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Analysis of the Stocks and Conditions of Harvesting for Forest Berries with Consideration for Their Spatial Distribution and Availability

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Abstract—As part of the multipurpose forest management concept, the resource and economic potential of harvesting wild berries has been analyzed under different forest management scenarios. As a tool for forecasting and analysis, scenario-based simulation is used to model the forest ecosystems dynamics under the management of clear-cutting and selective felling. The object of research is the Pashe-Kapetskoe district forestry of Leningrad oblast; the calculation was carried out for 120 years. The potential productivity of wild berries is calculated based on the forest condition types, species composition, and simulated illumination at the ground level data. The most productive resources on the territory are bilberry and lingonberries, the predicted yield of which reaches 25–48 t/year and 7–15 t/year, respectively. Zoning of the territory was carried out according to the resources availability for industrial harvesting, taking into account the interests of the local population; 37–48% of the wild berry harvest was available for industrial harvesting, about 30% was allocated for the needs of the local population, and 27–36% of the resource remained in economically inaccessible areas. The most promising was the scenario with artificial restoration of 50% of the clear-cut areas and a full maintenance cycle. For this scenario, the maximum profitability was predicted from both the food-resource procurement (4.1–5.7 million rubles per year) and the harvesting of timber.

Keywords: food resources, wild berries, scenario modeling, multipurpose forest management, economic accessibility

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One current area of forestry science is the development of ways to transition to multipurpose forest management. The need to combine several ecosystem services in one area is discussed in Russian and foreign studies (*Millennium*..., 2005; Tebenkova et al., 2019). A forecast of the compatibility of various ecosystem services can be carried out using scenario-based mathematical modeling (Grammatikopoulou and Vačkářová, 2021; Chumachenko et al., 2021). Using simulation models, it is possible to predict the full development cycle of all elements of the forest ecosystem over a long period and the consequences of forestry activities. Modeling capabilities make it possible to predict the growth and development of the forest stand, as well as other components of the forest community, for example, forest berry patches.

Russia can increase its rate of production of forest berries. Out of 1508000 t of operational reserves of lingonberries, 45000 t and 35000 t of bilberries are currently being harvested out of a possible 1309000 t. To increase the volume of harvesting wild berries, it is necessary to solve problems of a regulatory and resource nature, as well as methods for determining resource reserves (Kolerova, 2016; *Rynok dikorosov v Rossii*..., 2021).

In multipurpose forest management, a compromise between obtaining high-quality wood raw materials and a sustainable harvest of berries in the long term is possible with the proper organization of the economy and is economically justified (Kozhukhov and Klyuchnikov, 2000). In particular, logging in berry harvesting areas is possible, provided it is carried out in winter. Clear cuttings are undesirable for lingonberries and bilberries, as they contribute to the disappearance of shrubs for a long time (Obydennikov and Voityuk, 2007; Kurlovich et al., 2015). To find such a compromise, the influence of economic activities on berry gardens in the southern taiga of European Russia was analyzed (Kolycheva et al., 2022).

Yield assessment is divided into a long-term forecast (forecasting the average yield) and a short-term forecast for a specific plant community for the coming season (forecasting the possible yield by the presence of flower buds and the volume and weight of unripe berries, taking into account temperature and humidity for the growing season). The first method is conve-

Table 1. Script options

Farming parameters*	Scenario code		
	A	B	C
Wood harvesting, % of estimated logging area	60%	95%	95%
Forest crops, % of clear felling area	–	50%	50%
Thinning in young stands	–	–	In accordance with the Rules of Care (Order..., 2020)
Thinning in middle-aged stands	–	–	

The scenarios take into account the intended purpose of the forests. In production forests, clear cuttings are modeled; in protective forests, selective cuttings are modeled in those categories where this is not prohibited by the Forest Code.

nient to use, since it does not require any additional field observations. Standards based on this principle make it possible to predict the average yield using only forest management data. The second approach assumes high accuracy, but is highly costly and labor-intensive, and it is also not suitable for long-term planning; it is more often used as an addition to a certain area during a long-term forecast (Boltvina and Ivanyo, 2016; Shevelev and Nevzorov, 2017).

Currently, in Russia, the determination of reserves of food raw materials is carried out using taxation characteristics of stands (TCS)—species composition, age, and completeness. The specific calculation algorithm is determined by the presence of normative reference tables relating the yield of a species to taxation characteristics (Kurlovich and Kositsyn, 2018, 2019). For a more accurate forecast in multispecies, uneven-aged plantings, we take into account an additional factor that affects the productivity of berry gardens—illumination at the ground cover level, obtained as a result of model calculations (Dulina and Chumachenko, 2018; Kolycheva and Chumachenko, 2021).

Including berry harvesting in the calculation of the economic potential of forest areas can provide employment and additional income (Velm, 2009; Grivins and Tisenkopfs, 2018; Elsedig and Abdalbasit, 2019). However, the organization of procurement is impossible without a number of legal, scientific, and practical measures, the implementation of which will improve the legal framework for the exploitation of forest food resources, develop methods for accounting for raw materials and predicting the potential productivity of berry fields, and propose technological schemes and equipment for the processing of food and medicinal raw materials. To solve these problems, it is necessary to improve the state mechanism for the development of collection and processing of food forest resources by developing criteria for the allocation of forest areas leased for harvesting, creating the basis for a regulatory framework for assessing and accounting for raw materials and forecasting the potential productivity of wild plants, and developing a forest zoning scheme. The organization of multipurpose forest management should be based on a forecast of the nature of the dynamics of food resources and their potential reserves in different habitat conditions and under different forms of wood harvesting. One of the main tasks of forestry should be the development of methods for accounting for various forest products and assessing their operational value in the forestry system (Shevelev et al., 2011).

The purpose of this work is to analyze the reserves and conditions for the procurement of food resources for the territory of the district forestry, taking into account their spatial distribution and accessibility. To achieve the goal, it is necessary to (1) assess the overall potential of berry-bearing areas on the site, (2) select areas suitable for industrial use, and (3) calculate the economic potential of berry fields.

OBJECTS AND METHODS

Description of the FORRUS-S Model and Simulation Scenarios

For the calculation, the FORRUS-S (FORest of RUSsia-Stand) simulation model was used to predict the dynamics of the main taxation indicators of multispecies stands of different ages, making it possible to predict and analyze dynamic processes in forest plantations of European Russia (Chumachenko et al., 2004, 2006a, 2006b, 2008). Based on the characteristics of the planting, the model carries out a long-term forecast of the yield of wild berries with a step of 5 years and produces average yield values, which include high-yield and lean years (Kolycheva and Chumachenko, 2021).

To assess the impact of wood harvesting on the productivity of berry fields, several contrasting forest management scenarios were selected (Table 1): scenario A with 60% of the estimated logging area, without planting forest crops, without maintenance; scenario B with 95% of the development of the estimated logging area, planting forest crops on 50% of the felled areas; and scenario B with 95% of the development of the estimated logging area, planting forest crops on 50% of the felled areas, with management of young and middle-aged stands.

Table 2. Distribution of lands covered with forest vegetation in the forestry area by types of forest conditions and predominant species

Forest forming species	Type of forest conditions, ha											Total
	A2	A3	A4	A5	B2	B3	B4	B5	C2	C4	C5	
Scots pine	4156.2	1237.9	1018	1844.2	122.0	6.6	11.2	9.3	22.5		1.0	8428.9
Birch	130.6	14.1	69.9	32.9	3281.9	779.6	829.8	699.3	1688.8	150.7	94.4	7772
Spruce	73.0	26.5	19.9		1660.9	550.4	246.1	19.2	126.9	7.8	16.7	2747.4
Alder					9.9				2.7	1.4		14.0
Aspen	2.0				63.5	17.5	1.2		572.6	21.2		678.0
Mountain ash	91.7	16.0		0.9	20.8	2.2	3.4	5.0				140.0
Total	4453.5	1294.5	1107.8	1878.0	5159.0	1356.3	1091.7	732.8	2413.5	181.1	112.1	19780.3

Characteristics of the Research Object

The object of study is Pasha-Kapetsky district forestry of the IKEA Industry Tikhvin lease area, located in the east of Leningrad oblast in the Tikhvin district; the object area is 25129 ha. The territory is located on the border of the middle and southern taiga subzones; in accordance with forestry zoning, it belongs to the Baltic-Belozersky taiga forest region, the middle taiga region of the European part of the Russian Federation.

An analysis of the taxation description of the Pasha-Kapetsky district forestry showed that the average age of plantings is 69 years and completeness is 0.74. The types of forest vegetation conditions of the object are varied; a total of 11 types are described, from fresh forests (A2) to swampy complex subors (C5) (Table 2). The most common TCSs on the territory of the object are A2 and B2, which indicates the predominance of poor and fresh habitats (Vorobiev, 1953; Khanina, 2019). These TCSs, like A3 and B3, are favorable for the growth of berry bushes in European Russia (Dulina and Chumachenko, 2018). There are areas on the territory with relatively rich soils in complex subor conditions (C2), where good raspberry (*Rubus idaeus* L.) yields can be predicted.

The most preferred growing areas for bilberries are TCS A3-4, B3-4, and C3 with a predominance of pine, spruce, or birch, over 60 years in age with a density of 0.6–0.8; for lingonberries, TCS A2-4 and B2-4 with a predominance of pine, spruce or birch, over 40 years in age, with a density of 0.3–0.4; for raspberries, TCS A3, B3, and C3 on cuttings of pine, spruce, or birch, up to 15 years in age (Dulina and Chumachenko, 2018). It follows from this that high bilberry productivity can be expected in the forests of the district forestry.

Calculation of the Economic Potential of Wild Berry Harvesting

The yield of wild berries was predicted based on the initial state of the forest stand and the characteristics of tree species. When calculating, reference indicators were used for conditions of the southern taiga subzone close to Leningrad oblast (Kurlovich and Kositsyn, 2018).

The calculation of the yield of wild berries occurs in the Food Resources module of the FORRUS-S model. The yield forecast is carried out using previously developed universal equations, in which taxation characteristics of the forest stand and illumination calculated during the modeling process are used as variables (Kolycheva and Chumachenko, 2021).

For the economic assessment of berry resources, the commercial harvest is taken into account, which is part of the total biological stock (which can be removed without harm to the further reproduction of the resource) and amounts to 50%. The calculation took into account areas where the average long-term yield of berry fields was more than 50 kg/ha (*Metodika podbora*..., 1986).

To determine the possibility of harvesting wild berries in a specific area, several factors must be taken into account:

(1) collection sites should not be located on the territory of nature reserves or other protected areas where such activities or visits in general are prohibited;

(2) areas with an area of more than 3 ha or several adjacent areas with a total area of more than 3 ha are allocated for harvesting (*Potentsial'nye zapasy*..., 2017);

(3) according to the *Metodika*... (1987), areas in places located no more than 5 km from the nearest roads suitable for transporting raw materials are considered accessible. It is also necessary to take into account the rivers along which the export of raw materials is possible and the roads that will be built in the near future for the removal of wood (Shevelev et al., 2011);

(4) areas located at a distance of 2 km from populated areas are excluded from industrial harvesting, since these resources remain for the needs of the local population (*Metodika*..., 1986).

Promising areas for industrial procurement of berries are those for which the combination of availability and productivity is optimal (Gryazkin et al., 2020). Thus, in addition to the taxation description, the use

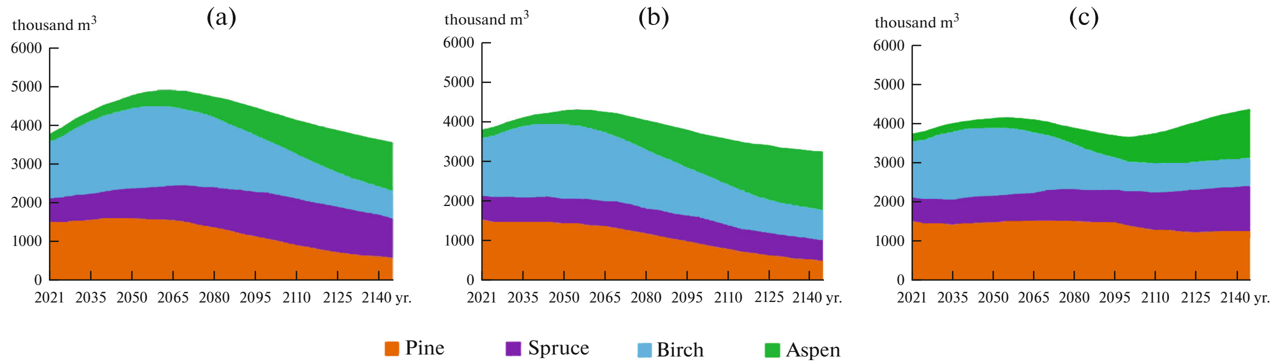

Fig. 1. Dynamics of species composition by planting stock for three farming scenarios.

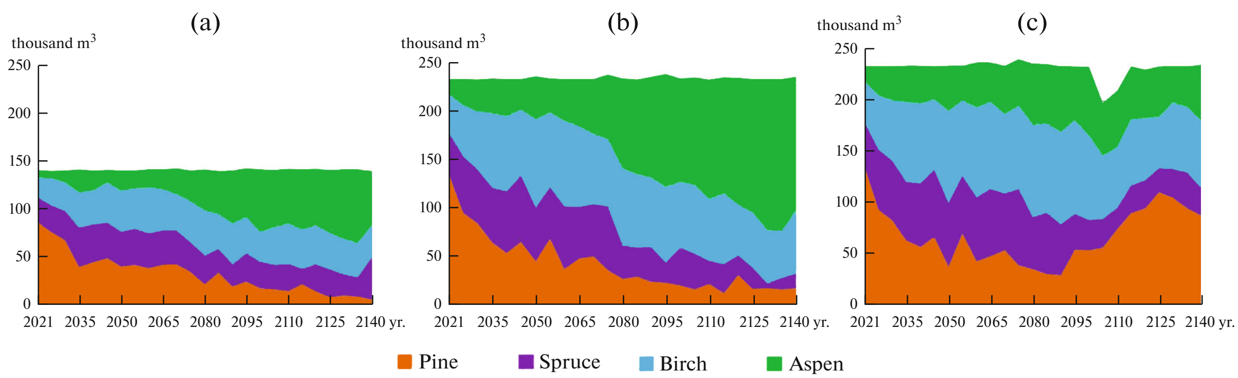

Fig. 2. Wood harvesting volumes for three farming scenarios.

of cartographic materials is necessary to determine the economic potential of the site. The solution to the currently relevant problem of transport modeling (Podolskaya, 2021) was carried out using a GIS package.

RESULTS AND DISCUSSION

Long-Term Forecast of the Dynamics of Plantings of the Pasha-Kapetsky District Forestry

The dynamics of plantings were calculated for 120 years for the three forestry scenarios described above. Scenario A (60% development of the estimated logging area, natural regeneration, and lack of management) leads to a gradual replacement of coniferous species with small-leaved trees, and mainly aspen is restored in the felled areas. In areas that have not been felled, spruce develops under the canopy of birch and pine and gradually replaces them (Fig. 1a). In scenario B (95% use of the estimated cutting area, without forest maintenance), the change in species is even more pronounced, because more areas fall into clear cutting; coniferous trees created in cleared areas die without maintenance and are replaced by small-leaved young trees (Fig. 1b). Scenario B, thanks to the full cycle of care for coniferous crops, maintains their reserves at a constant level, but even in this case it is not possible to avoid an increase in the area of aspen forests (Fig. 1b). Thus, the composition is dominated by pine and spruce reserves (Fig. 1).

In accordance with changes in rock reserves, the predicted volumes of their procurement also change (Fig. 2). Harvesting volumes are calculated for the entire area as the maximum possible volume of wood resources to achieve sustainable forest management. Scenarios A and B, which do not provide for forest maintenance, after 50–60 years lead to a significant decrease in the volume of harvesting of coniferous species, which are replaced by aspen.

Scenario B with the use of thinning makes it possible to achieve the best indicators in terms of both the volume and species composition of harvested wood, since starting in the year 2095 of modeling (the beginning of the second round of felling for coniferous species), the largest volumes of harvesting are pine, so this scenario is the most promising.

Based on the dynamics of forest stands, the relative illumination at soil level was analyzed under different forestry scenarios (Fig. 3). Histograms describe changes in the area of forest land with different levels of ground cover illumination. Felling thins the forest canopy, resulting in increased illumination in the area. Areas appear with illumination of 20–50% and 50–100% relative to open space, which has a beneficial

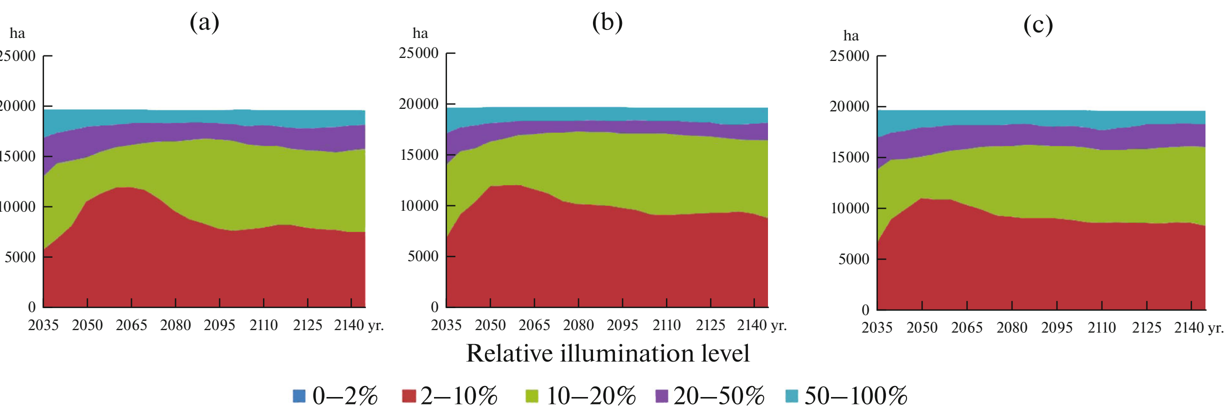

Fig. 3. Changes in the area of forest land with different light levels at ground level for three management scenarios.

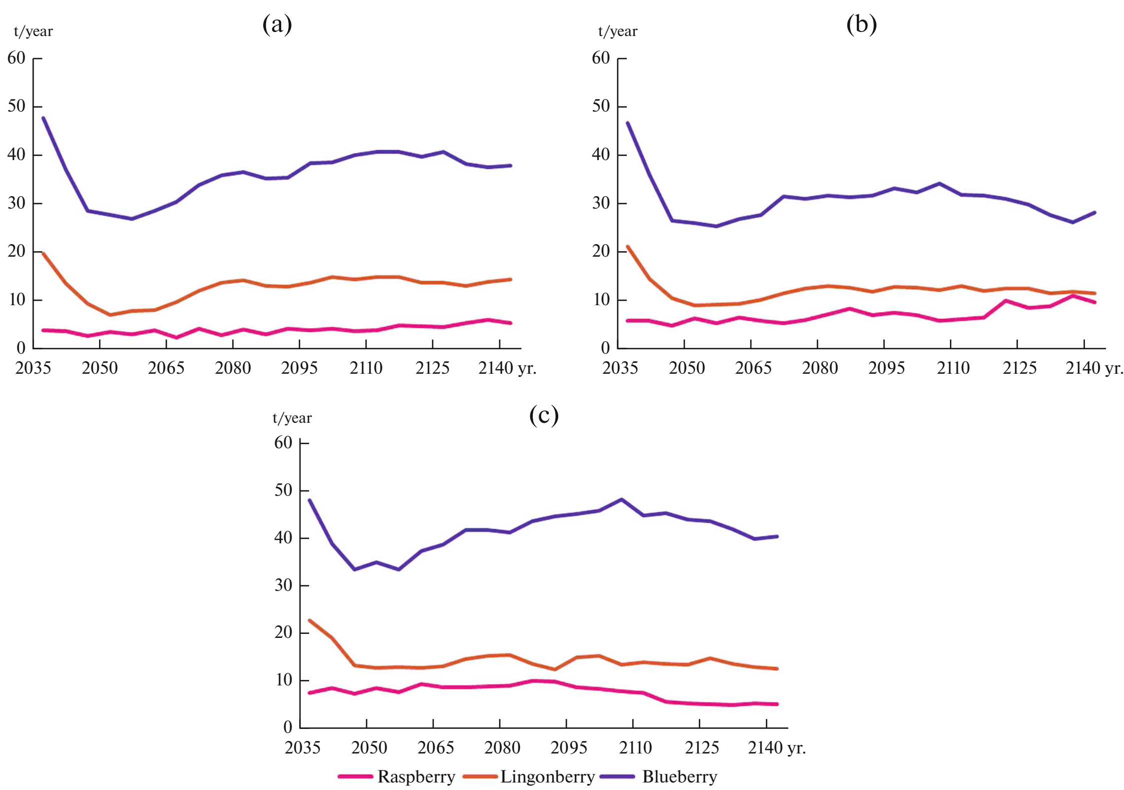

Fig. 4. Forecast of raspberry, lingonberry, and bilberry crop yield.

effect on the productivity of lingonberries and raspberries. At the same time, a large share of forestry areas constitute plots preferred for the growth of bilberries (up to 15%).

Resource Potential of Berry Growers on Site

The most productive berries throughout the territory are bilberries and lingonberries; the yield of the former under different farming scenarios varies from 25 to 48 t/year and the second is from 7 to 15 t/year (Fig. 4). The most productive forestry scenario is C, in which forest crops are planted on 50% of the areas covered by clear felling and there is mandatory care in young and middle-aged stands.

The lowest yield was recorded in scenario B, which is a consequence of the lack of care in forest crops due to the high density of plantings and the subsequent replacement of pine by aspen, under whose canopy berry beds do not form.

Under farming scenario C, maximum stable yields are maintained throughout the modeling period; the lowest indicators were recorded in scenario B. This distribution is directly related to the biological characteristics of the berry garden, which is suppressed under the influence of clear cuttings, and, without caring for forest crops, a canopy of average fullness is not formed in which the berries produce maximum yields.

The potential of lingonberries is lower than bilberries, but the reserves at the site are also significant.

Raspberries grow and bear fruit in production volumes only in open areas. The optimal conditions for fruiting are open areas cleared by clear felling—areas from the second year after cutting until the canopy closes. The greatest productivity is predicted in the first 15 years for scenario C (Fig. 4). Clearing large areas involves the growth of raspberries. Planting crops and caring for young growth have little effect on the raspberry yield, since the bulk of the berries can be obtained in the interrows of young plants up to 15 years old.

Forecast of Profitability of Food Resource Procurement

The total profit potential from the entire Pasha-Kapetsky district forestry from berry harvesting was calculated. For this purpose, purchase prices of resources in the Tikhvin region were used, obtained from websites and social networks advertising the purchase of berries and mushrooms for 2021. The cost of purchasing berries for bilberries and lingonberries was 200 rubles/kg and for raspberries 160 rubles/kg. The costs of harvesting and transporting berries were not taken into account.

High profitability rates are achieved in scenario C, from 10 to 15 million rubles per year from the entire area of the district forestry. The smallest total income is from 7 to 14 million rubles per year was observed in scenario B with a high percentage of development of the estimated logging area and lack of care in young stands. On average, the difference between the scenarios in the amount of income is 2 million rubles per year (or 13–20%).

Selection of Sites for Industrial Harvesting of Forest Berries and Sites for the Needs of the Local Population

Considering the characteristics of the site, not all excrements may be suitable for industrial collection. To assess the transport accessibility of areas and their proximity to populated areas, roads were vectorized in GIS software systems, subdividing them by passability, as well as populated areas. Publicly available vector and raster maps and remote sensing data were used as basic information for vectorization. A road graph was formed, supplemented by the shortest distances from existing roads to the centers of district forestry units, taking into account natural barriers—rivers, swamps, etc. Next, using network analysis tools, the GIS calculates the distance of each section from roads accessible for passenger cars and the distance from populated areas, taking into account all existing roads.

The industrial harvesting zone included areas located at a distance of more than 2 km from populated areas, but less than 5 km from roads accessible to passenger transport in the summer (Fig. 5) (represented in red on the map). Thus, a zone of possible industrial harvesting has been identified that will not affect the interests of the local population and will be economically profitable for harvesters. In addition to the economic profitability of the procurement of food resources, the social factor is also taken into account: the need to leave zones free from industrial procurement for the procurement of resources by the local population for personal purposes. It is known that most food resources are collected and processed not for commercial purposes, but by the population for self-sufficiency (Kolerova, 2016).

The possibility of industrial harvesting is feasible only on 42% of the entire territory, while its volume in these areas varies from 37 to 48% of the total reserves, depending on the scenario.

Figure 6 shows the potential income from berry harvesting by zone. For bilberries, the potential income from the entire plot for scenarios A and C is from 6 to 10 million rubles per year; industrial procurement can include resources worth 2–3.8 million rubles annually. In scenario B, with a reduction in the total profitability of the site to 5–7 million rubles per year, you can get 2–2.9 million rubles from harvesting berries per year in areas intended for industrial collection. For lingonberries, the difference in estimated income in the scenarios is lower than for bilberries—less than 1 million rubles per year. From sites for industrial procurement, the maximum amount of income can be obtained in scenarios A and C—from 1 to 1.7 million rubles per year. The least promising from the point of view of industrial procurement of lingonberries is scenario B with a profitability of 0.6 to 1.1 million rubles per in year.

Compared to bilberries and lingonberries, raspberries contribute less to the income from a forest plot. In the most productive scenario C, the total profitability of berries on the site is 0.9–1.5 million rubles per year, and industrial procurement can be obtained from 0.4 to 0.6 million rubles per year. The least productive scenario A for the entire modeling period can bring from 0.5 to 1 million rubles, and from the industrial procurement zone the revenue will be 0.2–0.3 million rubles per year.

Areas for the needs of the local population occupy 30% of the entire forestry area, while the supply of berries in such areas is 28–33% of the potential amount. Bilberry harvesting for the local population is estimated at 1–2.5 million rubles per year, lingonberries 0.5–1.5 million rubles per year, and raspberries 0.1–0.2 million rubles per year (Fig. 6).

Economically inaccessible areas occupy 28% of the forestry territory. On average, 27–36% of resources remain in these areas, depending on the farming scenario. The involvement of these resources in procurement can be helped by expanding road networks.

The simulation model used in the research makes it possible to calculate the possible productivity of forest

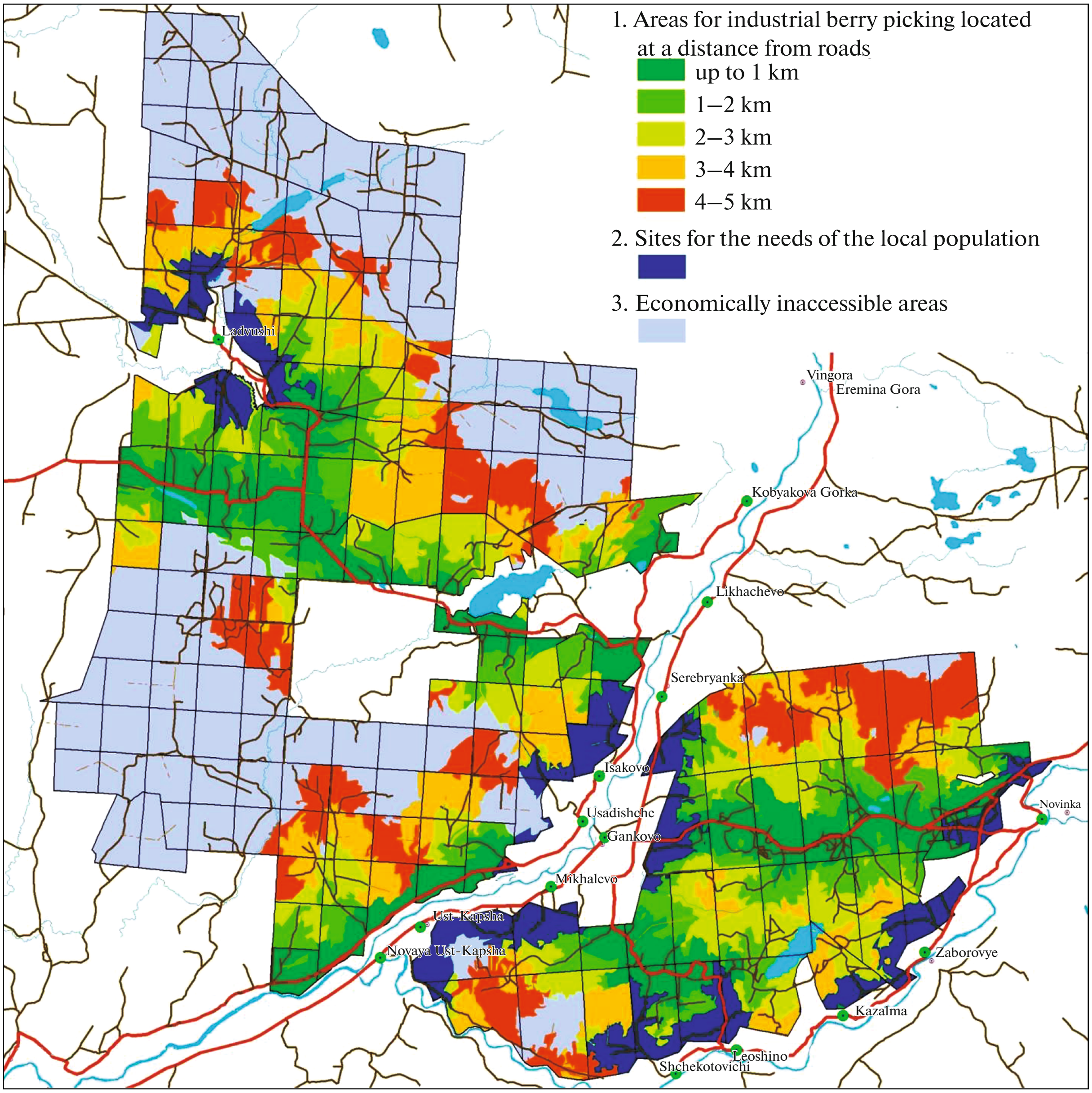

Fig. 5. Zoning of the territory of the Pasha-Kapetsky forestry according to the availability of food resources.

food resources (berries) for each stand based on the characteristics of the forest stand, including its vertical structure. When planning the procurement of food resources, it is necessary to make forecasts based on current data on the composition of the ground cover.

Economic activity affects the condition of berry fields both directly, through the destruction of ground cover during harvesting and 100% illumination in clearings, which is disastrous for bilberries, and indirectly, through a change in canopy density during selective felling and a change in the species composition. The course of the production productivity curves for bilberries and lingonberries under all three scenarios is similar: the maximum at the beginning of the period is replaced by a decline by 30–40 years, then some growth and stabilization. This can be explained by the fact that initially the planting has an average age of 69 years and the berry fields there are already actively bearing fruit, but after clear-cutting they need a long recovery period (40–60 years). If in scenarios A and C the total yield of berry fields (with the exception of raspberries) is restored to the original values, then in scenario B this does not happen due to the change in the ratio of the predominant species in favor of aspen.

An analysis of the resource base for a separate district forestry shows that the organization of harvesting can be complicated by at least two factors: the uneven distribution of the resource over the area and the lack of roads along which access to resources can be provided. In our case, resources are unavailable on 28% of

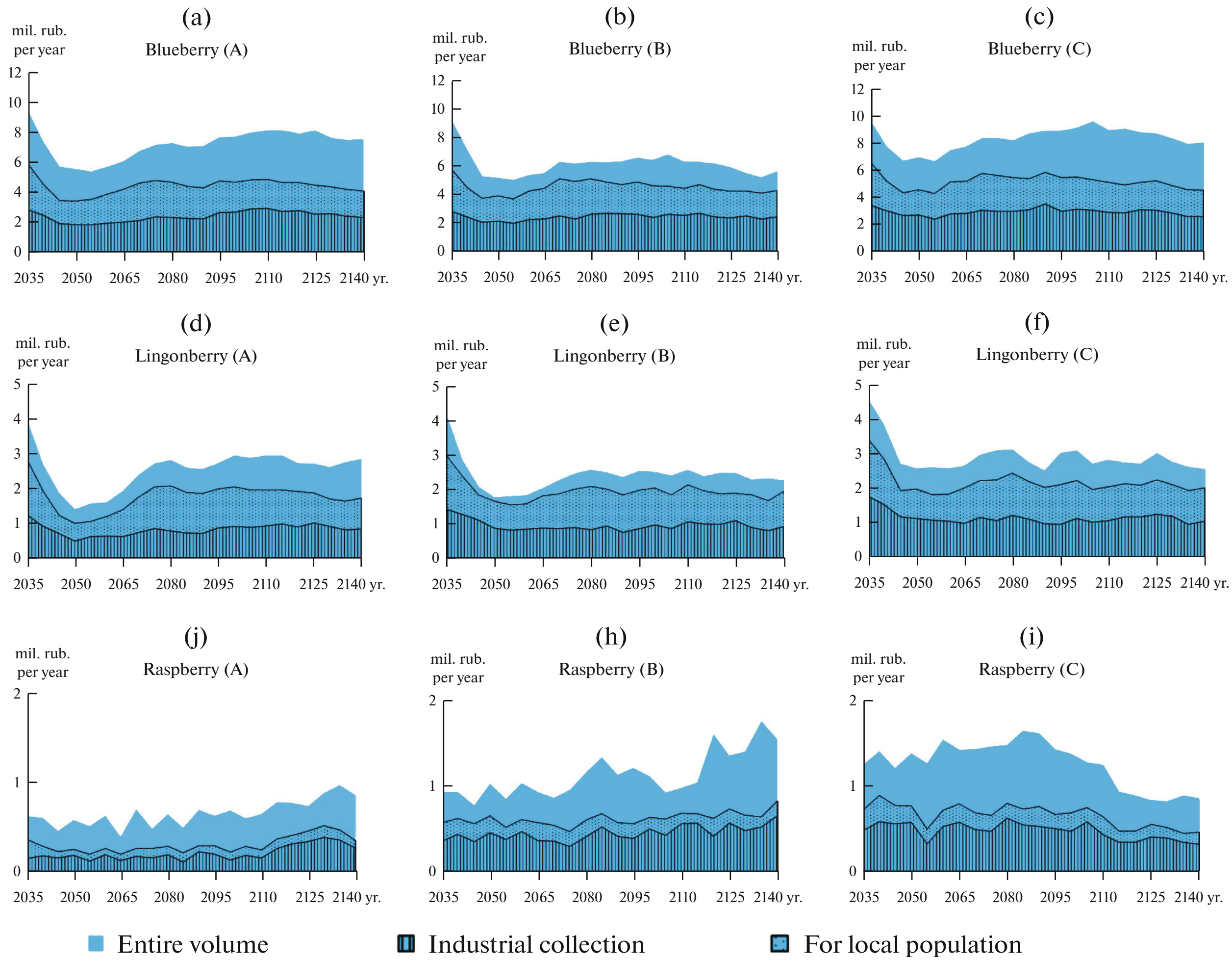

Fig. 6. Forecast of raspberry, lingonberry, and bilberry crop yield.

the area of the district forestry, which, depending on the farming scenario, corresponds to 27–36% of the volume of possible harvesting.

It is proposed to allocate approximately the same area for the needs of the local population. This is not regulated by any legal acts; the *Metodika*... (1986) is purely advisory in nature. The only norm of forest legislation that takes into account the interests of the local population is the allocation of forest areas: "forest areas around urban-type settlements and rural settlements" within a radius of 1 km from the borders of settlements. However, excluding a two-kilometer zone adjacent to populated areas from the lease area for the purpose of harvesting food resources will help mitigate potential conflicts with the local population in the absence of clear rules and regulations.

Modeling has shown that the maximum productivity of berry fields (Fig. 4), as well as the maximum possible income from harvesting berries (Fig. 6), is ensured with an intensive farming model, when coniferous plantings are restored in clearings in a short time and the optimal completeness for the main resource is bilberries is maintained by thinning. However, intensive farming is not always possible or advisable. With an extensive form of farming with the partial development of the estimated logging area and a focus on natural reforestation, it is also possible to maintain satisfactory productivity of berry fields.

Our previous studies have shown that the average net income for the entire period (less delivery and transportation) from timber harvesting can vary from 10.4 million rubles in scenario A up to 23.5 million rubles in scenario C (Kiselyova et al., 2021). The average income from industrial harvesting of berries in these scenarios is 4.5–5 million rubles. Thus, if it is impossible to organize intensive forest management, harvesting forest food resources can bring additional income comparable to the profit from timber cutting.

Scenario B, which involves active timber harvesting and the formal fulfillment of the requirements of the reforestation project, in the long term leads to both a qualitative change in the composition of cut wood and a drop in income, as well as a decrease in the total productivity of berry fields.

Thus, when considering the prospect of choosing a scenario aimed at the industrial procurement of berries to obtain additional profit, scenario C is recommended, the profitability of which ranges from 4.1 to 5.7 million rubles per year; the second most profitable is scenario A (from 3.2 to 4.6 million rubles per year), and the least effective is scenario B with a possible income from 2.5 to 4.4 million rubles per year.

CONCLUSIONS

This approach to analyzing the reserves and conditions for harvesting wild berries, taking into account their spatial distribution, can be applied when making management decisions on a forest plot, since potentially berry-bearing areas can bring additional income, but require compliance with a special regime of use. Long-term forecast is a universal approach for identifying promising areas for berry harvesting; it can be applied to all objects in the center of European Russia with which the FORRUS_S model works. Since reference data on the yield of berry fields does not exist everywhere in the regions, it is customary to use information from regions with similar climatic conditions; the availability of data for each region can provide a more accurate forecast, including model ones. It is also possible to increase the accuracy of the model if there are current taxation descriptions with complete information about the entire structure of the tree stand, including undergrowth and the understory.

As a result of the study and long-term model forecast, it was found that, with multipurpose forest management, it is possible to obtain additional income from harvesting forest berries. The calculation was carried out based on production productivity, as a result of which there remains enough resource in the areas for renewal. The potential of berry-bearing areas on the territory of the Pasha-Kapetsky district forestry site was assessed, and it was found that bilberries are the most productive berry crop on the site and reach yields from 25 to 48 t/year, depending on the farming scenario. The second most productive are lingonberries with a yield of 7 to 15 t/year. The most productive forestry scenario is C, with a mandatory 50% planting of forest crops from clear-cut areas, as well as mandatory maintenance in young and middle-aged plantings. The least promising is scenario B, with reforestation and no thinning, even in comparison with scenario A, where there is no planting of forest crops and no thinning.

Despite the fact that the total supply of berries on the site is large, not the entire territory is suitable for harvesting. The analysis carried out using GIS and solving the problem of transport modeling showed that the site is divided into the following zones: (1) which must be left for harvesting by the local population, (2) in which industrial harvesting is possible, and (3) economically unprofitable areas. Of the total supply of berry resources, only 37–48% can be harvested, while 28–33% remain for the needs of the local population and 27–36% of the territory is unprofitable for the procurement of food resources. The situation may change with the expansion of the road network.

The economic potential of plots for industrial harvesting of berries was calculated; it was found that the most promising scenario is scenario C, with the planting of forest crops and a full cycle of caring for them; the profitability from harvesting berries on the plot is 4.1–5.7 million rubles per year. Then follows scenario A, where there is no forest planting and maintenance; the profitability here is reduced compared to the previous one, but the additional income received is 3.2–4.6 million rubles per year. The least promising scenario is scenario B, with the planting of forest crops and lack of care for them; along with the productivity of the planting, the productivity of the berry fields also decreases, and the revenue that can be received is 2.5–4.4 million rubles per year.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work does not contain any studies involving human and animal subjects.

CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

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