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DISTRIBUTION AND DYNAMICS OF POTENTIALLY HIGH CONSERVATION VALUE FORESTS: POSSIBLE USE OF STATE FOREST REGISTER

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The study focused on analyzing biologically potentially valuable forest regional distribution and dynamic between 2005 and 2012 in Latvia. The main data source was State Forest Register. The set of criteria comprising age and compositional parameters were elaborated to select appropriate stands of numerous forest families. The results revealed various trends of area change of forest families at regional level. Generally, forest areas on wet sites were increased relating to both biodiversity aspects. On the contrary, the area of coniferous on dry sites was decreased.

Key words: State forest register, forest biodiversity components, potentially valuable forests, forest families.

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INTRODUCTION

Conservation of forest diversity is one of the goals of contemporary forest management. During past decades there were numerous approaches successfully implemented to enhance biodiversity at local level, e.g. woodland key habitats (Auzins et al. 2003). However, conservation of forest biodiversity at landscape level means maintenance of representative and functional networks of all forest habitat types (Angelstam & Anderson 2001, Lohmus et al. 2004). There was still a discussion on how to acquire spatially explicit and actual information on distribution of all naturally occurring forest habitat types. One solution was to aggregate existing forestry data bases by selecting parameters necessary to identify forest areas with potentially high conservation value (Kurlavicius et al. 2004). In Latvia, it was a promising solution as the forestry databases covers ca 97% of registered forest land, and operates with management units (so-called *stands*) having distinct characteristic that were regularly updated. The stands in database had detailed descriptions, which contained parameters of tree species composition, age structure, site type and remarks of previous management. In addition, data were highly detailed as finest stand size was set to 0,1ha and average stand size was 1,6 ha (State Forest Service) implying possible use for studies aimed to biodiversity conservation.

The aim of our study was to develop methods for selection of forest areas important for biodiversity

Table 1. The forest families (adopted from Kurlavicius et al. 2004)

Name of forest family	Description in terms of forestry database
Pioneer phase	Stands dominated by Silver birch *(Betula pendula)* or Common aspen *(Populus tremula)* on dry soils, for mixed stands total proportion of both species must be at least 50%
Old-growth spruce	Stands where proportion of spruce (*Picea abies)* is greater than 40%
Broad-leaved or nemoral	Stands dominated/ consisted of Pedunculate oak (*Quercus robur)*, Ash (*Fraxinus excelsior*), Small-leaved lime (*Tilia cordata*), Wych elm *(Ulmus glabra),* European White Elm *(Ulmus laevis)* Norway maple *(Acer platanoides)* in various proportions on dry soils
Wet deciduous	Birch, aspen, black alder *(Alnus glutinosa)* stands on undrained peatlands/ wet undrained soils
Wet spruce	Stands dominated (at least 40% of composition) by spruce on undrained peatlands/wet undrained soils
Dry pine	Stands dominated by Scotch pine *(Pinus sylvestris)* on dry soils
Dry oak-pine	Stands with substantial proportion of both species of Oak and Scotch pine (*Pinus sylvestris*). Sum of both species should be at least 40% of stands composition
Riparian	Mixed black alder, ash and oak stands along the streams. At least 2 of listed species have to be presented for selection
Pine bogs, wet pine	Stands on undrained peatlands/ wet undrained soils where pine dominated (40% and more)

by using forestry database (State Forest Register), and to analyze distribution and dynamics of representative habitat types from 2005 to 2012 on regional scale in Latvia.

MATERIAL AND METHODS

Depending on forest site type (Bušs, 1981), composition of tree species and its respective age, all records of forested areas in State Forest Register were grouped into three broad types of forest dynamics: succession, cohort or gap (Angelstam and Kuuluvainen, 2004), which were sub-divided into forest families thus reflection spectrum of forest ecological diversity.

The list of indicators to enhance diversity in terms of structural, compositional and functional aspects (Noss, 1990) was elaborated by further developing indicators previously used for *Baltic Forest Mapping Project* (Kurlavicius *et al* 2004). These indicators were defined as lower age limit, composition and age structure of represented species, presence of natural disturbances, e.g. flooding, fire, windbreaks and also specifically localized stands, e.g. forested ravines, steep slopes etc. A vital component e.g. deadwood was excluded out of analyses since the amount of deadwood was not registered and not being updated in forestry database. The preselected stands of forest families were tested to meeting the requirements of indicator set (see Table 2).

We also prioritized which aspect of biodiversity was primarily used for stand selection, and therefore avoid possible overlap between both criteria sets. It should be stressed that stands meeting age criteria might contain qualities of multilayered age structure stands, as well as those selected because of various age cohorts might contain considerable amounts of veteran trees i.e. individuals from previous forest generations.

In our study, 2 versions of forestry data bases, i.e. 2005 and 2012 were used. The results showing

Table 2. Criteria set for individual stands to be selected as potentially valuable in terms of biodiversity

Forest families (Kurlavicius *et al* 2004)	*Lower age limit for tree species presented at stand level*	*In terms of forestry database, multilayered stand structure is interpreted as occurrence of trees of several generations setting lower limit of 5% of total stand tree volume. Age of trees of previous tree generation is defined separately for each forest family, and is at least 20 to 40 years above the dominating age of stand*
Pioneer phase	80 years for aspen and for birch dominating stands 90 years for birch dominating stands	Not analyzed because of apparent extensive logging that led to succession by pioneer species
Old-growth spruce	120 years	Average age less than 120 years, and at least 140 years old trees presented
Broad leaved or nemoral	No age limit for stands where oak, which elm, European white elm and maple dominated 60 years for lime dominating stands 80 years for ash dominating stands	Average age less than 60 years, and at least 100 years old trees presented
Wet deciduous	90 years for stands where birch dominated 80 years for aspen, ash and black alder dominating stands	Average age less than 80/90 years, and at least 100/110 years old trees presented
Wet spruce	120 years	Average age less than 120 years, and at least 150 years old trees presented
Dry pine	140 years	Average age less than 140 years, and at least 150 years old trees presented
Dry oak-pine	140 years	Average age less than 140 years, and at least 150 years old trees presented
Riparian .	80 years for stands where black alder dominated 85 years for stands where ash dominated	Average age less than 80/85 years, and at least 100/105 years old trees presented
Pine bogs, wet pine Stands on undrained peatlands/ wet undrained soils where pine dominated	Dominating age at least 140 years	Average age less than 130 years, and at least 150 years old trees presented

list of stands meeting the criteria were summed up to municipality level. The necessary amendments were done to harmonize the differences between municipal units of 2005 and 2012 because of administrative reform in 2008. Additional parameters were calculated for each municipality including total forested area, number of forest land parcels with forest presence, total area of each forest family. We also calculated amount of forests logged of respective forest families during the 7 years period, and also area of stands selected in 2005 and logged by the 2012 were calculated. Data processing was performed by using ARCGis 10 basic software tools, SQL Server and Microsoft Excel software.

RESULTS AND DISCUSSION

First of all, the total distribution of natural forest family types was analyzed (Fig. 1). It was concluded that together with small municipalities, i.e. towns, there were large areas containing lesser proportion of natural forest family types throughout the country, and especially in eastern region. There were two explanations related to former processes in these areas, namely the high proportion of drained peatlands that were not selected because of altered hidrological processes, and secondary forest on former agriculural lands mainly covered by grey alder (*Alnus incana)* stands.

According to age criteria the most noticeable area increment was for wet deciduous forest family (Table 3). However, in terms of relative proportion change pine bogs/wet pine share had increased almost 2 times over last 7 years. The areas of dry spruce forest family type was increased by about half of its size since 2007, and had second largest increment in terms of area. Unlike wet deciduous and pine bogs/wet pine, the dry spruce dominated forest family area dynamics had larger difference among municipalities, indicating reduction for several municipalities that correspond to 3% of the total family type area in the whole country. The pioneer phase, broad-leaved and riparian forest family were

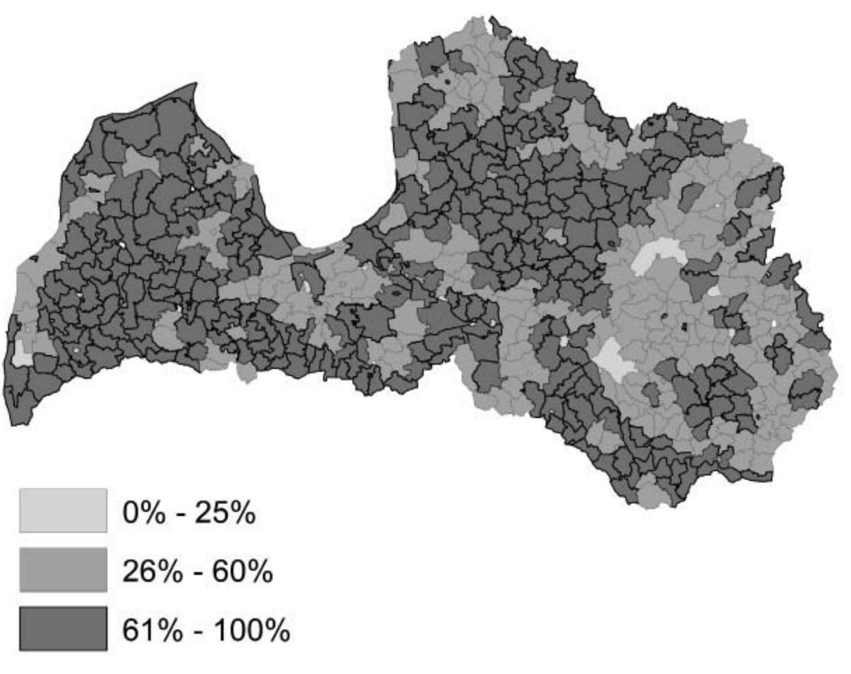

Fig. 1. The distribution of all described forest families' calculated from total forested area. However, it was found that there were also areas with least representation of forest families and decreasing area of stands meeting age and structural criteria (see Table 2 and Table 3).

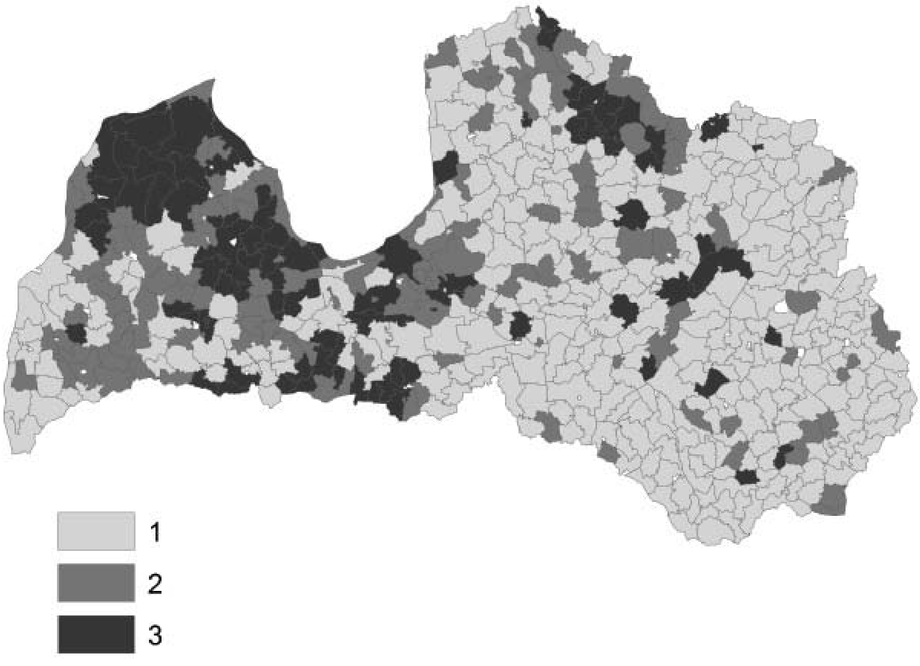

Fig. 2. The distribution of total area of represented forest families fulfilling the age criteria between 2005 and 2012. 1- Increasing area of stands, 2- Same amount of stands, 3- Decreasing area of stands.

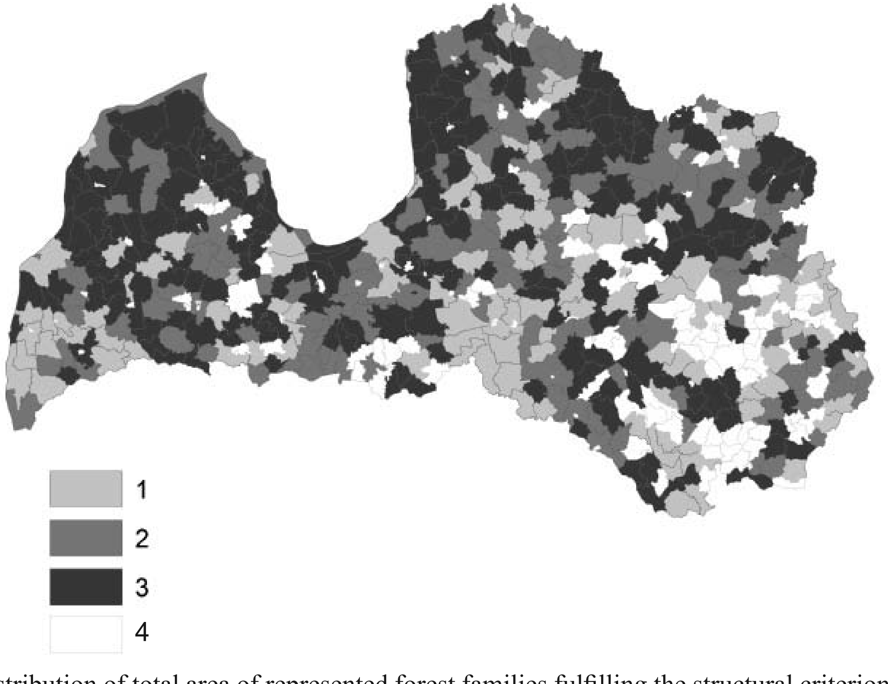

Fig. 3. Distribution of total area of represented forest families fulfilling the structural criterion comparing 2005 and 2012. 1- Increasing area of stands, 2- Same amount of stands, 3- Decreasing area of stands, 4-municipalities with absence of respective forest types meeting criteria.

Table 3. The dynamics of stands fulfilling minimum age criteria at local municipality scale in sequence of its relative change from 2005 to 2012.

Forest family	Count of represented municipalities	Change of area			Total in 2005	Change of area 2005 vs. 2012 (ha)				Area and proportion of forest family type by municipality (ha)		Municipalities where clear-cutting of selected stands was observed		Municipalities where any kind of logging of selected stands was observed	
		Not observed	Decreasing	Increasing		Min.	Max.	Total and Relative difference 2005 vs. 2012	Mean	Total	Logged	Count	Total (ha)	Count	Total (ha)
Pine bogs/ wet pine	168	23	8	137	1776,9	-4,3	92,6	1895,4 (106,6%)	11,3	179203 (2,0%)	2151,5	22	42,9	28	60,3
Wet deciduous	318	12	36	270	3201,4	-9,1	115,9	3071,9 (95,9%)	9,6	247241 (2,5%)	5106,6	124	4,6	144	306,3
Dry spruce	324	19	48	257	4961,8	-68,7	91,7	2387,5 (48,1%)	7,4	347274 (2,1%)	17316,6	94	270	130	644,4
Dry pioneer	472	17	187	268	13313,7	-50,9	98,1	1639,4 (12,3%)	3,5	416263 (3,5%)	31150,47	195	549,3	233	897
Broad leaved or nemoral	501	52	165	284	10932,3	-77,5	96,9	810,3 (7,4%)	1,6	19254 (60,9%)	370,3	36	43,7	137	370,3
Riparian	204	31	74	99	2216,6	-50	62,5	18,09 (0,8%)	0,1	16597 (13,4%)	102,9	30	50,9	35	62,8
Dry oak-pine	133	47	58	28	1311,7	-35,5	9,7	-206,9 (-15,7%)	-1,5	21058 (5,2%)	1224,3	4	133,9	18	43,8
Wet spruce	190	80	65	45	1562,9	-21	12,5	-121,2 (-7,7%)	-0,6	67765 (2,1%)	3580,7	26	44,3	35	71,2
Dry pine	349	72	179	98	24571,2	-198,2	207,9	-1248,3 (-5,1%)	-3,6	586025 (4,0%)	36052,2	86	448,1	124	1753,2

Table 4. The dynamics of stands fulfilling stand structural criteria at local municipality scale in sequence of its relative change from 2005 to 2012.

Forest family	Count of represented municipalities	% of municipalities where forest family presented	Change of area			Total area in 2005 (ha)	Change of area 2005 vs. 2012 (ha)				Municipalities where clear-cutting of selected stands was observed		Municipalities where any kind of logging of selected stands was observed	
			Not observed	Decreasing	Increasing		Min.	Max.	Total and Relative difference 2005 vs. 2012	Mean	Count	Total (ha)	Count	Total (ha)
Pine bogs/ wet pine	63 (12,1%)	12,1	16	-	47	793,1	0,1	33,4	384,2 (48,4%)	6,09	11	12,2	16	34,5
Wet spruce	55	10,9	26	3	26	177,3	-1	10,8	66,2 (37,3%)	1,2	6	6,4	8	10,4
Wet deciduous	242	44,4	84	73	85	848,1	-8,2	17,8	19,7 (2,3%)	0,1	18	17,1	36	55,5
Broad leaved or nemoral	51	9,9	38	8	5	120,8	-10,9	5,4	-7,5 (-6,2%)	0,1	-	-	-	-
Dry pine	218	39,6	55	104	59	5119,8	-134,8	34,2	-598,4 (-11,7%)	-2,7	24	59,1	61	301,6
Dry oak-pine	112 (23,3%)	23,3	41	53	18	772,4	-42,8	6,3	-194,8 (-25,2%	-1,7	4	3,8	12	59,8
Dry spruce	134	24,9	64	54	16	610,3	-37,7	7,15	-174,8 (-28,6%)	-1,3	11	4,7	22	55,8
Riparian	131 (30%)	30	47	64	20	618,8	-38,4	7,8	-221 (-35,7%)	-1,7	1	1,7	7	16,8

among those having limited but positive dynamic, 12.4%, 7.3% and 0.8% respectively. The dry pine forests had the largest decrement of area in more than half of municipalities of Latvia. There was also large difference of dry pine forest family area dynamics between municipalities ranging from -198.7 ha up to 207 ha. The dry oak pine forest families' old growth stands had the largest reduction of their relative proportion. At lesser extent also wet spruce forest families' stands area meeting age criteria are decreased.

The broad leaved forest family fulfilling age criteria was most represented relatively to their total area in Latvia, which is explained by relatively lower age limit used in stand selection. Although dry pine forest family stands meeting age criteria formed more than 10% of total forest family type area in Latvia, they were not evenly distributed (Fig. 4). It might be concluded that later ones were among those most represented and mostly influenced. The dry oak-pine forests meeting age criteria also formed more than 5% of their total forest family area. It was concluded that at state level the change of family forest type area was connected with total area though at regional level there were large differences among municipalities. It was also concluded that logging i.e. complete or partial removal of stands of certain age was not the only factor influencing dynamics of respective forest family type. It is influenced by age structure of respective forest family type, logging intensity and forest inventory that provided actual date on stand status. For example, the area of dry pine forests above the certain age were decreased by 1248 ha, however the clear felling of such forests was recorded in area of 448 ha, which indicated that rest of stands were changed in terms of age and species composition during the partial logging, and had not been selected during the selection in 2012. The change of area of dry oak-pine forest might be explained by update of forest inventory data reflecting change of species composition and especially age structure. This could be studied by analyzing dynamics of the same stands at local scale.

The change of forest stands area that fulfilled stand's structural criteria (Table 4) had different pattern than dynamics previously described. The list of sequence of forest families' dynamics relative change also indicated pine bogs/wet pine, wet spruce and wet deciduous forest family as ones with largest surplus. However, the rest of analyzed families stands area decreased by 7.5 to 35.7% of respective area. The reduction was observed more in dry forest types. Stands in dry pine forests were reduced by more than 11.7% comparing to the area in 2005, and also had the largest reduction in terms of area. The negative dynamics of multi aged stands of broad leaved, dry pine, dry oak pine, dry spruce and riparian forest families at large extent was explained by forest inventory data change that had caused simplified records of stands, i.e. apparently old veteran trees and trees from previous stand were not recorded. The argument is supported by looking at the total area of respective stands areas that area completely or partly logged between 2005 and 2012. It indicated that reduction of forest family area is larger than total area of logging by several times, implying that there is change in data itself rather than actual change of status of stands in the field.

In spite the fact that dry pine forests were at some extent distributed throughout the country, there were still areas where a lack of stands of certain age was observed. These areas were located in both landscapes where extensive agriculture land use was dominant, e.g. Zemgale plain as well in the Latgales and Vidzemes upland where it was explained by specific land use history. It is also observed that reduction of old growth dry pine forests occurred in areas where dry pine forests prevailed (Fig. 4). For example, Northern Kurzeme dry pine forest formed up to 60% of total forest family area; the area of forest family meeting age criteria was decreased considerably.

The same trend was noticed for all municipalities where dry pine forest prevailed.

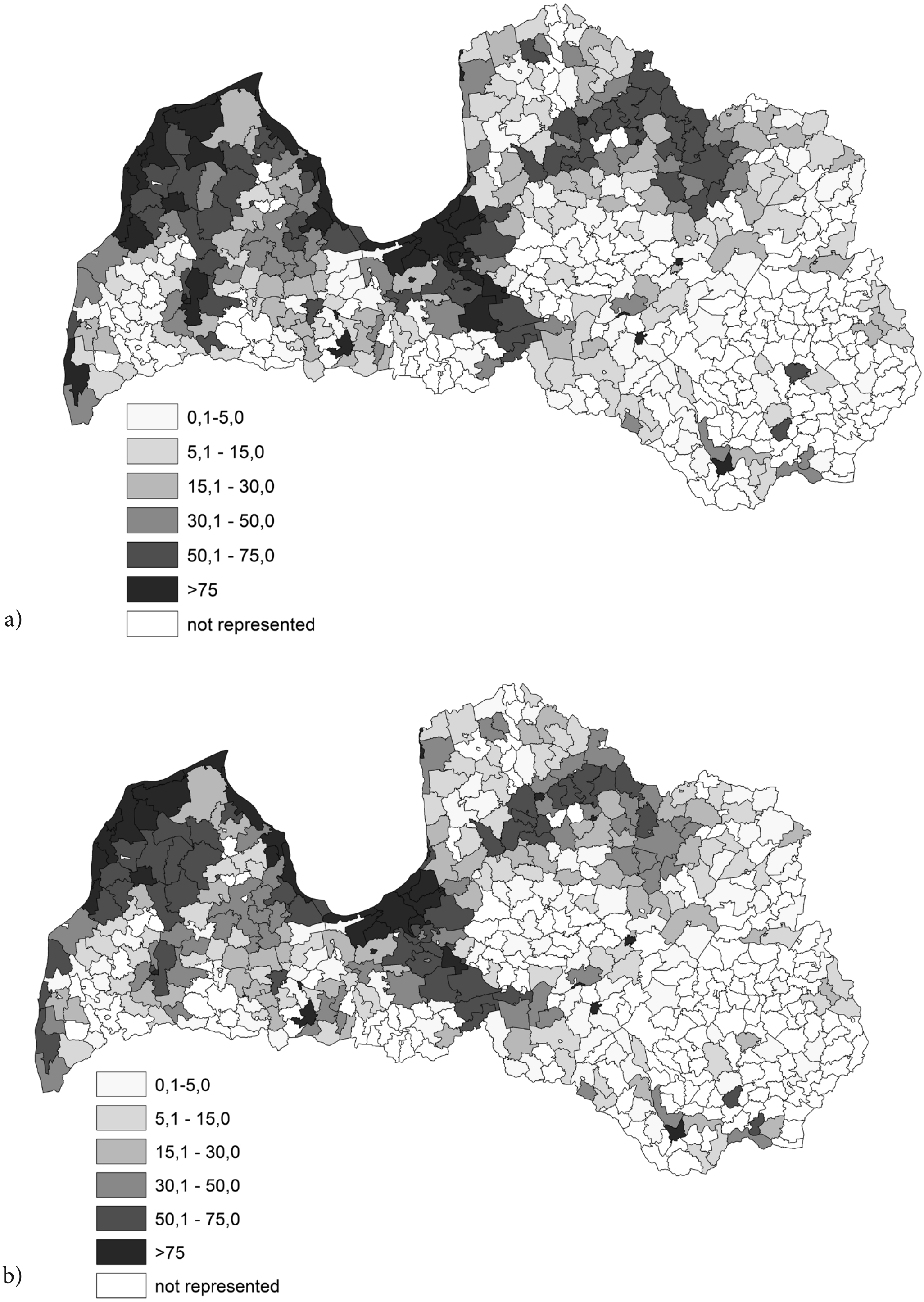

Fig. 4. Dynamics of dry pine forests fulfilling age criteria between 2005 and 2012.
a) Area of selected dry pine forests in 2005 (% of total area of stands fulfilling age criteria) and
b) Area of selected dry pine forests in 2012 (% of total area of stands fulfilling age criteria).

There were also remarkably higher proportion of dry pine forests in areas with existing restriction for logging to sustain environmental and biodiversity conservation objectives, e.g. protection zone along Baltic sea coast and Specially Protected Nature Areas.

CONCLUSIONS

The State Forest Register was useful tool for selection of several parameters describing potential status for biodiversity at stand scale. This applied to age of presented tree species and their relative abundance. The main drawbacks were related to correlated aspects of unrecorded management activities and data reliability because of newer stands inventory. The distribution and relative change of selected forest families suggested the need to included stands age and compositional aspects and spatial location aspects in sustainable planning of forest resource use.

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