Green Tree Retention and Bird Communities on Clearcuts in Lithuania

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We analyse the influence of green tree retention in bird communities on 1-15 year-old clearcuts. The highest number of bird species was found in clearcuts with 0.1-1.0 of large (D>20 cm) residual green trees per hectare. Small (D<20 cm; H>8m) residual tree retention had no significant impact on the number of bird species. Neither small nor large trees influenced the density of breeding bird community. Green tree retention greatly influenced bird species composition on clearcuts. Most of common bird species prefer low density of large residual trees. The largest number of species was observed in clearcuts with 0.1-1.0 tree/ha and dip in clearcut without trees. The density of residual green trees was significant negative correlated with discussed bird community parameters in small 0-2.0 ha clearcuts with an increase in their age till six year. A total of 53 bird species were classified into four categories by the effect of tree retention (number of bird species in brackets: dependent on large and small trees, respectively): negatively influenced (10; 3), positively influenced (14; 16), as well as typical of clearcuts with relative low or moderate residual tree density (9; 7) and uninfluenced species (20; 27). It is recommended to leave one group (3-5 trees) of large and 5-10 dispersed small residual trees per hectare in clearcut. In forests where rare woodpeckers (white-backed) or other hollow-nesting species breed it is recommended for long-term effect to leave 10-30 large and 20-40 small residual trees, half of them dispersed equally and half in group or small patches, proportionate softwoods (mainly for woodpeckers) and hardwoods or pine (mainly for large nests).

Key words: residual tree, green tree retention, bird community, clearcut, Lithuania

Introduction

Harvesting of mature forest stands is one of the main factors influencing the abundance and regional distribution of forest birds (Virkkala 1987, Avery & Leslie 1991, Haila *et al.* 1994, Mönkkönen & Welsh 1994, Edenius & Elmberg 1996, Jansson 1999). Shorter rotation of stands and economic use of forest products reduce the number of hollow trees and large-branched trees suitable for hole nesters and big birds of prey (Shaw & Dowell 1990). Many researchers agree that to avoid such problems, forestry must imitate natural forest disturbance regimes (Niemi & Probst 1990, DesGranges & Rondeau 1993, Hunter 1993, Angelstam & Mikusinski 1994, Hejl 1994). The main natural disturbances are associated with fire, wind, fungal diseases, insects and mammals (beavers and large ungulate) (Peterken 1996, Nilsson & Ericsson 1992). All kinds of forest disturbance have cumulative effect and create multipartite mosaic of the forest landscape of various-aged stands (Nilsson & Ericsson 1992, Peterken 1996).

With the intention of emulating natural disturbance in forestry, it is recommended that green and dead trees, groups of trees and small forest patches were retained on clearcuts (Angelstam & Pettersson 1997, Fries et al. 1997, Schulte & Niemi 1998). A variety of attempts have been made to hasten the production of old-growth attributes in managed forests (Bunnell 1999). Most of them focused on the requirements of single species and we lack community level studies (Anderson 1985, Bunnell 1985). For multi-species management the combination of different kinds of stand treatments can be economically more efficient than simply maintaining old growth (Bunnell 1999).

Recently green tree retention has become an important management tool, but its ecological significance is still poorly known (Vanha-Majamaa & Jalonen 2001). Green tree retention is practised in many countries. Most of the countries recommend to leave 5-10 large trees/ha (Anon. 1994, Anon.1997, Anon. 1999a, Anon 1999c, Anon. 2001), some states recommend to leave 15-30 trees/ha (Anon. 1986) or 10-20% of old stand trees (Anon 1999b). Green tree retention has three major objectives: (1) "life boating" species and processes over the regeneration phase, (2) increasing structural variation at the tree level of stand, and (3) enhancing connectivity at a landscape level (Franklin *et al.* 1997) by making the area between patches more favourable for movement (Bunnell 1999). The impact of green tree retention can be classified into two kinds of effects:, i.e. (1) a long-term effect that should be congruous with the life span of the new stand or longer, and (2) a short-term effect that mitigates the problem that the first succession stage after harvesting differs considerably compared to later stages.

The aim of this paper is to analyse the influence of green tree retention on bird communities on early successional clearcuts by comparing the requirements of bird species.

Methods

Study area

This study was made in the Marijampole, Dubrava, Kaunas and Prienai forest enterprises in southwestern Lithuania (54.4-55.1° N; 23.2-24.2° E). Phytogeographically the study area locates in the transitional zone between the temperate lowland and hemiboreal forests (Ahti *et al.* 1968, Natkevičaitė-Ivanauskienė 1983). The dominating tree species on study area were Aspen *Populus tremula*, Birch *Betula pendula*, Black alder *Alnus glutinosa*, Hornbeam *Carpinus betulus*, Ash *Fraxinus excelsior* and Oak *Quercus robur*. Coniferous species were not common on the study area except for a few stands, which were omitted in this study. The same deciduous tree species were dominated in investigated clearcut.

As study sites we used 164 clearcuts (0.5-20.0 ha) covering a total area of 546 hectares.

Inventory of bird communities

Birds were counted by two-time mapping method (Brazaitis & Kurlavičius, in press), which is similar to the well-known standard mapping method (Tomialojc 1980, Pridnieks *et al.* 1986, Bibby *et al.* 1992). The main difference is that census plots were visited twice. Two-time mapping had excellence on evaluating bird communities in the relative small or medium sized irregular shape counting plots because of the better possibility to detect birds location and avoid registrations that are outside the plot as well as with the same efficiency evaluate the total area. The inventory started on 10 April and lasted till mid June. The first visit was performed before 15 May, and the second visit later. Visits lasted up to 4.5 hours after sunrise. Inventories were made under clear, sunny and calm weather conditions without rain. Per one hour was inventoried 8-10 ha area. Simultaneous registration of the same species was used to separate neighbouring territories on one visit. The total number of breeding territories was estimated considering the distance between registered birds on separate visits. When the distance was larger than the average width of breeding territory, two territories were noted, otherwise one breeding territory was identified.

Scientific and English bird names, acronyms of studied bird species are presented in appendix 1. We analysed the distribution of 53 bird species in clearcuts in relation to green tree retention.

Estimation of retention tree density and environmental factors

Residual trees in the study area mostly were dispersed equally. Oak and ash were dominating residual tree species. Residual tree density was estimated by counting the large and small trees on each investigated clearcut area. Large trees were defined as the trees in diameter of stem larger than 20 cm. Small trees are smaller than 20 cm in diameter of stem while the height of tree is larger than 8 m. We analysed the influence of large, small and total residual tree density on bird communities.

The area and age of clearcuts were estimated from special forest maps used for the forest management purposes. We have defined three groups of clearcut sizes: small (0-2.0 ha), middle (2.1-5.0 ha) and large (5.1 ha and more). The clearcuts' age were grouped into fresh (1-3 yr.), middle aged (4-6 yr.) and old (7-15 yr.). The proportion of young forest stand (up to 20 yr) in the landscape were evaluated from forest maps as 0-10 %; 11-35%; 36-65 %; 66-90 %; 90-100 % of young stands in 1 km² of forest. The shape coefficient of clearcut was calculated according to Thomas (1979) where M is the shape coefficient; P - the perimeter (m) and S - the area (m²):

$$M = \frac{P}{2\sqrt{S\pi}}$$

We ranged residual tree density values into 5 groups: 0; 0.1-1.0; 1.1-5.0; 5.1-10.0; 10.1-30.0 trees/ha. Such categories have spatial background. The clearcuts without residual trees represent open areas. The clearcuts with less that 1 residual tree per hectare represent areas with extremely low density and impact of residual trees. The clearcuts with 1-5 trees/ha represent areas that the distance between trees is more than two large trees height as well as clearcuts with 5-10 trees/ha represent areas that the distance between trees is more than large trees height. The clearcuts with 10-

30 trees/ha represent areas that the distance between trees is lower than the height of a large residual tree height. On this category the impact of residual trees is relatively high.

Statistical methods

One way and two-way ANOVA (F test) was used for hypothesis testing. We performed post-hoc tests (Turkey's HSD) to distinguish significantly different groups. Correlation between variables was estimated with Pearson correlation coefficients.

Bird species distribution in relation to green tree retention was analysed by the coefficient of indicator value IndVal (Dufrene & Legendre 1997). IndVal analysis defined the interval of characteristic factor values for each bird species. The probability of species presence and density is highest in this interval. This method has advantages because of consideration relative abundance with its relative frequency of occurrence in the various groups of sites. IndVal ranged within the pale from 0 to 100. Index was at the maximum when the individuals of species had been observed on all sites of only one site group. The statistical significance of the species indicator values was evaluated using randomisation procedure Monte Carlo test. PC-ORD software was used for IndVal calculation (McCune & Mefford 1997).

We analysed IndVal coefficients calculated for each species between all possible paired residual tree density cases. If IndVal coefficients differed significantly or the difference between designed groups, representing species, was 100% or more we assumed bird species preference to selected category.

All bird species in relation to their distribution status were classified into four categories: (1) bird species that were typical of clearcuts without or with relatively low residual tree density. Green tree retention had a negative influence; (2) bird species that were typical of clearcuts with relative high residual tree density. Green tree retention had a positive influence; (3) bird species that were typical of clearcuts with relative low or moderate residual tree density, with exception of clearcuts without or with highest tree density; (4) bird species that were not influenced by green tree retention. We have analysed large and small green tree retention separately.

Results

Green tree retention in various clearcuts

The density of large green trees did not significantly differ in clearcuts with various size ($F=0,64$, $df=3$; $p<0.59$) as well as shape ($F=0.52$, $df=3$; $p<0.67$), the proportion of young stand in the landscape ($F=0.80$, $df=4$; $p<0.59$) and age of clearcuts ($F=2.56$, $df=2$; $p<0.08$). The density of small green trees didn't significantly differ in clearcuts with various size ($F=0,70$, $df=3$; $p<0.55$) as well as shape ($F=1.25$, $df=3$; $p<0.30$), the proportion of young stand in the landscape ($F=1.16$, $df=4$; $p<0.33$) and age of clearcuts ($F=1.88$, $df=2$; $p<0.16$). Moreover, we found that the density of large and small trees is independent ($F=1.78$, $df=4$; $p<0.14$).

Green tree retention and the number of bird species

The number of bird species on clearcut differed significantly between density groups of large residual trees ($F=3.9$, $df=4$; $p<0.005$). The highest number of species was observed on clearcuts with 0.1-1.0 tree/ha as well as lowest in clearcuts ($p<005$) with 5.1-10 trees/ha (Fig. 1). The number of bird species on clearcut did not differ among density groups of small residual trees ($F=0.17$, $df=4$; $p<0.95$) (Fig. 1). The number of bird species in clearcut significantly differed in density groups of all residual trees ($F=2.92$, $df=4$; $p<0.05$). The variation character of this factor was similar to large residual trees (Fig. 1).

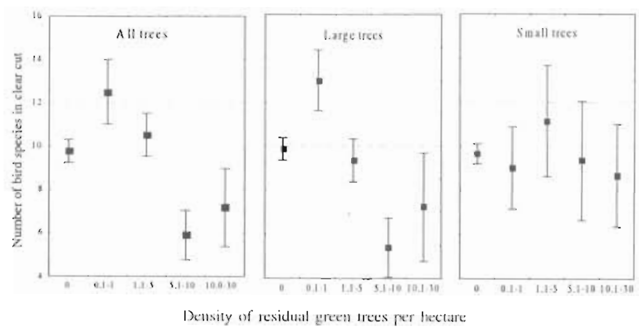

Figure 1. Influence of large, small residual trees and their total density in clearcuts on the number of bird species

Green tree retention and the total density of breeding birds

The total density of birds in clearcut did not differ among density groups of large residual trees ($F=2.19$, $df=4$; $p<0.1$) (Fig. 2) as well as among densi-

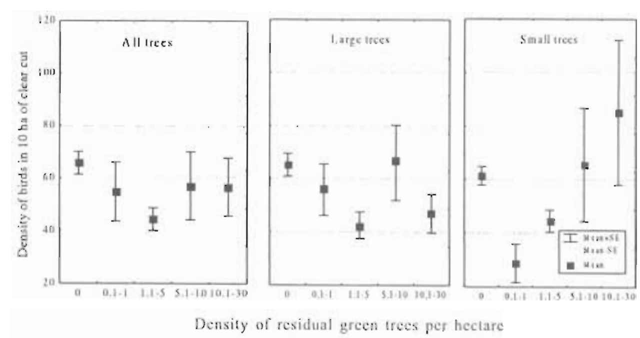

Figure 2. Influence of large, small residual trees and their total density on cutovers on the total density of birds

ty groups of small (F=1.35, df=4; p<0.25) and total (F=1.61, df=4; p<0.17) residual trees.

Influence of green tree retention on bird communities at different age and size of clearcuts

Two-way ANOVA analysis showed significant influence of the clearcut age and the large residual tree density on the total number of bird species (F=2.00 df=8 p<0.05). Similar impact was found of the total density of residual trees (F=2.87 df=8 p<0.02). The clearcut age and various residual tree densities had no significant influence (F=0.63-1.46 df=8; p<0.18-0.75) on the total density of birds. Simultaneously, correlation coefficients (R) between density of residual trees and the number of bird species or the total density of birds in various groups of clearcut age were analysed (Tab. 1). Large residual trees were getting more important only in 4-6-year-old clear-cut areas. Negative effect on the number of species and the total density of birds was observed at this age category. The response of birds in fresh and old clear-cuts were insignificant and mostly positive.

Table 1. The correlation between RTD and the number of bird species, total density of birds in various-age of clearcuts *** p<0,001; ** p<0,01; * p<0,05; ° p<0,10

Residual trees	Age of clearcut					
	Number of bird species			Total density of birds		
	1-3	4-6	7-15	1-3	4-6	7-15
Small	0.14	-0.14	0.07	0.19	-0.16	0.21
Large	0.06	-0.31**	-0.03	-0.11	-0.22°	0.03
All	0.15	-0.32**	0.02	0.05	-0.24*	0.15

Two-way ANOVA analysis showed no significant influence of clearcut with various residual trees on the number of bird species and the total density of birds (F=0.66-1.45, df=10; p<0.72-0.33). The density of residual trees at various categories of clearcut (Tab. 2) was not correlated significantly with the parameters of bird communities with exception of large residual trees impact on the number of bird species in a small clearcut category.

Table 2. The correlation between KTD and the number of bird species, total density of birds in various-size of clearcuts *** p<0,001; ** p<0,01; * p<0,05; ° p<0,10

Residual trees	Size of clearcut, ha					
	Number of bird species			Total density of birds		
	0-2.0 ha	2.1-5.0 ha	> 5.0 ha	0-2.0 ha	2.1-5.0 ha	> 5.0 ha
Small	-0.03	0.12	0.20	0.05	0.08	0.05
Large	-0.26*	0.02	0.10	-0.18	0.02	0.04
All	-0.23°	0.10	0.13	-0.13	0.05	0.05

Green tree retention and bird species

The distribution of 33 species was related with the special density of large residual trees and 26 species – with the density of small residual trees. Most of species were typical of some contiguous residual tree density categories (Fig. 3-4).

Large green tree retention had a negative influence on such bird species (1): Snipe, Tree pipit, Robin, Song thrush, Wren, Sedge warbler, River warbler, Whitethroat, Garden warbler, Yellowhammer.

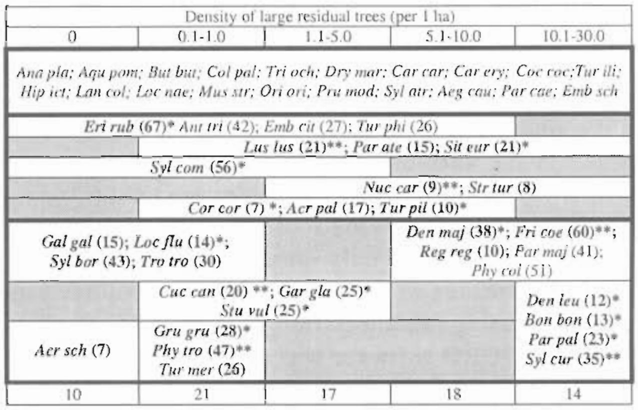

Figure 3. Influence of large residual trees on bird species distribution. Size of cell shows breadth of niche. In brackets value of IndVal. In bold – distribution described significant or near significant. ** p<0,001; * p<0,05; Model represents all bird species that show IndVal>25 without reference to significance if double difference between groups exist

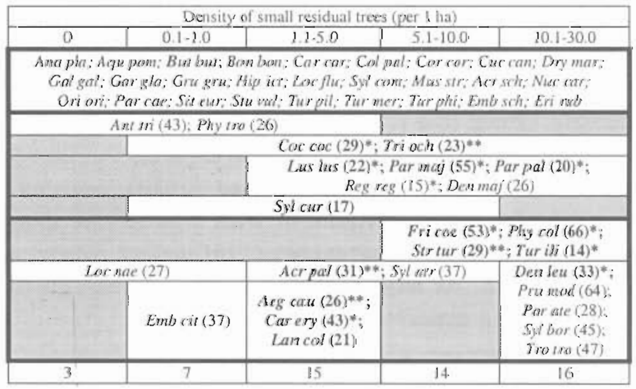

Figure 4. Influence of small residual trees on bird species distribution. Size of cell shows breadth of niche. In brackets value of IndVal. In bold – distribution described significance or near significant: ** p<0,001; * p<0,05. Model represents all bird species that show IndVal>25 without reference to significance if double difference between groups exist

Large green tree retention had a positive influence on such bird species (2): Turtle dove, Hazel grouse, Great spotted woodpecker, White-backed woodpecker, Thrush nightingale, Lesser whitethroat, Chiffchaff, Nuthatch, Nutcracker, Goldcrest, Great tit, Coal tit, Marsh tit, Chaffinch. The following bird species were typical of clear cuttings with relative low or moderate density of large residual trees (3): Common crane, Cuckoo, Blackbird, Fieldfare, Marsh warbler, Willow warbler, Raven, Jay, Starling. Bird species for which green tree retention had no influence (4): Mallard, Lesser spotted eagle, Buzzard, Woodpigeon, Green sandpiper, Black woodpecker, Red-backed shrike, Spotted flycatcher, Redwing, Grasshopper warbler, Icterine warbler, Blackcap, Dunnock, Long-tailed tit, Blue tit, Golden oriole, Goldfinch, Common rosefinch, Hawfinch and Reed bunting.

Small green tree retention had a negative influence on such bird species (1): Tree pipit, Willow warbler, and Grasshopper warbler. Small green tree retention had a positive influence on such bird species (2): Green sandpiper, Turtle dove, White-backed woodpecker, Great spotted woodpecker, Thrush nightingale, Redwing, Dunnock, Garden warbler, Chiffchaff, Wren, Great tit, Marsh tit, Goldcrest, Chaffinch, Coal tit, Hawfinch. The following bird species were typical of clear cuttings with relative low or moderate density of small residual trees (3): Red-backed shrike, Marsh warbler, Lesser whitethroat, Blackcap, Long-tailed tit, Common rosefinch, Yellowhammer. Bird species that small green tree retention hadn't any significant influence (4): Mallard, Lesser spotted eagle, Buzzard, Snipe, Common crane, Hazel grouse, Cuckoo, Woodpigeon, Black woodpecker, Spotted flycatcher, Goldfinch, Raven, Jay, Starling, Robin, Fieldfare, Blackbird, Song thrush, Icterine warbler, River warbler, Sedge warbler, Whitethroat, Blue tit, Nuthatch, Nutcracker, Golden oriole, Reed bunting.

Discussion

Most of the negatively influenced bird species were common species typical of non-forest habitats: open dry habitats (Whitethroat, Garden warbler, River warbler), marsh and wetlands (Snipe, Sedge warbler) or forest landscape species associated with edges (Tree pipit, Willow warbler, Yellowhammer). Most of the species that were positively influenced by green tree retention are typical of later succession stages of forest ecosystem.

The number of bird species in clearcuts varied in relation to the requirements of individual species. An increase in the density of large residual tree, affected positively the number of typical forest species, and decreased the number of species that are associated with open or wet landscapes. Most of the open landscape species were characteristic of clearcuts without residual trees. The reduction of the open landscape bird species was more intensive as compared to colonization of old forest species (up to 5 trees/ha density) in the clearcuts. This is the main reason why the total number of bird species decreased. On the areas with higher density (more than 5 trees/ha) of residual trees, the list of typical bird species mostly consisted of later successional stage assigners and rare birds. The conventionally accepted in forestry amount of residual trees is not sufficient for rare bird species existence in clearcut.

Clearcuts occupy large areas and has high impact to the whole forest ecosystem. Generally, we found that increased total density of residual trees did not positively affect the number of bird species or the total density of birds in clearcut. There is a danger to overestimate this argument. The most typical bird species of clearcuts are widespread and their populations were increasing recently (Helle & Järvinen 1986, Väisänen *et al.* 1986). Clearcuts are not important habitat for such birds (Ahlen 1975). Preference should be given for endangered and protected species. Species, which are rare in Lithuania and/or other parts of Europe were positively influenced by green tree retention (e.g., White-backed woodpecker, Hazel grouse, Turtle dove, Common crane, Long-tailed tit).

The ecological significance of large tree retention was different compared to small tree retention. Some species were influenced by large residual trees, but not by small trees: Hazel grouse, Raven, Cuckoo, Robin, Snipe, Jay, Common crane, River warbler, Sedge warbler, Blue tit, Nuthatch, Starling, Fieldfare, Blackbird and Song thrush. It is associated with some reasons:

1. Open landscape birds (Snipe, Sedge warbler, River warbler) were influenced much more stronger by large trees compared to small. For this reason small residual trees did not affect those birds (at least up to 30 trees/ha).

2. Large residual trees can made a connection for nest parasites and predators from clearcut edge (Cuckoo, Jay, Raven). Studies showed that a predation rate on shrub nesters in green tree retention areas is greater compared with clearcuts (Vega 1993).

3. Large residual trees can be good nesting or feeding habitat for hole-nesters and some other species (Tits, Nuthatch, Starling, Fieldfare, Hazel grouse).

Common rosefinch, Blackcap, Hawfinch, Red-backed shrike, Grasshopper warbler, Dunnock, Green sandpiper and Redwing were significantly influenced by small trees, but large trees were not related with species distribution. Most of mentioned above species shows priority to more heterogeneous habitats in respect of bushes height. If tall, even small residual trees were good for perching (Red-backed shrike), or for territorial demonstration behaviour (Common rosefinch, Dunnock, Blackcap).

Correlation coefficients showed an increase in residual trees significance in small 0-2.0 ha clearcuts with an increase in their age till six years. It is associated with the peak of negative influence by residual trees open landscape species in bush stage clearcuts. Small clearcuts had critical threshold of required open space resources and residual trees negatively change this balance.

The long-lasting value of green tree retention to bird communities are also important. Intensive forestry dominated by a clear-cutting management system changes the stand structure of the forest landscape. Old-growth forest bird species are adapted to dominating uneven-aged stands with plenty of over-mature and dead trees. Such components are lacking in managed even-aged stands. Consequently, green tree retention is of high value for old-growth forest bird species during the whole stand rotation cycle. Diversity of environmental conditions is getting favourable for bird species with the high-specialized requirements.

Large trees with big branches are necessary for large raptor nests (Petty 1998). However, the large raptors have requirements not only for the nesting tree, but also for the surrounding stand, as well the landscape in which they feed. Most of them inhabit middle-aged or older stands (Skuja & Budrys 1999). Relative tree mortality depends on size of the residual tree (Peltola et al. 1999). Smaller trees have higher probability to survive up to the period, when stand will satisfy environmental requirements for rare raptors. Hardwoods and pine are more important than softwood tree species.

Over-mature and dead trees are a necessary habitat component for woodpeckers and others hollow nesters (Amcoff & Eriksson 1996, Fernandez & Azkona 1996, Pasinelli 2000). Green tree retention for cavity nesters should be appreciable up to regenerated stand will fill the gap without large softwood that fit for cavities. The length of period depends on tree species composition and geographical position influencing growing rate of trees. It varies between 40-70 years. Large green tree retention without small trees in clearcuts would not fulfil long-term function for cavity nesters, because of susceptibility to windthrow (Arnott & Beese 1997). Softwood tree species has priority for hollow nesters. Aspen is recommended because of importance to many declining beetle, lichen and bryophyte too (Siitonen & Martikainen 1994, Kuusinen 1996).

Green tree retention in groups has advantages over an equal dispersion of residual trees. (1) Typical forest bird species of the first successional stages require larger open areas that increase concentrating residual trees. Concentration mutually harmonizes requirements of specialized birds that require greater tree retention and species of the first successional stages. (2) The groups of trees are more resistant to windthrow (Esseen 1994). The actual number of windthrows depends on many factors: climate, shape of the retention tree group, stand characteristic, ecology of tree species and others (Foster 1988, Peltola *et al.* 1999). (3) Grouping of trees in clearcuts makes positive impact on old forest species guild, because of maintenance of environmental conditions near old forest (Vanha-Majamaa & Jalonen 2001).

Residual trees are under high pressure of negative environmental factors. Trees grown inside stand are not adapted to open landscape. Many of them are damaged by wind or dry and die. Arnott and Beese (1997) reported a residual trees loss of 25% after three years. For this reason the density of residual trees should be higher than the theoretical optimum.

Conclusions

When clear-cutting, forest management practices should be based on leaving two categories of both large (D>20cm) and small (D<20cm, H>8m) residual trees. Two categories of large residual trees for management practice were defined: clearcuts with relative low density (0.1-1.0 tree/ha) and clearcuts with high density (10.1-30.0 trees/ha) of residual trees. Forest management practices should be based on small residual tree retention within two categories: 1.1-5.0 and 10-30 tree/ha. However, because of high wind damage risks even more residual trees should be left.

It is recommended for forest birds in 1 ha of the clearcut to leave one group (3-5 trees) of large (D>20 cm) and 5-10 small (D<20 cm; H>8m) residual trees. Small residual trees should be dispersed equally on the clearcut. In forests, where rare woodpecker or other hollow-nest species breed it is recommended to leave 10-30 large and 20-40 small residual trees, half of them disperse equally half – group in small patches.

The retention of different tree species is important for different species. It is therefore recommended that retention is made both of softwood (mainly for woodpeckers) and hardwood (mainly for large nests).

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СОХРАНЕНИЕ ЖИВЫХ ДЕРЕВЬЕВ И СООБЩЕСТВ ПТИЦ НА СПЛОШНЫХ РУБКАХ

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Резюме

Изучалось влияние сохраненных живых деревьев на гнездовые сообщества птиц на лесосеках возрастом от 1 до 15 лет. Самое большое число видов птиц найдено на лесосеках с плотностью 0,1-1 крупных деревьев (диаметр > 20 см) на 1 га. Сохранённые сравнительно мелкие деревья (диаметр < 20 см, высота > 8 м) не имели важного влияния на число видов птиц. Как мелкие, так и крупные деревья не имели влияния на плотность гнездового населения птиц. Сохранённые растущие деревья значительно влияли на видовой состав сообщества птиц на лесосеках. Большинство обычных видов птиц предпочитали низкую плотность крупных растущих деревьев. Самое большое число видов обнаружено на лесосеках с 0,1-1 дерево/га, а самое меньшее число – на чистых лесосеках без единного дерева. На сплошных мелких рубках площадью до 2,0 га проанализированные характеристики сообществ птиц достоверно отрицательно коррелировали с числом одиночных сохранённых деревьев, растущих на единице площади. 53 вида птиц сгруппированы на 4 кластера по влиянию сохранённых деревьев на их численность (число видов птиц в скобках: зависящие от крупных и соответственно - мелких деревьев): отрицательно влияемые (10; 3), положительно влияемые (14; 16), характерные для лесосек со сравнительно низким или средним числом сохранённых одиночных живых деревьев (9; 7), и виды, на численность которых одиночные сохраненные живые деревья не влияют. Рекомендуется во время сплошных рубок на 1 га сплошной лесосек сохранять одну группу из 3-5 крупных и 5-10 одиночных мелких, распределённых по всей площади деревьевю В лесах, где гнездятся редкие дятловые (*Dendrocopos lencotos*) или другие дуплогнездники, рекомендуется для долговременного эффекта сохранять 10-30 крупных и 20-40 мелких растущих деревьев на 1 га лесосеки. Половина из них должна быть распределены равномерно, а другая половина – на одной или несколько групп, пропорционально как из мелколиственных пород (в основном полезны для дятловых), так и крупнолиственных или сосны обыкновенной (в основном важные для гнездования хищников).

Ключевые слова: живые деревья, сохранение, сообщества птиц, сплошные рубки, Литва