and Russian. It offers a possibility for scientists in the East and West to get acquainted with the material and major statements and it undoubtedly increases the international value of the book.

The monograph is a significant contribution to comprehension of the physiological function of the interaction between trees and the environment.

The material is set forth perfectly, the book is easy to read and its statements will undoubtedly find application and followers for further development of physiological investigations of trees.

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