

- Oak forests in the study region cover an area of 461.5 thousand ha, which amounts to nearly 27.1 % of Ukraine's oak forests. The most part of common oak-participating stands is concentrated in Lviv region (over 95.6 thousand ha), somewhat less amount of oak stands is found in Ternopil region (78.6 thousand ha).
- It has been found that in the most representative forest type (moist hornbeam oakery) in the western part of the study region, a substantial proportion of the area is occupied by secondary stands. Large areas of secondary stands are found in Vynnyky forest management unit (over 73 %), Borshchovychy (over 71 %) and in Krasiv forest management unit subsidiary "Lviv Lisgosp" (over 63.6 %).
- The age structure of the stands analyzed, is essentially disturbed. A major portion is made up of middle-aged stands (over 57.2 %), somewhat less is represented by stands of sapling stage (21.1 %), and the smallest part is made up of mature stands (6.3 %).

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Поширення, структура та продуктивність дубових насаджень заходу України

Проведено аналіз поширення дубових лісостанів в межах регіону досліджень. Подано динаміку зміни площі лісових насаджень, особливостей типологічної структури, продуктивності за участю дуба звичайного в західній частині України в межах Західного Лісотепу та Прикарпаття. Досліджено специфіку співвідношення корінних та похідних дубових деревостанів в умовах сфіжних та вологих грабових дібров.

Ключові слова: дубові насадження, дубові ліси, структура, продуктивність.

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THE DYNAMICS OF BEAR POPULATION IN THE EASTERN CARPATIANS

In the dynamics of bear population in the Eastern Carpatians, there are two recorded periods of change in the numbers. The first one that lasted over 50 years, started in the late 1940s and ended in the year 2001. The second one has started in the early 21-st century.

Keywords: population, hunting, environmental factors, poaching.

The brown bear (*Ursus arctos* L.) numbers in the Eastern Carpathians had been rather considerable up to the mid – 19th century, their number, however, began to decrease dramatically through overhunting, reduction in the forested area; this led to the prohibition against hunting on bears in the 1930 s. After World War II, in the late 1940 s, the bear population counted only several tens of animals (70 to 80 individuals) [18, 21, 23, 24]. In the 1970 s, there was an increase in the number of the species due to protective measures taken as well as improvement of their habitat conditions, as a result bears numbers reached their peak i.e. over 1000 individuals. However, a decrease in the species population in the 1990 s caused a serious concern about the future of this species [2, 7, 8, 25]. On the basis on the fact that the annual reduction in the bear numbers averaged 28 individuals, this species was predicted to extinct in the Eastern Carpathians within a 12-year period [9]. The species was entered into Ukraine's Red Book just on the grounds of the species number reduction without conducting a detailed analysis of the population dynamics and the factors which influence the numbers of the predator etc. [8]. That is why the purpose of this work is to analyze the bear population dynamics in the Eastern Carpathians as well as to reveal the factors causing these changes. This beast of prey is common under mountainous conditions of the Carpathians in four regions: Lviv region, Ivano-Frankivsk region, TransCarpathians, and Chernivtsi region. The dynamics of bear numbers in these regions shows an increase in the population size in the period from the 1940 s to 1968. The years 1968 shows the maximum size of bear population: 1,236 individuals. In the year that followed (1969), the numbers decreased by 305 individuals, which makes up 24.7 % of the total number of the population.

It is impossible to give any reasonable explanation for substantial decline in the numbers during the period 1969-1970 as well as their abrupt increase by 17.8 % in 1971 (Fig. 1). In the early 1970 s, 1,100 individuals were registered in the Eastern Carpathians. According O. Slobodian, the total number of this species amounted to 1,300 individuals at that time. The difference of 18 % is accounted for by inaccuracy of inventory methods (which may produce an error of up to 20 %), inadequate professional training of the record-keepers, non-observance of the inventory methodology etc. O. Slobodian allows for the inaccuracy of inventory results in the early 1970 s [21].

The over-estimate of bear population size was observed not only in Ukraine but also in other European countries (Poland, Slovakia) [27, 28]. The information on the bear numbers in the Eastern Carpathians is contradictory in some research works [3-5, 10, 13, 17, 18, 20-22, 24], sometimes the difference between researchers' studies and the inventory records on animals done by the users of the game lands, amounted to over 250 individuals (25 %) [20]. According to I. Turianyn [24], the species numbers amounted to 70 individuals in 1947; after 10 years the number of bears was already as much as 484 individuals (in 1956). The population size in other European ranges of bear distribution, in particular Kalinin region, Russia, increased only twice as much within a 15-year period. With the total population size being 400 individuals, the annual increase made up 13 individuals [15]. In Belarus, the micropopulation of 20 head increased annually only by 4 individuals of which one or two little bears failed to live more that one year [12]. Therefore, the increase in the bear numbers by 6.5 times in the Carpathians within a 10-year period is unlikely. According to K. Tatarynov [22], the number of this species in the early 1950 s was estimated at 150 to 200 individuals, having increased by 2.1 to 2.8 times as compared with the 1940 s. If the bear numbers amounted to 70 indi-

viduals in 1947, this population could reach over 200 head in number in the 1950 s with the annual increase rate being 17 to 18 % while the numbers of 600 head was reached in 1960 with the annual increase being about 20 %.

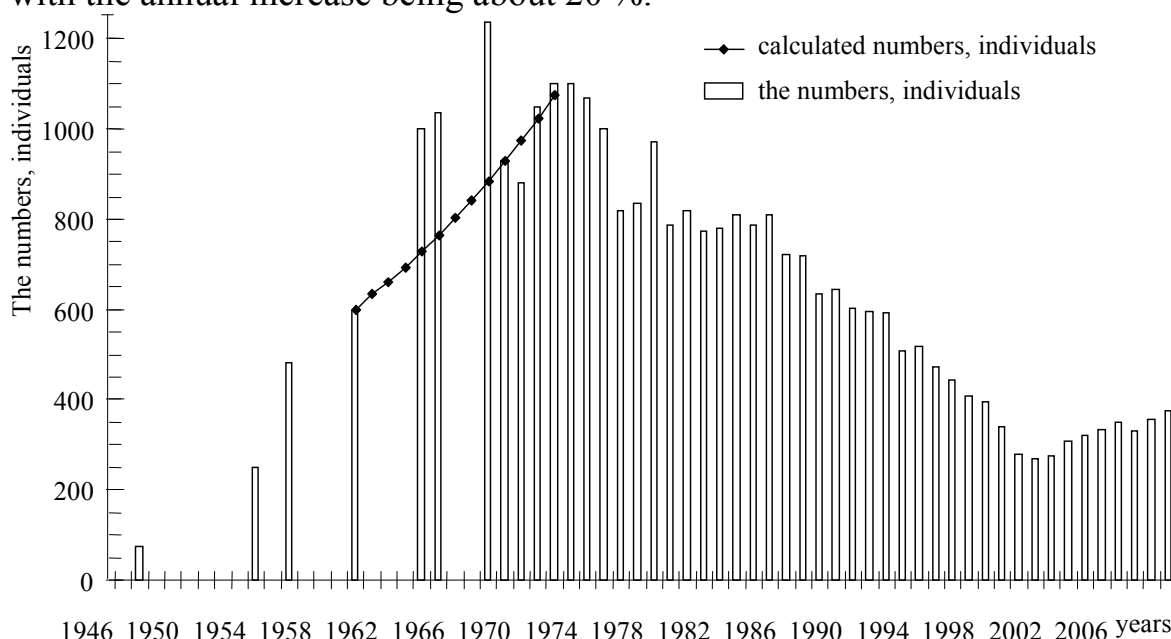


Fig. 1. Dynamics of the numbers of *Ursus arctos* in the Ukrainian Carpathians

Large mammals, in particularly bears, are characterized by a slow rate of reproduction which is accounted for by late maturity, reproduction does not occur every year, and their productive performance is relatively low [19]. That is why the increase in the bear population by 17 to 20 % is essential for the Eastern Carpathians. According to M. Hunchak [7], the increase in some game management units amounted to 19.6 % in the 1990 s. With a knowledge of main parameters of the population (numbers, increase), it is possible to restore the dynamics of the bear population in the Carpathians in the 1960 s. Setting the population size in 1960 at about 600 individuals and the average annual increase rate being 5 %, the bear population size could theoretically reach the numbers of 1000 to 1,100 individuals by the beginning of the 1970 s.

Periodic and regular variations in species numbers are a natural process in the life of any population, which is explained by intrapopulation mechanisms [14]. Two types of numbers dynamics are recognized for wild animals [26]. The first one – labile – is typical of small-sized animals (mouse-like rodentia and others), they have a short life-span and are characterized by high productive performance. The distinctive features of this type are considerable fluctuation amplitudes according to which the population size may vary several-fold, the period duration being 4 to 8 years.

The other type – steady – is typical of large animals that are characterized by big sizes, a long life-span, late maturity, and low productive performance (fecundity). This type is marked by a moderate amplitude and an extended period of the numbers change that may last for several decades [26]. The dynamics pattern of the numbers for each separate species is specific, it results from the interaction of the population with its environment and is a consequence of this species adaptation to specific habitat conditions, which, in its turn, is determined by biological peculiarities of the species. One hypothesis holds that the life-span of a species roughly corresponds to one period of the numbers change [14]. Generally, the life-span of a bear in a zoo makes up 47 years [6], it is shorter under natural conditions and makes up about 20 years [11], sometimes there can

be found individuals aged up to 27-30 years, which gives grounds for researchers to indicate the average age as being within the range of 30 to 50 years [16].

Thus, in the dynamics of bear numbers in the Eastern Carpathians, one may distinguish two periods of the numbers variation. The first one that lasted over 50 years, started in the late 1940s and ended in 2001. The phase of increasing population lasted over 20 years. The bears numbers reached their peak in the early 1970s, the population density being about 1.0 individual per 1000 ha. Starting in 1972-1973, a decline in the numbers was registered that lasted up to the beginning of the 21-st century. The smallest numbers (270 individuals) were registered in the year 2001. The duration of the phase of decreasing population was about 30 years. At the beginning of the 21-st century, the population size decreased by four times as compared with the 1970s, with the fluctuation amplitude of the numbers being nearly 830 individuals.

The second period of the population size change started in 2001 (it is not over yet). During a 8-year period (2001-2009), the number of the species increased by 10.3 %. The average annual increase of the population amounts to 5.4 ± 1.3 % ($S=3.1$; $V=58.0$ %). The variation coefficient points to the essential annual variation of increase. Thus, during the study period, the minimum 1.8 % increase of the population was recorded in 2002 while the largest – in 2003 (10.7 %). In general, from 1968 to 2009, the average bear numbers in the Eastern Carpathians amounted to 649.4 ± 28.4 individuals ($S=184.4$; $V=28.4$ %), the increase being 5.2 ± 1.1 % and the elimination amounting to 11.1 ± 1.8 %, which is twice as much as the increase.

Direct and indirect human activity, in particular hunting, poaching etc., may be the deciding factor in the change in numbers of game animals, it may influence the dynamics of the population. It should be marked, however, that the effect of hunting on the bear numbers is insignificant and this cannot cause the population number to decrease. In the 1950s, in the Ukrainian Carpathians, approximately 20 animals were hunted according to the issued licenses. In the late 1960s – the early 1970s, the number of hunted animals made up nearly 9 % of the total number of the bear population [5]. From 1991 to 1998, only four individuals were shot in the Carpathians. The maximum permissible Level of hunting on game population is considered to be 15 %, while further escalation of shooting will result in the population decrease [4].

According to the official statistics data, the decline in the population size began in the early 1970s. At that time, the guarding of game lands was much more efficient than it was in the 1990s, a period of people's mass impoverishment, weakening of state protection of game animals, the ease of procuring firearms, both smoothbore and rifled. That is why the poaching in the 1970s was not the cause of decrease in the predator numbers while the illegal hunting in the 1990s simply contributed to the depression of the population and prolonged the phase of the numbers decrease. The extent of poaching at the beginning of the 21-st century still remains of sizable proportions, and this may adversely affect the dynamics of the bear population. According to our investigation, poach hunting is responsible for 85 % of registered cases of bear death, of which about 8.7 % of animals are killed by noosing. Totally, anthropogenic factors are responsible for 96.0 % of the registered cases of bear death (Fig. 2). Quite often after the death of a female bear through poaching hunting, the little bears are left to the mercy of fate. Thus, in 1995, in the vicinity of the village of Kozakivka (Ivano-Frankivsk region), a forest guard found two live little bears and the female bear that had been killed by poachers.

The cases like this are not uncommon ones in the Carpathians. There were cases when a female bear left her little bears due to human disturbance. In 1986, in the Bukhtivets forest district (Ivano-Frankivsk region) the foresters were keeping two little bears (female) that had been found in a critical state in the forest without their mother-bear.

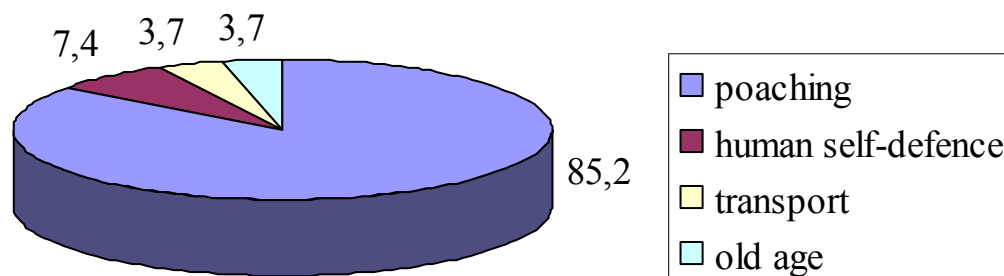


Fig. 2. Causes of *Ursus arctos* death in the Ukrainian Carpathians, in %

At the end of April 2008, a little bear was found in the area of the Bereziv forest district, it was quite exhausted and the female bear was not near-by. Our studies have revealed that no less than 19 bears of various age are being kept in enclosures in three Carpathian regions (Lviv-, Chernivtsi-, and Ivano-Frankivsk regions). The majority of the animals are kept in the enclosures at hotels, motels, restaurants.

Table 1. Keeping *Ursus arctos* in enclosures (as of 2009)

Sex	Age, years				
	up to 2	2-3	4-10	over 10	not revealed
Male	1	1	3	2	1
Female	1	1	3	1	1
Not revealed	-	-	1	-	3
Total	2	2	7	3	5

As is seen from Table 1, almost 58 % of the animals are of reproductive age. The ratio of genders is nearly 1: 1. Therefore it is necessary that a rehabilitation centre should be established in one of the natural reserves in the Carpathians (the Skolivski Beskydy National Natural Park, the Carpathian National Natural Park and others) for the purpose of keeping animals there and further introduction of little bears in the wild. The assistance in establishing such centres could be rendered by the International Fund of Animal Welfare (IFAW). A centre of this type has been already organized in Russia. The employees of the centre have managed to rescue and return to the wild over 90 little bears. In particular, the little ones that were kept in the rehabilitation centre and then released to the areas of the Briansky Les Reserve, got accustomed to the place and helped to recover the local bear population that had been degrading due to the prolonged isolation and close-related mating. Direct and indirect human activity may be a determining factor in the change of game animals numbers.

The evidence for human activity impact on the population dynamics could be the bear numbers in the game hunting areas of Ivano-Frankivsk region. In the dynamics of numbers, there are three registered periods of the population decrease: two of them are completed while the third one is still lasting. There is an intimate relationship between the species numbers in the Eastern Carpathians and the population size in the game lands in Ivano-Frankivsk region, which is supported by the correlation coefficient ($R = 0.91$). The data on the bear inventory is available only from 1965 on, but the above mentioned relationship between the species numbers in the Carpathians and the popula-

tion size within Ivano-Frankivsk region allows for stating the phase of increase in the numbers from the late 1940 s to the early 1970 s. A 1971 bear inventory in the region recorded the maximum number of the animals – 390 individuals. An 8-year period that followed the peak, witnessed a decline in the bear numbers. The first period of the population size change ended in 1978. This period lasted for over 30 years. The numbers of bears decreased by 2.4 times as compared with the early 1970 s (Fig. 3).

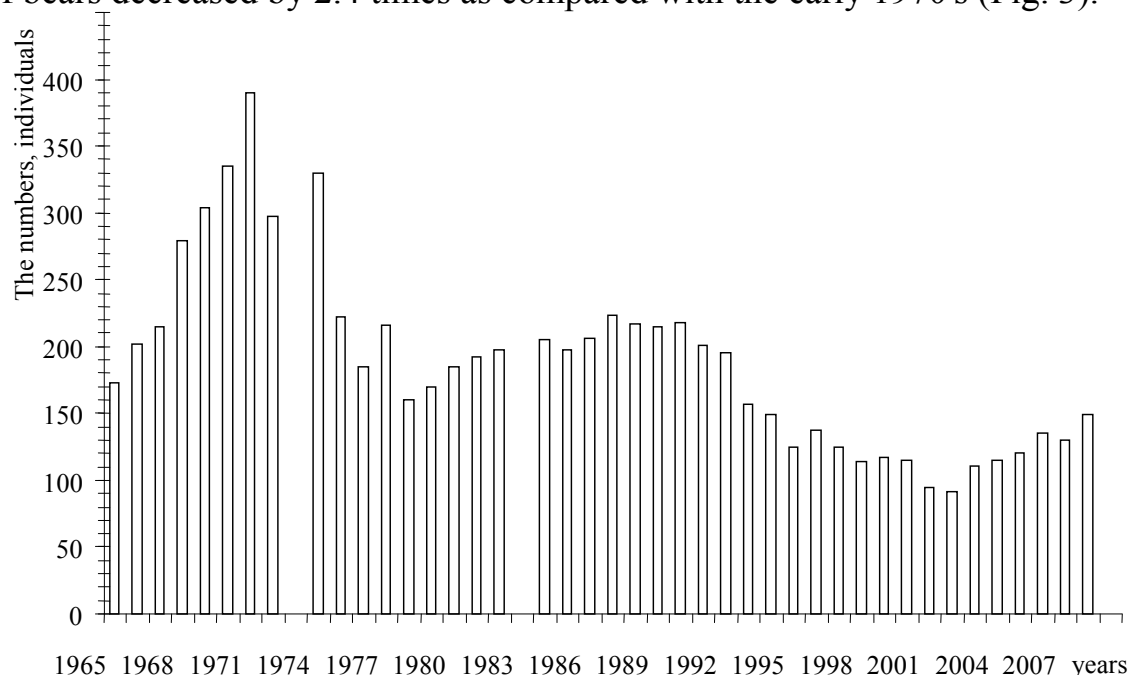


Fig. 3. Dynamics of the numbers of *Ursus arctos* in the game lands of Ivano-Frankivsk region

The second period lasted from 1978 to 2002. An increase in the numbers occurred between 1978 and 1987, the phase duration being 9 years. Bears numbers reached their peak (over 220 individuals) in 1987. During the period from 1984 to 1991, the numbers were steady, over 220 individuals were registered in the region's lands. Starting with 1992, there occurred a decrease in the numbers, illegal hunting being one of the causes. The minimum number of bears (over 90 individuals) was recorded in 2002.

Thus, the second period of the numbers change lasted for 24 years and is shorter than the first one. Most probably, the poaching in the early 1990 s caused the phase of increasing the numbers to change for the phase of decreasing the numbers which lasted for 11 years. The third (incomplete) period is characterized by the average annual increase of 9.9 ± 2.7 % ($S=6.1$; $V=61.5$ %) which is higher than in the Carpathians as a whole. The population increased by 1.6 times during a 7-year period (2002-2009).

The numbers of the predators increased also in the game lands of other regions. In particular, the total number of this species increased twice as much in Chernivtsi region. However, the tendency for the population change is influenced by the number of bears in game lands of Ivano-Frankivsk and TransCarpathian regions. There is a very close relationship between the number of this species in the game lands of TransCarpathian region and the Eastern Carpathians ($R=0.98$) while a slight relationship is registered in the game lands of Chernivtsi region ($R=0.16$), which is due to the small numbers of bears – about 12 % of the total number of the population.

A slightly negative relationship is registered between the bear population in the lands of Lviv region and the Carpathians which is either due to inaccurate inventory re-

sults or because of considerable fragmentation of the area resulting in the establishment of an isolated bear population that does not have any contact with the main population, thus acquiring the features of a “patch” population. “Patch” population of bears retain their viability even if their population size drops to 35 individuals [1]. The population of bears in the Eastern Carpathians makes an integral part with the bear population in the Southern and Western Carpathians. There is continual migration of bears from Romania to Ukraine’s territory, and vice versa. The animals come to the territory of TransCarpathians region during a spring-summer period as disturbance factors increase due to the beginning of sheep-grazing season in the mountain valleys. Thus, migration of bears from the territory of Romania to the adjacent area of the Vyshkiv forest district (State enterprise “Khust forest research centre – SE “Khust FRC”) occurs on a regular basis. In particular, a case of coming from Romanian territory of a female bear together with little bears was recorded in march 2005. The lands of SE “Khust FRC” are characterized by favourable conditions for wintering. In 1997, the windfalls in the borderland of SE “Vynogradovo forest management unit” and SE “Khust FRC” threw down a 120 m³ – volume of forest trees, the area was not fully cleared but despite the resulting favourable shelter conditions, the bears did not make their dens there.

In the borderland, on Poland’s side, there are no engineering structures, also the fencing on Ukraine’s side has been partially dismantled, which furnishes an opportunity for animals to migrate freely from Poland’s territory into the interior of Ukraine, and vice versa – to Poland. The translocation of animals across the borderline occurs regularly. Thus, the border guards have registered migration of elk, deer, bison, and bear across the border. In the area of the Bircha gmina (rural council district) that is adjacent to the Poland-Ukraine border. Cases of bear migration from this area to the land of the Dobromyl forest district (SE “Vynogradovo forest management unit”) are recorded from time to time. In order to restore the wholeness of bear population within the area of the Eastern Carpathians, it is necessary that ecological corridors should be created. Such corridors need to be created first at the western boundary of the Eastern Carpathians, the area of which is considerably fragmented and heavily populated as compared with other areas of the Ukrainian Carpathians.

Thus, the entering of the brown bear into Ukraine’s Red Book was done without due consideration for natural dynamic processes of the species population. Two periods are revealed in the population dynamics in the Eastern Carpathians from the second part of the 20th century to the beginning of the 21-st century. The first period lasted over 50 years, the second one (still lasting) started early in the 21-st century. The periodic and cyclic pattern of the population change may be substantially influenced by human activity, in particular poaching. The illegal hunting prolonged the duration of the phase of decreasing the population number in the 1990 s, and this is the factor which is slowing down the species restoration at the beginning of the 21-st century. That is why the efforts of nature-protection bodies, the huntsmen service of game management units should be directed towards revealing cases of illegal hunting, and preventive measures against poaching should be taken. The restoration of the bear population will be promoted by the establishment of rehabilitation centres and creation of ecological corridors.

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Динаміка чисельності ведмедя у Східних Карпатах

Встановлено, що у динаміці чисельності ведмедя у Східних Карпатах зареєстровано два періоди зміни чисельності. Перший період тривалістю понад 50 років, розпочався у кінці 40-х років XX ст. і завершився у 2001 р. Другий період (триваючий) почався на початку XXI ст. Максимальної чисельності близько 1100 особин поголів'я ведмедя досягнуло на початку 70-х років минулого століття. У понад 85 % виявлених випадків загибелі ведмедя причиною є браконьєрське полювання.

Ключові слова: популяція, полювання, чинники середовища, браконьєрство.

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STATE AND PERSPECTIVES IMPROVEMENT OF FOREST TRANSPORT NETWORK

The state of forest roads network in Ukraine and some countries of Europe is analyzed. The optimum values of forest roads density are substantiated for different geomorphologic conditions on the basis of analysis of forest road planning results.

Keywords: forest roads network conditions, model of timber transport development, density of forest roads network.

Introduction. Forest roads is a kind of entrance to the forest areas, the possibility of providing its essential functions, rational and ecologically safe use of natural resources, effective functioning of the tourism and recreation industry. Transport routes play a critical role at the forestry production of mountainous area, where forest areas are scattered over a large territory and such territory has the following characteristic features: difficult relief and soil-hydrological conditions, low concentration of harvestable timber per unit area, one-sided cargo traffic and other factors. The development of road networks in forested areas has a positive effect on the intensification and expansion of opportunities for many sectors of the economy and, promote the population with the employment, reduction of staff turnover, improvement of working and living conditions of the population. But so far in Ukraine there is has not been any concept concerning the extension of forest roads network with the recommendations regarding its main parameters and choice of technology of primary timber transportation. The aim of this study is to substantiate the optimal density of forest road network in different geomorphological regions of Ukraine under the conditions of the economically viable use of promising timber transport means.

The forest road network condition. It should be noted that the work concerning the investigations of the road network condition of the forest areas in Ukraine, its assessment and inventory are nearly absent. Therefore at first we analyze the data concerning other countries, in particular those that have natural and geomorphological conditions similar to Ukraine. The study [9] provides a detailed analysis of forest access network in neighboring Slovakia, which according to its location, structure and density, should ensure optimal transport accessibility of forestland. Forest access network of this country includes forest road network (Table. 1), intended for the timber hauling by trucks and the