

## **BIOMASS OF PINE SAW TIMBER STANDS GROWING ON THE FRESH MIXED CONIFEROUS SITE**

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**Abstract.** The presented paper discusses the results of investigations on the biomass of a stand which developed on the fresh mixed coniferous forest site. The precise knowledge of data concerning the weight of individual tree elements can provide information allowing researchers to carry out other experiments associated with, for example, the determination of the biomass as the raw material base, the assessment of nutrients withdrawn from the forest with the harvested raw material as well as other types of information. The performed investigations revealed that, in the case of the examined site, the total over ground weight of pine trees amounted to 264 500 kg/ha of which the greatest proportion fell on the bole timber (approximately 212 t/ha), whereas the smallest share – on thicker branches (of the diameter over 4 cm). The performed moisture content experiments allowed the authors to determine the dry weight of individual parts of trees. The percentage proportion of individual parts was similar to the weight structure of the fresh parts. The highest difference was determined in the case of bark – its dry weight was by 2 percent higher in comparison with the fresh weight.

**Key words:** tree biomass, Scots pine

### **INTRODUCTION**

Since 1980's some investigations have been carried out involving complex determination of the tree biomass instead of their single individual constituents [Kubiak et al. 1985 b, Gornowicz and Pilarek 1993]. The premises which triggered off more comprehensive studies of the problem varied. Some of these premises were associated with the quantitative determination of the biomass as a base which could provide additional source of timber for different purposes, others with the possibilities of mechanization of certain forest works [Kubiak et al. 1990]. The information about tree biomass is also important in the case of investigations concerning the impact of timber harvesting using different systems of the forest environment [Pilarek 1998]. It is impossible to establish the quantity of nutrients withdrawn from the forest together with the harvested raw material without the exact knowledge of this problem. In addition, the recognition of the

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energy flow in forests, closely connected with the carbon turnover in nature, requires our good understanding of these problems.

The occurrence of Scots pine in Poland is associated mainly with coniferous forest sites. Our knowledge of the biomass on the fresh coniferous sites is relatively large but it appears equally important to expand our knowledge of the problem on other sites. That is why, this study undertook an attempt to estimate more precisely both the fresh and dry weights of the individual tree parts growing on the mixed fresh coniferous site. The content of individual elements in the plant material is given in dry matter.

## LOCATION AND METHODS OF RESEARCH

Experiments were carried out in September 2003 in the Okonek Forest District (Regional Directorate of State Forests in Szczecin) in compartment 46c and the area of the experimental plot was 2.8 ha. Table 1 presents characteristics of the experimental surface. Diameters of all trees growing on the experimental surface were measured as well as the heights in all degrees of thickness using, for this purpose, a Sunto height meter. The obtained measurements served to select 15 test trees with the assistance of the Draudt method. Dimensions of test trees are presented in Table 2.

Table 1. Characteristics of the experimental surface  
Tabela. 1. Charakterystyka powierzchni badawczej

Natural-forest region – Kraina przyrodniczo-leśna	Wielkopolsko-Pomorska
Forest site type – Typ siedliskowy lasu	fresh mixed coniferous forest – bór mieszany świeży
Principal species – Gatunek główny	pine – sosna
Age – Wiek	102 years old – 102 lata
Closure – Zwarcie	moderate – umiarkowane
Stocking – Zadrzewienie	0.9
Number of trees – Liczba drzew	392 trees·ha <sup>-1</sup>
Timber volume – Zasobność	265 m <sup>3</sup> ·ha <sup>-1</sup>

Table 2. Calculated dimensions of test trees  
Tabela 2. Obliczone wymiary drzew próbnych

Number of trees Liczba drzew	Breast height diameter, cm Pierśnica, cm	Calculated height, m Wysokość obliczona, m
1	19.4	18.6
1	22.0	19.7
2	24.0	20.3
2	26.0	20.9
3	29.0	21.7
3	33.0	22.6
2	37.0	23.3
1	42.5	24.1

After felling test trees onto canvases, they were debranched, debarked and later divided into segments short enough to allow them to be placed on a decimal balance.

The biomass of the following tree parts was determined:

- bole timber
- bole bark
- branches up to 4 cm thick
- branches over 4 cm thick
- needles.

The cut tree tops were also included in branches.

Individual parts of the test tree (with the exception of needles) were weighed with the accuracy of 0.5 kg. In order to determine the weight of needles, a sample of approximately 2 kg of twigs with needles was taken to the laboratory where the needles were separated from twigs and the percentage weight ratio of needles to twigs was determined. Then the weight of twigs with needles was reduced by the weight of needles and the weight of twigs was included in the total weight of branches.

In order to establish the dry weight of tree elements, samples for moisture content determination were collected from each test tree. The moisture content was determined by the drier-gravimetric method.

## RESULTS

The total of 1097 trees was found on the entire experimental surface. The thinnest of them were classified into the thickness class with the diameter of 16 cm, while the thickest had the diameter of 52 cm.

The total fresh weight of trees on the entire experimental surface calculated on the basis of test trees amounted to 740 788 kg which, when converted into area unit, amounted to 264 567 kg/ha. From among the examined tree parts, the greatest weight was found in the bole timber (over 593 t), whereas the lowest weight was determined in the case of branches with the diameter more than 4 cm (about 20.3 t). Detailed data about the weight of individual tree parts are presented in Table 3. When converted into one hectare of the stand, these weights reached the following values: almost 212 t for the bole timber and over 7 t for branches with their diameter over 4 cm (Fig. 1).

The highest proportion of the bole timber in the total tree biomass was found to be slightly more than 80% and the successive tree elements arranged in the decreasing order were as follows: bark from the bole, branches of up to (and including) 4 cm diameter, needles and branches of the diameter over 4 cm. The percentage structure of the examined fresh tree elements is presented in Figure 2.

The results of the moisture content determination obtained in the laboratory for individual test trees allowed the authors to assess the weight of these elements in dry state. Mean relative moisture contents of the examined tree elements were as follows:

- bole timber – 46.2%
- bark – 33.4%
- thick branches (over 4 cm diameter) – 44.8%
- thin branches (up to 4 cm diameter) – 56.8%
- needles – 57.9%.

Table 3. Total fresh weight of the examined tree parts  
Tabela 3. Łączna masa świeża badanych części drzewa

Tree part Część drzewa	Fresh weight, kg Masa świeża, kg
Bole timber – Drewno strzały	593 377.9
Bark – Kora	64 922.6
Branches – Gałęzie	
> 4 cm	20 295.0
≤ 4 cm	36 068.5
Needles – Igliwie	26 125.0
Total – Łącznie	740 789.0

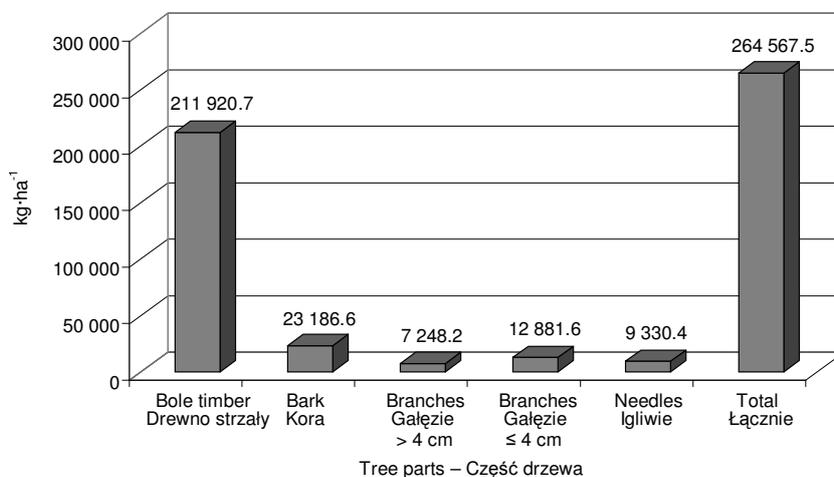


Fig. 1. Weight of fresh tree parts per 1 ha of surface  
Rys. 1. Masa części drzew w stanie świeżym na 1 ha powierzchni

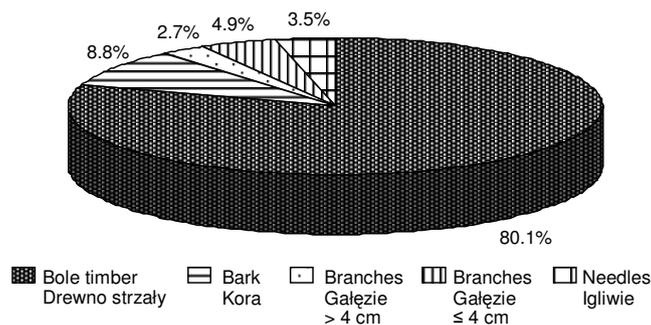


Fig. 2. Structure of the examined fresh tree elements  
Rys. 2. Struktura badanych elementów drzewa w stanie świeżym

The obtained results indicate that, similarly as in the case of the fresh weight, the highest dry weight value was recorded for the bole timber. A difference was observed in the case of the smallest weight, i.e. of needles but even in this case, the weight of needles was only slightly lower than that of branches of the diameter over 4 cm. The total weight of dry trees converted into 1 ha of area exceeded slightly 143 t which constituted 54% of the fresh weight per 1 ha. Values referring to the examined tree elements are presented in Table 4.

Table 4. Dry weight of individual tree elements calculated per 1 ha  
Tabela 4. Masa poszczególnych elementów drzewa w stanie suchym w przeliczeniu na 1 ha

Tree part Część drzewa	Dry weight, kg·ha <sup>-1</sup> Masa w stanie suchym, kg·ha <sup>-1</sup>
Bole timber – Drewno strzały	114 092
Bark – Kora	15 446
Branches – Gałęzie	
> 4 cm	4 005
≤ 4 cm	5 564
Needles – Igliwie	3 930
Total – Łącznie	143 037

Proportions of the individual dry tree parts on the area of 1 ha in relation to the total dry tree weight are presented in Figure 3. The percentage proportion is similar to the structure of weights in the fresh state. The greatest difference was found in the case of bark – its weight was by 2% higher in comparison with the fresh weight.

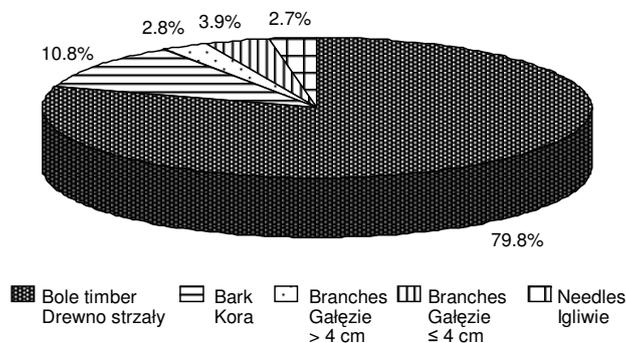


Fig. 3. Structure of the examined dry tree elements  
Rys. 3. Struktura badanych elementów drzewa w stanie suchym

The determined values of the biomass in the pine sawtimber stand growing on the fresh mixed coniferous forest site are similar to the results reported by Kubiak et al. [1985 a]. According the above-mentioned studies, the over ground weight of dry pine wood on the area of 1 ha amounted to 144 466 kg and exceeded by 1% the values de-

terminated in the course of these experiments. Greater differences were observed in the case of the structure of the over ground biomass. Kubiak et al. [1985 a] reported smaller proportions of the trunk timber and bark and by 2.3% higher quantities of branches and needles.

## CONCLUSIONS

The results obtained in the course of the described investigations allowed the authors to draw the following conclusions:

1. In the case of the fresh mixed coniferous forest site, the fresh pine biomass amounted to 264 568 kg/ha. The determined dry weight constituted 54% of the determined biomass (143 037 kg/ha).

2. Mean over ground fresh weight of one tree amounted to 675 kg, whereas that of the dry weight – 365 kg.

3. The performed investigations revealed that the proportion of the weight of individual fresh tree parts was as follows: bole timber – 80.1%, bole bark – 8.8%, branches – 4.9% and needles – 3.5%. The percentage structure of the individual dry tree parts was similar to the share of the fresh weight. The greatest difference was observed in the case of the bole bark, its dry weight was by 2% higher in comparison with the fresh weight.

4. The determined biomass values in the pine sawtimber stand growing on the fresh mixed coniferous forest site were similar to the results found in the Polish literature on the subject.

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## **BIOMASA RĘBNEGO DRZEWOSTANU SOSNOWEGO ROSNĄCEGO NA SIEDLISKU BORU MIESZANEGO ŚWIEŻEGO**

**Streszczenie.** W pracy przedstawiono wyniki badań dotyczące biomasy drzewostanu wyrosłego na siedlisku boru mieszanego świeżego. Dokładna znajomość danych dotyczących masy poszczególnych elementów drzewa może być przyczynkiem do prowadzenia innych badań, np. związanych z określeniem biomasy jako bazy surowcowej czy ustaleniem ilości pierwiastków odżywczych wycofywanych z lasu wraz pozyskiwanym surowcem. Przeprowadzone badania wykazały, że na tym siedlisku całkowita masa naziemna sosen wyniosła ponad 264 500 kg/ha, z czego największy udział przypadła na drewno strzały (około 212 t/ha), a najmniejszy na grubsze gałęzie (o średnicy powyżej 4 cm). Przeprowadzone badania wilgotności pozwoliły ustalić masę poszczególnych części drzewa w stanie suchym. Struktura procentowa jest zbliżona do struktury mas w stanie świeżym. Największą różnicę stwierdzono w wypadku kory – jest jej o 2% więcej w porównaniu z masą w stanie świeżym.

**Słowa kluczowe:** biomasa drzew, sosna zwyczajna

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