Organization of rational and environmentally sound use of forest resources, taking into account the economic factor on the example of the Kartopsky forestry of the Khanty-Mansi Autonomous Okrug (Yugra)

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Abstract. Balanced ecological and economic development is possible only with the development and implementation of a single comprehensive program for the use of natural resources, taking into account the need for environmental protection, restoration of natural resources, restoration and production of flora and fauna resources. The scale of the impact of anthropogenic factors has not yet been fully assessed, however, it can be said with confidence that the environmental losses that nature incurs from all types of negative impact on the environment significantly exceed the currently calculated economic losses.

1 Introduction

The pace of economic development has exacerbated the problem of limited natural resources, on the basis of this, it became necessary to take into account environmental requirements in the economy. In the "economy-environment" system, neither the economy over the environment nor the environment over the economy can be given priority. There is a need to ensure such interaction, in which high rates of expanded reproduction, economic growth would be combined not only with the preservation, but also with the continuous improvement and development of both individual components and the entire environment [1].

One of the important problems of rational nature management is the development of an objective economic assessment of forest resources, taking into account environmental factors [2]. The solution to this problem largely depends on the description of forest types carried out on the basis of ecological and phytocentotic studies.

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2 Materials and methods

In this regard, we conducted a survey of forest areas and performed a forest typological description on the territory of the Khanty-Mansiysk Autonomous Okrug, using the example of the Kartopsky forestry of the Soviet forestry of the Khanty-Mansiysk forestry department. Before going into the forest, forest management materials (explanatory note, forest inventory descriptions, afforestation plan) and all changes occurring in the forest fund of indigenous (over 100 years old) types of pine forests over the inter-inventory period (cutting down logging sites, sanitary felling, reforestation and other forest management activities) were studied.) [5-6]. A plan-scheme of primary pine plantations was copied with the drawing of quarters and taxation allotments - ripe and overmature pine plots. The field study of native pine forests in the territory of the forestry was carried out by the method of detailed route research using specially prepared forest typological forms of forest stand descriptions by adjusting the taxation indicators of the last forest inventory, which were taken from the taxation descriptions.

3 Results

When adjusting the taxation data, the contours of the former forest stands were preserved to the extent possible, and their taxation indicators were determined visually or instrumentally (Table 1) [7].

Table 1. Species composition and age structure of forests (numerator - area, ha; denominator - reserve, thousand cubic meters).

According to the present forest inventory						
Dominant breed	**Youngsters**	**Middle age**	**Ripening**	**Total**	**Ripe and overripe incl. overripe**	**Total**
Total for forestry						
1	*2*	*3*	*4*	*5*	*6*	*7*
Pine	139593 4440.6	25188 3242.6	52259 8567.9	197298 27085.1	88542 13012.1	414338 43396.2
Spruce	5627 83.0	3893 316.4	8745 1201.7	31976 4518.9	8212 1165.8	50241 6120.0
Larch	494 17.1	286 56.4	327 54.1	4446 891.7	3418 679.9	5553 1019.3
Cedar	5203 115.0	17341 2653.7	6191 916.9	4829 604.5	39 5.1	33564 4290.1
TOTAL coniferous	150917 4655.7	46708 6269.1	67522 10740.6	238549 33100.2	100211 14862.9	503696 54765.6
Birch	5925 63.3	3164 148.9	854 64.8	25913 116.0	20911 2648.4	35856 3393.0
Aspen	1040 15.2	-	-	89 21.1	89 21.1	1129 36.3
TOTAL deciduous	6965 78.5	3164 148.9	854 64.8	26002 3137.1	21000 2669.5	36985 3429.3
TOTAL	157882 4734.2	49872 6418.0	68376 10805.4	264551 36237.3	121211 17532.4	540681 58194.9

Natural lowland for the past revision period of the middle class of bonitet. slight fluctuations in average fullness. A significant volume of felling of mature plantations explains the decline in pine and larch in such indicators as the average stock per 1 ha and stock per 1 ha of mature and overmature plantations. Similar indicators for lightly affected fellings of spruce, cedar, birch and aspen plantations are more stable, and the changes are caused by the age development of plantations.

The description of forest types was carried out by the method of laying visual circular areas with a radius of 15-20 meters. For complete descriptions of forest types, the number of the description (account site), the name of the forest type, the position of the site in the relief (floodplain, watershed, slope, its exposure and steepness, the nature of the micro- and nano-relief) were indicated. Next, the soil was described by genetic horizons. After describing the soil, a silvicultural-taxation and botanical description of the type of forest was given by tiers. The description began with a tree layer. His taxation indicators were determined visually with instrumental verification (using a measuring fork, altimeter, tape measure, Pressler's gimlet to determine the age). The species composition of the forest stand was determined. The state of the plantation was determined by the degree of cluttering of the territory, the presence of windfall, windblow and dead wood.

Pine forests in the study area of the Kartopskoye forestry occupy a significant area (77%) and are mainly composed of forest types of the green moss group, with a smaller participation of the sphagnum lichen and herbaceous groups, less often the long moss group. This is typical for areas of the northern taiga subzone, where, with the heavy mechanical composition of soil-forming works, pine is not able to compete with spruce and is pushed back by it to peat and dry places, substrates with low forest growth properties [10]. Under such conditions, pine plays a small role in reforestation processes (for example, after felling) of plantations. In this region (forestry), pine is also found in small-leaved forest stands, but more often in areas bordering large upland and transitional bogs. By themselves, the forest-growing properties of the soil of upland (flat-drained areas) habitats are apparently favorable for pine. For example, on thin podzolic soils, there are single pine trees. In sparse spruce and birch forests, pine stands at the age of 120 years reach a height of 23-25.5 meters with a diameter of 34-38 cm. Thus, the position of pine in the forests of the region under consideration is mainly determined by phytocenotic and soil-historical factors, and one of the significant factors limiting its distribution and introduction into the derivatives of small-leaved plantations is low seed productivity and seed germination of sphagnum and lichen pine forests. Being an edificator with the participation of other tree species, pine has a great influence on the lower tier and, under different forest conditions on different soils, forms pine forest types that differ in floristic composition, structure, and the most important silvicultural indicators. All pine forests on the territory of the Kartop forestry can be grouped into five groups of forest types. The most relatively elevated, more steeply sloping and well-drained habitats on poor sandy soils are occupied by pine forests with a lichen group: moss-lichen, lingonberry-lichen and shrub-lichen ground cover species. Pine reigns supreme in the forest stand, other tree species are found, but relatively rarely and cannot compete with it. Such pine forests are allocated to the lichen group of forest types, which is not typical for plantations of other tree species. This group includes upland areas that do not experience swamping processes, but at the same time do not show an excessive lack of moisture. The forest types of this group are quite widespread, especially on the second floodplain terraces and the upper parts of the hills. It accounts for about 1/5 of all pine forests. Based on the data obtained, we built an edapho-phytocenotic scheme of pine forest types, built on the principles of Academician V.N. Sukachev in the study area. (Figure 1) [9]. It shows the edapho-phytocenotic series of soil richness and moisture (A, B, C, D, E) with arrows. Roman numerals denote groups of pine forest types, Arabic numerals denote pine forest types.

Edapho-phytocenotic series:

- A - an increase in dead wood and a decrease in the wealth of the soil.
- C - increase in moisture and deterioration of wealth and soil aeration with stagnant moisture.
- C - increase in soil wealth with optimal aeration.
- D - increase in moistening by running water.

- E - transitional series from flowing humidification to stagnant.
  Forest types identified in the study area:
- Green moss group: blueberry pine forest; lingonberry-blueberry pine forest; cowberry pine forest; blueberry-fern pine forest; horsetail-bilberry pine forest; blueberry-forb pine forest.
- Herbal group: grass-green-moss pine forest; grass-meadowsweet pine forest.
- Dolgomoshnaya group: blueberry pine forest; sedge-horsetail-long-moss pine forest.
- Sphagnum group: blueberry-sphagnum pine forest; cottongrass-sphagnum pine forest; shrub-sphagnum pine forest; shrub-sphagnum-floodplain pine forest.
- Lichen group: lingonberry-lichen pine forest; green moss-lichen pine forest; lichen pine forest.

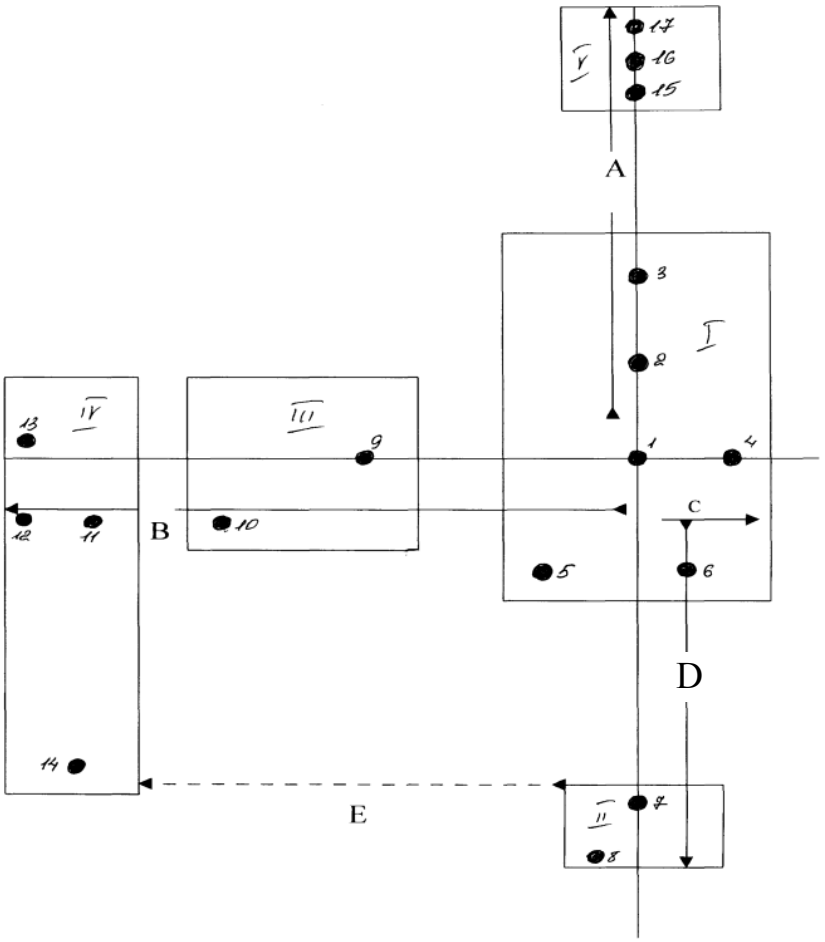

Fig. 1. Edapho-phytocenotic scheme of pine forests of the Kartop forestry.

To perform an ecological and economic assessment (based on forestry and taxation indicators) of the forest massif of the Kartopsky forestry, test plots were laid mainly in the green moss and sphagnum groups of the forest type. The description of forest phytocenoses (forest types) on test plots is based on ecobiomorphs. The description of the phytocenosis contains the necessary data for carrying out an ecological and economic assessment: the height and diameter of each species are taken into account, the composition of the forest stand, the quality class, the wood stock are determined, the undergrowth and its

composition, the shrub layer, grass-shrub and lichen-moss are described [8]. The assessment of the cost of standing wood is given in Table 2 on the basis of the Decree of the Government of the Russian Federation of 19.09.1997. No. 1199 "On the minimum rates of payment for standing timber" [4].

Table 2. The cost of standing wood per 1 cubic meter.

Forest Type Group / Forest Type	Reserve 1 m^3/ha	Dachshund ranks	Quality class	Breed variety	Average diameter (centimeters)	Marketability category of finished products				
						Commercial timber			Firewood	The cost of 1 m^3 of wood
						Large	Medium	Small		
1	2	3	4	5	6	7	8	9	10	11
1. Lichen: Cowberry-lichen	16	3	5	C	14	-	4.68	5.88	0.028	10.538
				C	18	0.546	8.19	4.018	0.028	12.782
Total:										23.34
2. Sphagnum: Blueberry-sphagnum	4.3	3	5Б	C	12	0	1.56	7.35	0.035	8.945
				E	12	0	1.76	6.438	0.028	8.226
				B	12	0	0.784	2.832	0.16	3.776
Total:										20.947
Pushy-sphagnum	5	3	5б	C	12	0	1.56	7.35	0.035	8.945
				K	20	2.952	10.998	2.552	0.1	16.592
				E	12	0	1.76	6.438	0.028	8.826
Total:										25.418
Shrub-sphagnum	4.7	3	5а-5б	C	12	0	1.56	7.35	0.035	8.945
				K	16	0	7.956	5.104	0.09	13.15
				E	10	0	1.76	6.438	0.028	8.226
Total:										30.321
3. Dolgomosnaya: sedge-horsetail-long moss	10	3	5а	C	16	0	6.435	5.096	0.028	11.559
				K	12	0	1.76	6.438	0.028	8.226
				E	24	6.232	11.232	1.276	0.11	18.85
				B	14	0	1.764	2.4	0.16	4.324
Total:										42.959
4. Herbal: Grass-green moss	23	3	5	C	28	5.46	10.92	0.98	0.021	17.381
				E	20	0.49	8.272	2.523	0.028	11.313
				B	16	0.137	3.038	1.728	0.16	5.063
Total:										33.757
5. Greenmoss: Cowberry-blueberry	18.5	3	5	C	22	1.638	10.92	2.352	0.021	14.931
				E	16	0.49	8.272	2.523	0.028	11.313
				B	16	0.137	3.038	1.728	0.16	5.063
				L	26	4.123	7.285	0.624	0.042	12.074
				K	24	6.232	11.232	1.276	0.11	36.314
Total:										79.695
Bilberry	11.4	3	5-5a	C	20	0.819	9.945	3.038	0.028	13.83
				E	16	0.049	8272	2.523	0.028	11.313
				K	24	6.232	11.232	1.276	0.11	18.85
				B	14	0	1.764	2.4	0.16	4.324
				L	22	1.736	7.13	1.482	0.042	10.39
Total:										59.707
Horsetail blueberry	13.9	3	5-5a	C	20	0.819	9.945	3.038	0.028	13.83
				L	24	2.821	7.285	1.092	0.042	11.24
				E	16	0.49	8.272	2.523	0.028	11.313
				K	26	7.872	10.764	1.044	0.11	19.79
				B	14	0	1.764	2.4	0.16	4.324
Total:										60.497

*K - cedar, C - pine, E - spruce, B - birch, L - larch

4 Discussion

Ecological and economic assessment of some types of forests was carried out for all selected test sites, for each type of forest, taking into account the following indicators: composition of the tree layer, quality class, timber stock (m/ha), cost of marketable timber (ruble/ha). The cost of marketable wood (rubles/ha) is determined taking into account the stock of wood (m/ha) and the cost of standing wood (rubles/m). In addition, taking into account the ecological and taxation state of each type of forest, compensation for losses and losses in forestry production (rubles/ha) was calculated (Table 3), while the standard value was the price of forests of the 5th class of quality. The normative price of the described forests in accordance with Decree of the Government of the Russian Federation of December 29, 2018 N 1730 (as amended on December 18, 2020) "On approval of the

features of compensation for damage caused to forests and natural objects located in them due to violation of forest legislation".

Table 3. Ecological and economic assessment of some forest types of the Kartopsky forestry.

Forest type	Soil type	Quality class	Timber stock m/ha	Standing wood cost rub./m	The cost of marketable timber rub./ha	Compensation for damages and losses of l / x production, rub / ha
1	2	3	4	5	6	7
Lingonberry blueberry	Sandy loam podzolized fresh	5	18.5	79.695	1474.3	17384.6
Horsetail blueberry	Loamy (cypeschanaya) podzolized, wet	5-5a	13.9	60.497	840.9	66952.9
Grass-green moss	Peaty-humus purulent, slightly loamy. Soupy wet.	5	23	33.757	776.4	61817.4
Bilberry	Sandy loamy (light loamy), podzolized with gleying interlayers	5-5a	11.4	58.707	669.2	53282.1
Sedge-horsetail	Peaty-podzolic-gleyic loamy (sandy loam). Over hydrated	5a	10	42.959	429.6	34205
Lingonberry-lichen	Dry, sandy, medium to strongly podzolic	5	16	23.34	373.4	29730.3
Shrub-sphagnum	Peaty (peaty)-podzolic-gley waterlogged	5a-5б	4.7	30.321	142.5	I1345.9
Cottonseed-sphagnum	Peat-gley bog	5б	5	25.418	127.1	10119.8
Blueberry-sphagnum	Peaty (peaty)-podzolic-gley waterlogged on loams and gleys	5б	4.3	20.947	90.1	7173.8
TOTAL:						392011.8

The differentiation of pine forests into forest types is determined mainly by differences in the forest-growing properties of soils, which are mainly determined by thermal and water-air regimes.

5 Conclusion

Within the territory of the Soviet forestry, a total of 16 types of pine forests were identified, united in five groups:

- Lichen.
- Green moss.
- Long length.
- Sphagnum.
- Herbal.

The most common central (according to Sukachev's scheme) type of pine forests in the study area is lingonberry-blueberry pine forest, it is a zonal northern taiga forest type that fully reflects all regional edapho-climatic features. The state of pine forests is generally satisfactory, however, in the areas of logging there is a strong clutter of cutting areas, the presence of undercuts, which gradually dry out and are a breeding ground for forest pests. In heavily waterlogged pine forests with potentially fertile soil, it is desirable to carry out reclamation to increase the productivity of the forest stand; therefore, it is necessary to conduct a qualitative assessment of forest lands. The main condition for increasing the productivity of forests and the general level of forest management should be the improvement of the quality of activities, the rational use of tree species, compliance with appropriate agricultural practices, forest monitoring to prevent forest fires [3].

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