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Changes in the threat of spruce stand disintegration in the Beskid Śląski and Żywiecki Mts. in the years 2007–2010

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ABSTRACT: The present paper describes the dynamics of changes in spruce stand disintegration in the Beskid Śląski and Żywiecki Mts. on the basis of the results of inventory performed in 2010 as compared to those in 2009. The research was done in six forest districts in the Beskidy Mts. The area of spruce stands in degrees of threat of disintegration on the day of 30th September in the research period was determined for forest districts Bielsko, Ustroń, Wisła, Węgierska Górka, Jeleśnia and Ujsoły, on the basis of data in the State Forests Electronic Database (SILP) in degrees of threat of stand disintegration as well as in climate and vegetation zones. A comparison of the results of inventory of the stands threatened with disintegration in six forest districts in 2007 (altogether 24,446 ha) and in 2010 (altogether 16,886 ha) indicates a decrease in the rate of spruce stand disintegration. This may point to the slowing down of the rate of spruce stand disintegration as well as to considerable intensification of reconstruction work.

Keywords: spruce stands; degrees of reconstruction urgency; inventory; climate and vegetation zones; Beskid Śląski and Żywiecki Mts.

The spruce stands of the Beskid Śląski and Beskid Żywiecki Mts. are affected by a forest system disease. The problem concerns spruce in its whole European range (Šrámek et al. 2010). What contributes to the disintegration of the stands of this species are unfavourable climatic changes, anthropogenic factors and historical reasons related to the establishment of spruce monocultures, usually of foreign origin, without regard to site conditions (Broda 1965; Mach, Barszcz 1983; Szujecki 1992; Sierota 1995; Barszcz, Małek 2003; Grodzki 2007; Barka et al. 2010; Hlásny et al. 2010a, b; Šrámek et al. 2010). The need to reconstruct these spruce stands was indicated already in the past (Mach, Barszcz 1983). No one expected that their disease would assume such a rapid and mass character. During the last few years there has occurred rapid acceleration of tree dieback and stand disintegration, which leads to the degradation of the entire forest environment, threat to forest biocoenosis stability, lowering of the production potential and changes in forest management. The process is further intensified by violent, extreme weather phenomena, such as windstorms, winters that are either long and severe or too mild, droughts, etc. These phenomena have been making the condition of these forests increasingly worse in terms of both area and quality. In the last two years there has occurred a distinct decrease in the area of the spruce stands threatened by disintegration, which may point to a decline of this phenomenon, due to such factors as a fall in the population of

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the bark beetle as well as a fall in the area of dying spruce stands, which are gradually removed.

The aim of the present study was to assess changes in the degree of threat of spruce stand disintegration in the Beskid Śląski and Żywiecki Mts. in the years 2009–2010 on the basis of the instructions, developed and improved by the present authors, of data acquisition from the State Forests Electronic Database (SILP). The present study is a response to an urgent need in forest practice for fast and objective periodical assessment of the dynamically changing area of disintegrating spruce stands in the analysed regions.

MATERIAL AND METHODS

The research was done in six forest districts in the Beskidy Mts., belonging to the Regional Directorate of the State Forests in Katowice. The area of spruce stands in degrees of disintegration threat on the day of 30th September 2010 was determined by K. Majsterkiewicz for all the forest districts under assessment (Bielsko, Ustroń, Wisła, Węgierska Górka, Jeleśnia and Ujsoły). Due to a limited possibility of data acquisition from the State Forests Electronic Database (SILP), the following data contained in this database were considered: the year of developing the forest management plan; forest management year; the index of increase of sanitary deadwood (NPS) and of increase of active deadwood (NPC); stand density in particular forest layers; the degree of area being covered by the regeneration layer, with a division into classes (0.1–0.3; 0.4–0.5; > 0.5) for the year of the forest management plan; the record of recognized natural regeneration and underplanting in a given year; altitude: minimum, maximum and medium for a given division; blanks and irregularly stocked open stands; for spruce which occurs in the first forest layer: initial stock (for the year of developing the forest management plan) and stock for the current year.

As the above-mentioned forest districts do not have the area division corresponding to climate and vegetation zones yet, the stand divisions were included on the basis of medium altitude into one of the four altitude zones: foothills, lower forest zone, middle forest zone and upper forest zone, assuming that in the Beskid Śląski and Mały Mts. the upper borders of the first three zones will be roughly delimited by the following contour lines: 500, 800 and 1,000 m a.s.l., while in the Beskid Żywiecki Mts. they will be: 600, 900 and 1,100 m a.s.l., respectively. The Beskid Śląski Mts. include the following forest districts: Ustroń, Bielsko and Wisła as well as the whole division of Lipowa belonging to the forest district of Węgierska Górka and the forest subdistricts of Kamesznica, Sikorczany and Zielona from the division of Węgierska Górka. The Beskid Żywiecki Mts. include the remaining forest subdistricts of the division of Węgierska Górka and the forest districts: Jeleśnia and Ujsoły.

In the form of the algorithm applied here the researchers used the joined area of regeneration (natural and planted) because of the lack of precise data on its origin in the SILP database. In-field recognition of the possibility to obtain data from SILP according to the above criteria allowed for adopting the following rules of qualification of stands for reconstruction in accordance with degrees of its urgency:

(1) very urgent reconstruction within a very short period (up to a few years – max. 10 years), which should include the following stands: dying ones, where the harvesting of sanitary deadwood (NPS) is above 50 $m^3 \cdot ha^{-1}$, which corresponds to the active deadwood increase index (NPC) over 16, tree coverage in the stand of 0.1–0.3 and degree of coverage with a young generation of 0.1–0.3;
(2) urgent reconstruction within a relatively short period (up to several years – 10 to max. 20 years), which should include the following stands: weakened ones, where the harvesting of sanitary deadwood (NPS) is 30–50 $m^3 \cdot ha^{-1}$, which corresponds to the active deadwood increase index (NPC) of 10–16, stand tree coverage of 0.4–0.5 and degree of coverage with a young generation of 0.4–0.5;
(3) relatively urgent reconstruction within a longer period (within 20–30 years), which should include the following stands: weakened ones, where the harvesting of sanitary deadwood (NPS) is below 30 $m^3 \cdot ha^{-1}$, which corresponds to the active deadwood increase index (NPC) below 10, stand tree coverage of 0.5–0.7 and degree of coverage with a young generation above 0.5;

As in their previous research (Barszcz, Małek 2005, 2007, 2009, 2010; Barszcz et al. 2009), the present authors recommend introducing the 4th degree of stand reconstruction urgency in order to include the remaining spruce stands, mostly cultures, with tree coverage above 0.7, as well as a few spruce stands which should undergo reconstruction within a long period (over 30 years).

The data obtained from SILP allowed for an attempt at visualization of the results of the current inventory in the form of digital maps showing dif-

ferent degrees of stand reconstruction urgency in accordance with the divisions within each of the six forest districts under analysis (Figs. 1 and 2).

RESULTS AND DISCUSSION

The inventory of the stands threatened with disintegration (lacking sufficient regeneration) in degrees of their reconstruction urgency 1–3, performed in 2005, showed that in the six forest districts under analysis the total area of these stands amounted to 14,609 ha (Barszcz, Małek 2005), in 2007 it was already 24,446 ha (Barszcz, Małek 2007; Barszcz et al. 2009), whereas in 2009 their area decreased to 20,557 ha, i.e. by about 14% (Barszcz, Małek 2009), and in 2010 to 16,886 ha (Barszcz, Małek 2010). The decrease in the area of the threatened stands in the last period under analysis amounts to 3,671 ha, i.e. about 19.0%, which indicates a slowing down of the rate of spruce stand disintegration in the research area (Table 1). It must be remembered, however, that this slower rate is also caused by a decrease in the area of the threatened stands due to their removal during sanitary cutting (which was the most intensive in Węgierska Górka Forest District) as well as a lower rate of tree dying caused by a fall in the gradation of the spruce bark beetle (Grodzki 2007).

The area that is the most threatened in this respect is Ujsoły Forest District and, to a smaller degree, Jeleśnia and Wisła Forest Districts. Against this background, the forest districts of Bielsko and Ustroń face a relatively lower threat. This indicates constant dieback of spruce stands in the southern and south-eastern part of the research area (Table 1, Figs. 1 and 2), which is where it began the latest.

In 2010, with regard to altitude, the largest area of stands threatened with disintegration in the six forest districts (including Jeleśnia Forest District) occurred in the lower forest zone (Tables 2 and 3), particularly in the following forest districts: Ujsoły (about 6,127 ha), Wisła (about 3,490 ha) and Ustroń (about 2,231 ha) – cf. Table 2.

Reconstruction of stands in the lower forest zone and those in foothills should not pose any large problems thanks to good site conditions, possibility to use numerous tree species and a considerable area of stands producing seeds of the main forest-creating species. The next group (in terms of area) consists of threatened spruce stands in the middle forest zone, especially in Ujsoły Forest District (approx. 2,945 ha), and next in Jeleśnia (approx. 1,345 ha) – cf. Table 2.

Table 1. The area (in ha) of stands threatened with disintegration, with regard to natural and artificial regeneration, in degrees of their reconstruction urgency in the mountain areas of forest districts of the Regional Directorate of the State Forests in Katowice in 2009–2010

Type of area and degree of reconstruction urgency				Forest districts						Total
				Bielsko	Ustroń	Wisła	Węgierska Górka	Jeleśnia	Ujsoły	
Forest area in forest district			2009	9.966	11.226	8.506	9.107	11.539	13.225	63.569
			2010	9.964	11.219	8.493	9.091	11.539	13.225	63.531
Area of stands threatened with disintegration			2009	2.114	3.360	4.489	4.222	3.993	9.341	2.7519
			2010	1.767	3.279	3.950	3.739	3.730	9.350	2.2785
Including	area with regeneration		2009	331	1.135	834	1.237	838	2.586	6.961
			2010	184	1.059	1.119	233	470	2.832	5.897
	for reconstruction	degree 1	2009	491	422	456	859	181	296	2.705
			2010	349	364	247	149	199	406	1.713
		degree 2	2009	283	287	672	759	223	505	2.729
			2010	217	193	400	228	240	317	1.595
		degree 3	2009	1.009	1.515	2.527	1.367	2.751	5.953	15.122
			2010	1.017	1.632	2.184	129	2.821	5.755	13.538
		all degrees 1–3	2009	1.783	2.224	3.655	2.985	3.155	6.755	20.557
			2010	1.583	2.188	2.831	506	3.260	6.518	16.886

degrees of reconstruction urgency: 1 – very urgent, 2 – urgent, 3 – relatively urgent

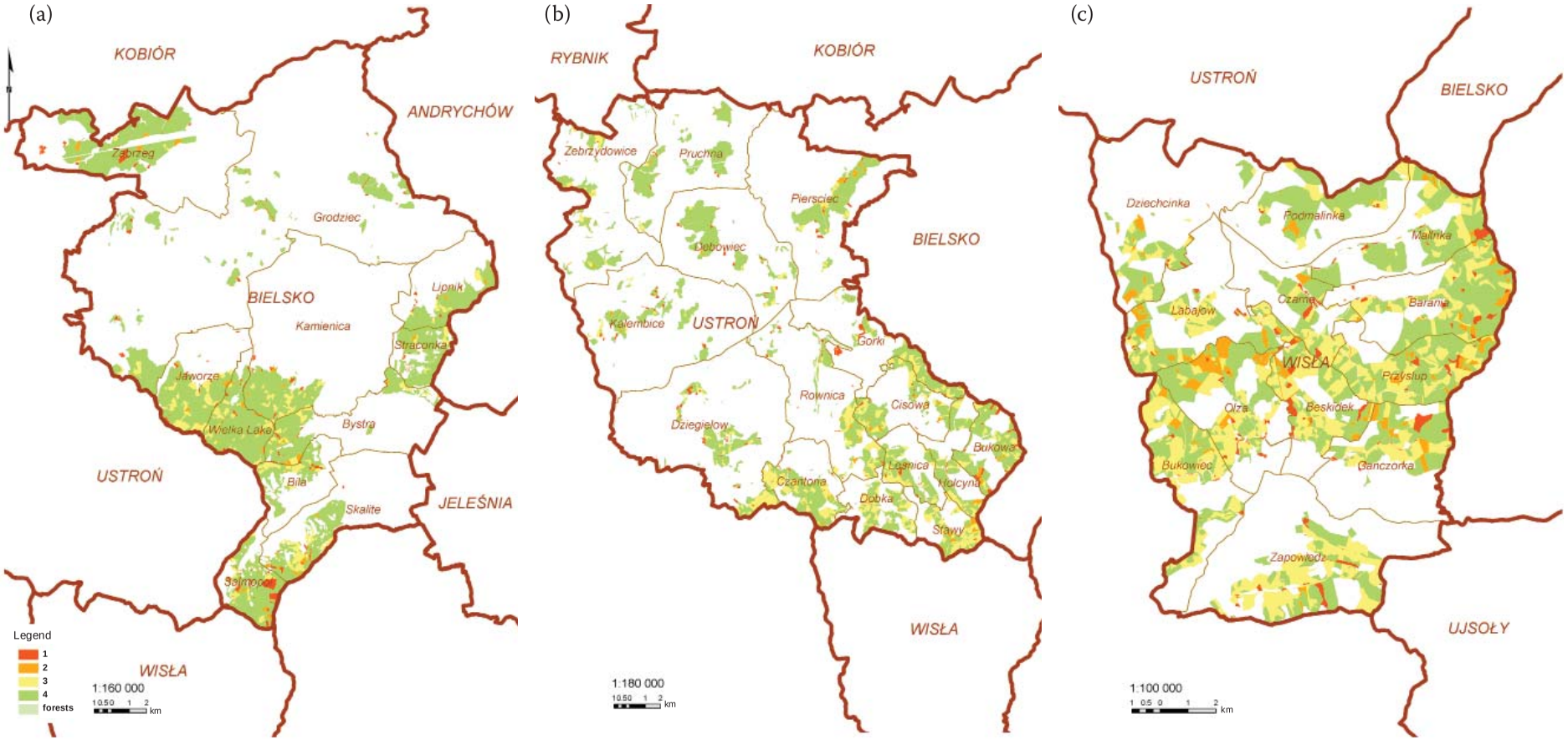

Fig. 1. The distribution of spruce stands for reconstruction (in degrees of reconstruction urgency: 1 – very urgent, 2 – urgent, 3 – relatively urgent, 4 – other spruce stands) in the forest districts: (a) Bielsko, (b) Ustroń and (c) Wisła, according to data obtained from SILP (on 30.08.2010)

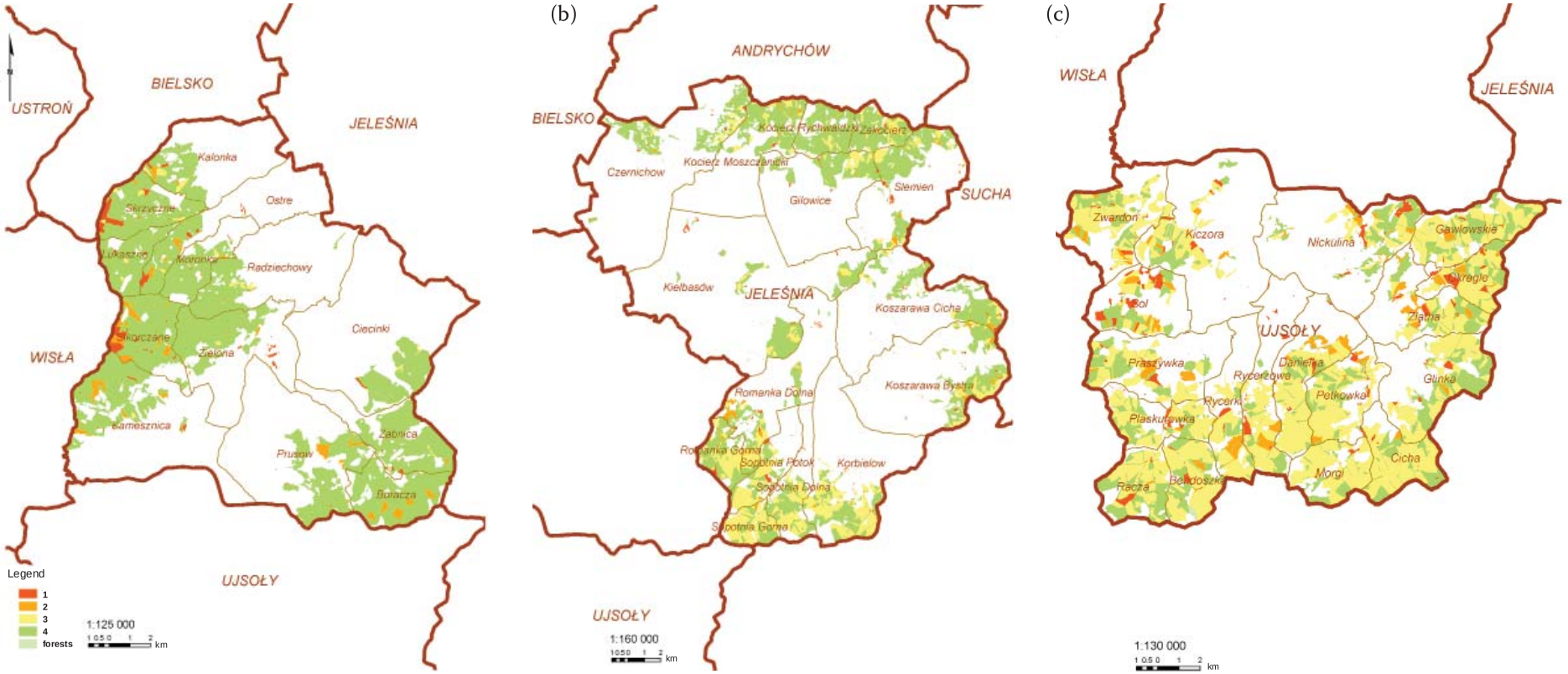

Fig. 2. The distribution of spruce stands for reconstruction (in degrees of reconstruction urgency: 1 – very urgent, 2 – urgent, 3 – relatively urgent, 4 – other spruce stands) in the forest districts: (a) Węgierska Górka, (b) Jeleśnia and (c) Ujsoły, according to data obtained from SILP (on 30.08.2010)

Table 2. The area of divisions threatened with disintegration (in ha) divided into areas with regeneration and those for reconstruction in climate and vegetation zones in the mountain stands of forest districts of the Regional Directorate of the State Forests in Katowice in 2009–2010

Climate and vegetation zones		Area of divisions threatened with disintegration (ha)		
		total	regeneration	for reconstruction
Bielsko Forest District				
Foothills	2009	268	1	267
	2010	417	5	412
Lower forest zone	2009	1134	177	957
	2010	760	42	718
Middle forest zone	2009	520	77	443
	2010	395	54	341
Upper forest zone	2009	192	76	116
	2010	195	83	112
Ustroń Forest District				
Foothills	2009	932	234	698
	2010	1.030	181	849
Lower forest zone	2009	2.231	781	1.450
	2010	1.934	756	1.178
Middle forest zone	2009	197	120	76
	2010	285	122	161
Upper forest zone	2009	0	0	0
	2010	0	0	0
Wisła Forest District				
Foothills	2009	0	0	0
	2010	56	0	56
Lower forest zone	2009	3.490	613	2.877
	2010	3.006	858	2.148
Middle forest zone	2009	792	202	590
	2010	677	187	490
Upper forest zone	2009	207	19	188
	2010	211	74	137
Węgierska Górka Forest District				
Foothills	2009	95	18	77
	2010	41	0	41
Lower forest zone	2009	2.892	842	2.050
	2010	275	57	218
Middle forest zone	2009	1.156	345	811
	2010	220	87	133
Upper forest zone	2009	79	32	47
	2010	203	89	114

Table 2 to be continued

Climate and vegetation zones		Area of divisions threatened with disintegration (ha)		
		total	regeneration	for reconstruction
Jeleśnia Forest District*				
Foothills	2010	277	51	226
Lower forest zone		1.789	213	1.576
Middle forest zone		1.345	172	1.173
Upper forest zone		319	34	285
Ujsoły Forest District				
Foothills	2009	234	50	184
	2010	175	18	157
Lower forest zone	2009	6.127	1.852	4.275
	2010	6.163	1.895	4.268
Middle forest zone	2009	2.945	684	2.261
	2010	2.912	857	2.055
Upper forest zone	2009	35	0	35
	2010	100	62	38

*for Jeleśnia Forest District in 2009 there were no data in the SILP-LAS base that would make it possible to ascribe divisions to climate and vegetation zones

The total area of threatened stands in this zone amounts to about 6,000 ha. In the middle forest zone, the problem (apart from a large area of stands for reconstruction) is a smaller area of spruce seed-bearing stands, a small area of such beech stands and a lack of such a base for fir and admixture species. Threatened stands in the upper forest zone (altogether about 1,000 ha, mostly in Jeleśnia Forest District) are going to, despite a relatively small area (Table 2), cause the largest reconstruction problems due to a lack of recognized seed-bearing stands, a small number of species and very difficult site conditions, especially at mountain tops and ridges and because of the need for different silvicultural measures in such areas.

The above data (only for five forest districts, except Jeleśnia) show that between 2009 and 2010 there occurred a decrease in the area of threatened spruce stands in the lower and middle forest zones, a distinct increase in the foothills and a slight increase in the upper forest zone (Table 2). A comparison between the areas of the recognized natural and artificial regeneration in regions threatened with disintegration shows that in the years 2009–2010 there were about 5,900 ha that were considered as reconstructed (Table 1). With regard to altitude, the largest number of areas included in this group occurs in the lower and middle forest zones, particularly in the forest districts of Ujsoły, Wisła and Ustroń.

A comparison of the shares of areas of particular degrees of reconstruction urgency in the total area of stands threatened with disintegration shows a decrease, which is the largest in degree 1 – cf. Table 1. Despite these changes, relative proportions between the area for reconstruction in particular climate and vegetation zones and the total area in the whole region under analysis are similar to those in previous record periods (Fig. 1, Table 3).

At high altitudes, mountain areas will have to undergo artificial regeneration and in certain cases also measures stimulating natural regeneration (Barszcz, Małek 2003, 2005).

CONCLUSIONS

Comparison of the results of inventory (from the year 2007: 24,446 ha, 2009: 20,557 ha and 2010: 16,886 ha) of stands threatened with disintegration in six forest districts of the Beskidy Mts: Bielsko, Ustroń, Wisła, Węgierska Górka, Jeleśnia and Ujsoły shows a decrease in the threat of spruce stand disintegration. In total, the decrease in such stands in the period 2009–2010 amounted to 3,671 ha (i.e. nearly

Table 3. The area of fragments of divisions for reconstruction (in ha) according to degrees of its urgency in climate and vegetation zones in the mountain stands of forest districts of the Regional Directorate of the State Forests in Katowice in 2009–2010

Climate and vegetation zones		Degree of reconstruction urgency			Total
		1	2	3	
Bielsko Forest District					
Foothills	2009	111	55	101	267
	2010	176	73	163	412
Lower forest zone	2009	156	113	688	957
	2010	47	67	604	718
Middle forest zone	2009	165	103	175	443
	2010	92	51	198	341
Upper forest zone	2009	59	12	45	116
	2010	34	26	52	112
Ustroń Forest District					
Foothills	2009	256	53	389	698
	2010	281	80	488	849
Lower forest zone	2009	165	214	1.071	1.450
	2010	60	85	1.033	1.178
Middle forest zone	2009	1	20	55	76
	2010	22	28	111	161
Upper forest zone					
Wisła Forest District					
Foothills	2009	0	0	0	0
	2010	11	0	45	56
Lower forest zone	2009	331	506	2.040	2.877
	2010	171	258	1.719	2.148
Middle forest zone	2009	53	136	401	590
	2010	45	89	356	490
Upper forest zone	2009	72	30	86	188
	2010	20	53	64	137
Węgierska Górka Forest District					
Foothills	2009	21	6	50	77
	2010	41	0	0	41
Lower forest zone	2009	448	523	1.079	2.050
	2010	34	119	65	218
Middle forest zone	2009	381	211	219	811
	2010	22	64	47	133
Upper forest zone	2009	9	19	19	47
	2010	52	45	17	114

Table 3 to be continued

Climate and vegetation zones		Degree of reconstruction urgency			Total
		1	2	3	
Jeleśnia Forest District*					
foothills	2010	93	25	108	226
lower forest zone		83	170	1323	1.576
middle forest zone		23	45	1.105	1.173
upper forest zone		0	0	285	285
Ujsoły Forest District					
Foothills	2009	7	1	176	184
	2010	38	16	103	157
Lower forest zone	2009	204	429	3.641	4.275
	2010	336	238	3.694	4.268
Middle forest zone	2009	85	75	2.101	2.261
	2010	29	63	1.963	2.055
Upper forest zone	2009	0	0	35	35
	2010	3	0	35	38

*for Jeleśnia Forest District in 2009 there were no data in the SILP-LAS base that would make it possible to ascribe divisions to climate and vegetation zones; 1 – very urgent, 2 – urgent, 3 – relatively urgent

20%). This indicates a slowing down of the rate of spruce stand disintegration, and increase in the area of stands with recognized regeneration, but also a decrease in the total area of spruce stands due to their removal during sanitary cutting (especially in Węgierska Górka Forest District).

At present, spruce stands which are the most threatened with disintegration are found in Ujsoły Forest District, and to smaller degrees in the forest districts of Jeleśnia and Wisła. It indicates a constant rate of dieback of stands in the same, southern and south-eastern part of the analysed region. Moreover, the dieback has extended considerably in the foothills and slightly in the upper forest zone, whereas it decreased in the lower and middle forest zones.

The reconstruction of stands in the lower forest zone and those in the foothills should not pose any large problems except for their size, thanks to good site conditions, the possibility to use a large number of tree species and a considerable area of the existing seed-bearing stands of the main forest-creating species.

The second group with regard to area are threatened spruce stands in the middle forest zone, mainly in Ujsoły Forest District, and then in Jeleśnia. In this zone, the problem is due to a smaller area of seed-bearing spruce stands, only a small one for beech and practically none for fir and admixture species.

Threatened stands in the upper forest zone (most of which are in Jeleśnia) are going to cause the greatest problems with their reconstruction because of a lack of recognized seed-bearing stands, a small number of species and very difficult site conditions, especially in top and ridge mountain locations and because of the necessity to change silvicultural measures in these areas.

Reconstruction or conversion should also be applied in the remaining, artificial spruce stands in the mountains, with the relatively least visible signs of damage. The above-mentioned measures should be conducted in areas of all degrees of reconstruction urgency, with the intensity suitable for the adopted reconstruction periods.

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