A spiral-bound notebook with a light brown, textured cover and a silver metal spiral binding on the left side. The notebook is open to a blank page with a similar light brown, textured background. The text is centered on the page in a dark brown, serif font.

Methodology of determining of
potential production area (PPA)
and effective productivity area

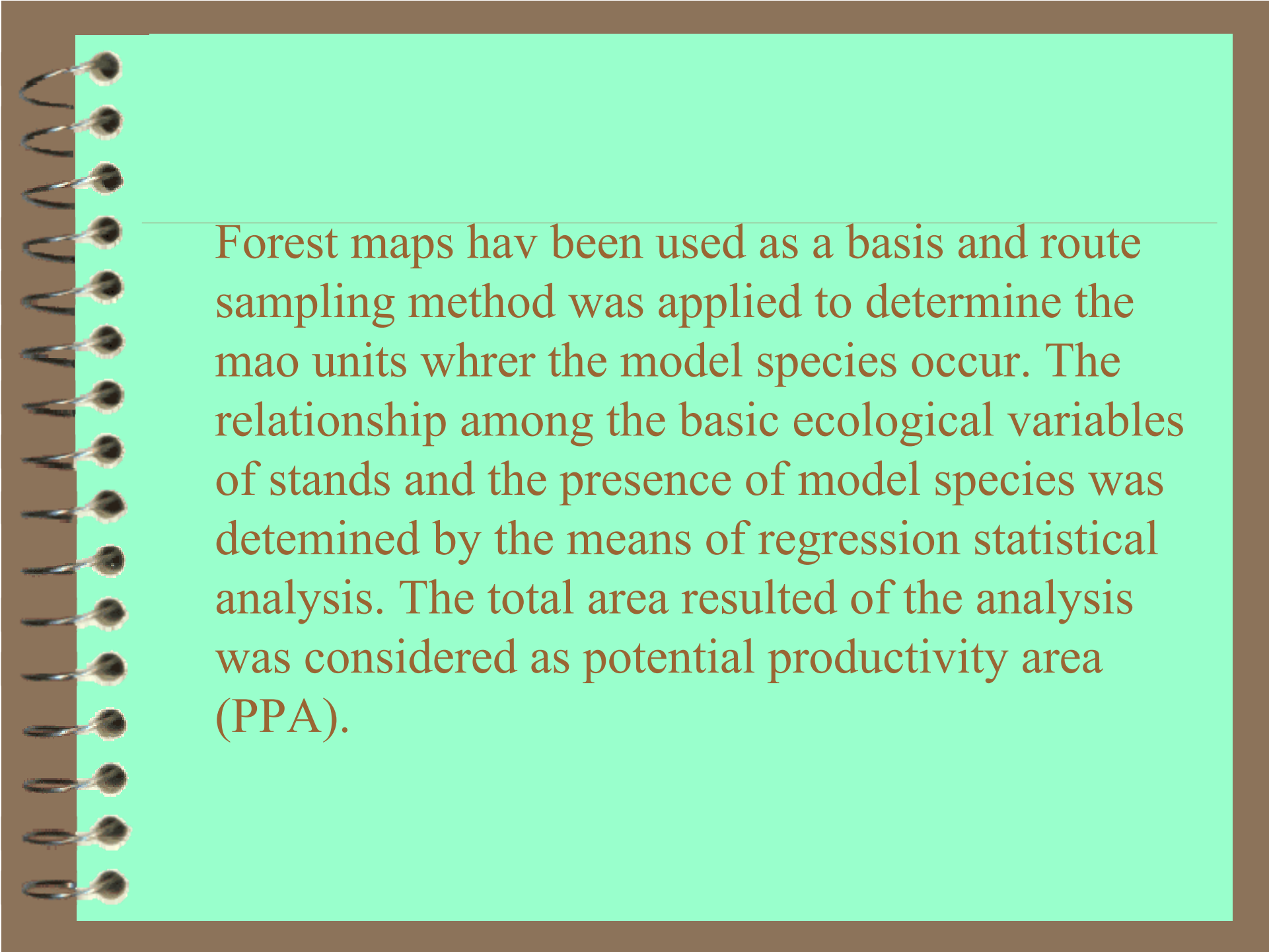
Hipotesis:

The plant inventory has been done at three stages:


7 Mapping

7 Assessment of productivity

7 Assessment of stock


A graphic of a spiral-bound notebook with a light green cover and a brown spine. The spiral binding is on the left side. The notebook is open to a page with a light green background. A horizontal line is drawn across the page, and a paragraph of text is written below it.

Forest maps have been used as a basis and route sampling method was applied to determine the main units where the model species occur. The relationship among the basic ecological variables of stands and the presence of model species was determined by the means of regression statistical analysis. The total area resulted of the analysis was considered as potential productivity area (PPA).

A graphic of a spiral-bound notebook with a silver metal spiral on the left side. The notebook is open to a light green page. The text is written in a dark brown, serif font. A horizontal line is drawn across the page, separating the introductory text from the list of characteristics.

Determining of effective productivity (EPA)
was performed by means of experimental
plots and in each plot the following
characteristics were assessed:

1. Coverage of the model species
2. Area covered by the populations of the model species
3. Productivity (g/sq.m and kg/ha)
4. Growing stock (kg/ha or t/ha)



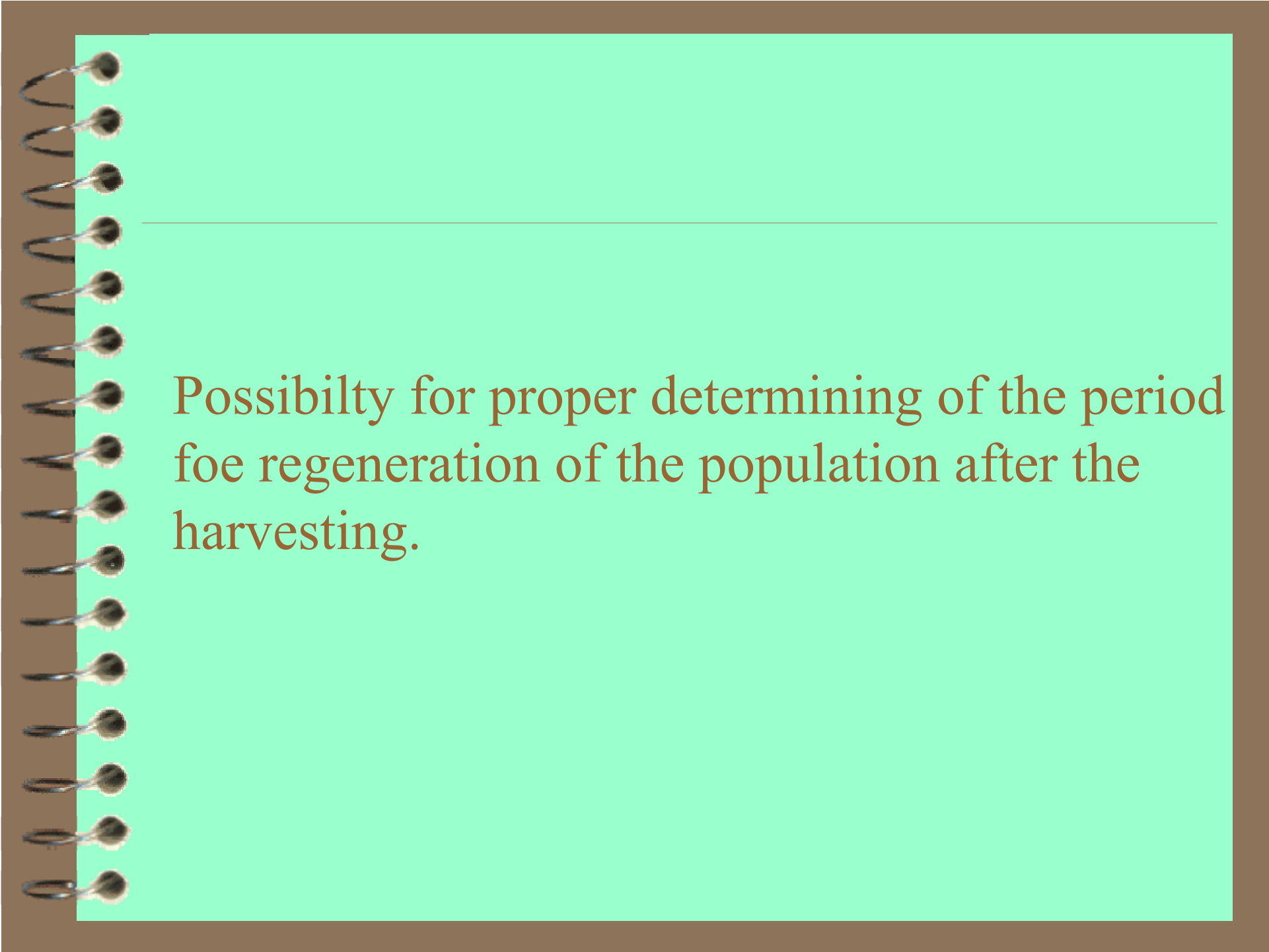
These characteristics were used to determine the effective productivity areas (EPAs). Only where enough stock for exploitation was available were considered as effective productivity areas (EPA). Exploitation stock should meet the following criteria:

1. Economical effectiveness of the harvesting
2. Accessibility to the localities
3. Possibility for application of criteria for sustainable use


A graphic of a spiral-bound notebook with a silver metal spiral on the left side. The notebook is open to a light green page. The text is written in a dark brown, serif font. A horizontal line is drawn across the page, separating the title from the main text.

These criteria are:

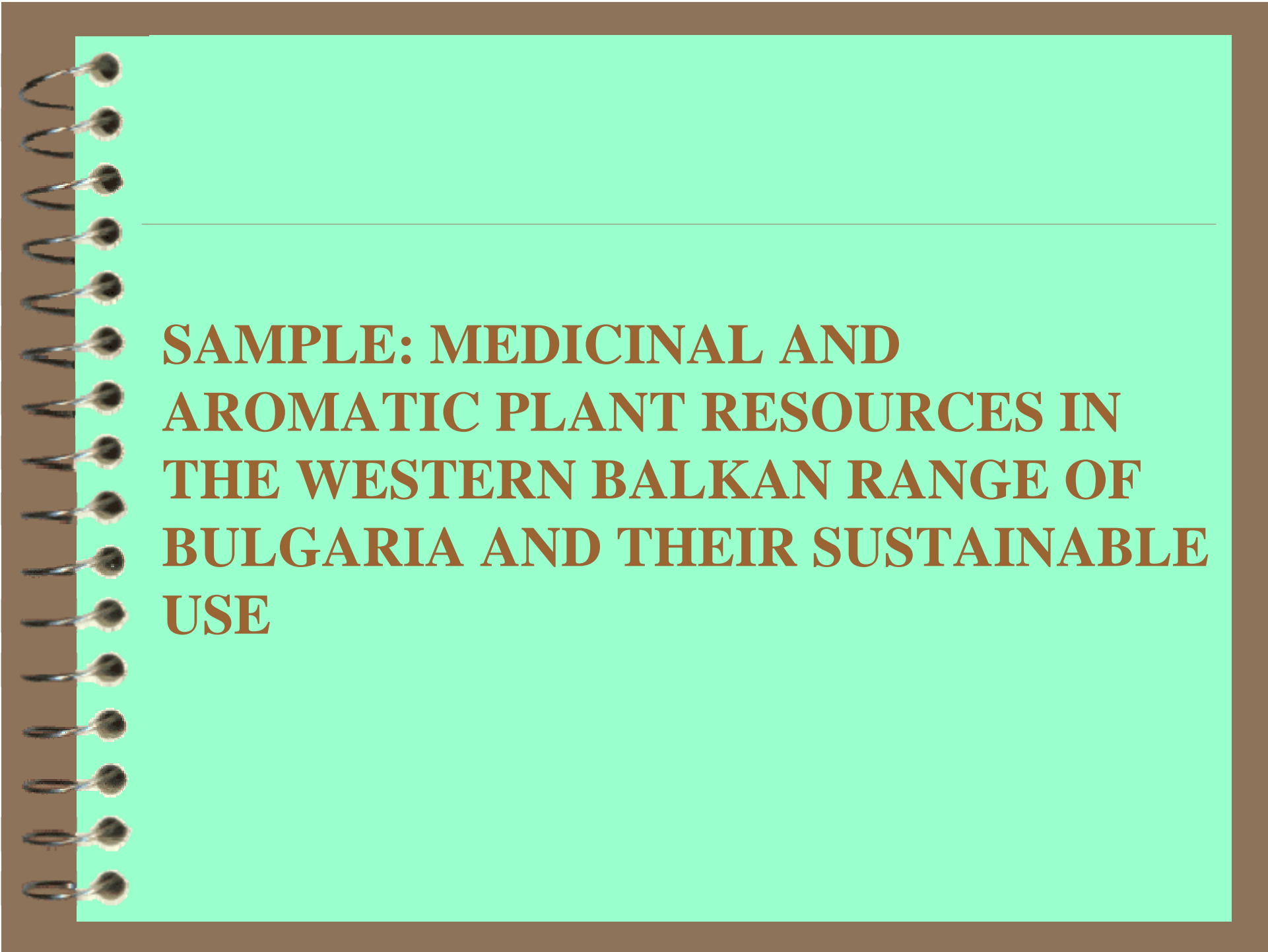
Possibility for application of rotations of harvesting. It is determined according to the period of full regeneration of the population. If such regeneration continues, for example 5 years, then the rotation period of harvesting is 5 years (each year $1/5$ of the stock is harvested) – for sustainable use.

A graphic of a spiral-bound notebook with a brown cover and a light green page. The spiral binding is on the left side. A horizontal line is drawn across the page, approximately one-third of the way down. The text is written in a brown, serif font on the right side of the page.

Possibility for proper determining of the period
for regeneration of the population after the
harvesting.



Possibility to determine the annual harvest on a territory that will not destroy the population of the respective species. This parameter is determined as a ratio of exploitation stock and the rotation period.

A spiral-bound notebook with a light green cover and a brown spine. The notebook is open to a blank page with a horizontal line near the top. The text is written in a bold, serif font in a dark brown color.

**SAMPLE: MEDICINAL AND
AROMATIC PLANT RESOURCES IN
THE WESTERN BALKAN RANGE OF
BULGARIA AND THEIR SUSTAINABLE
USE**

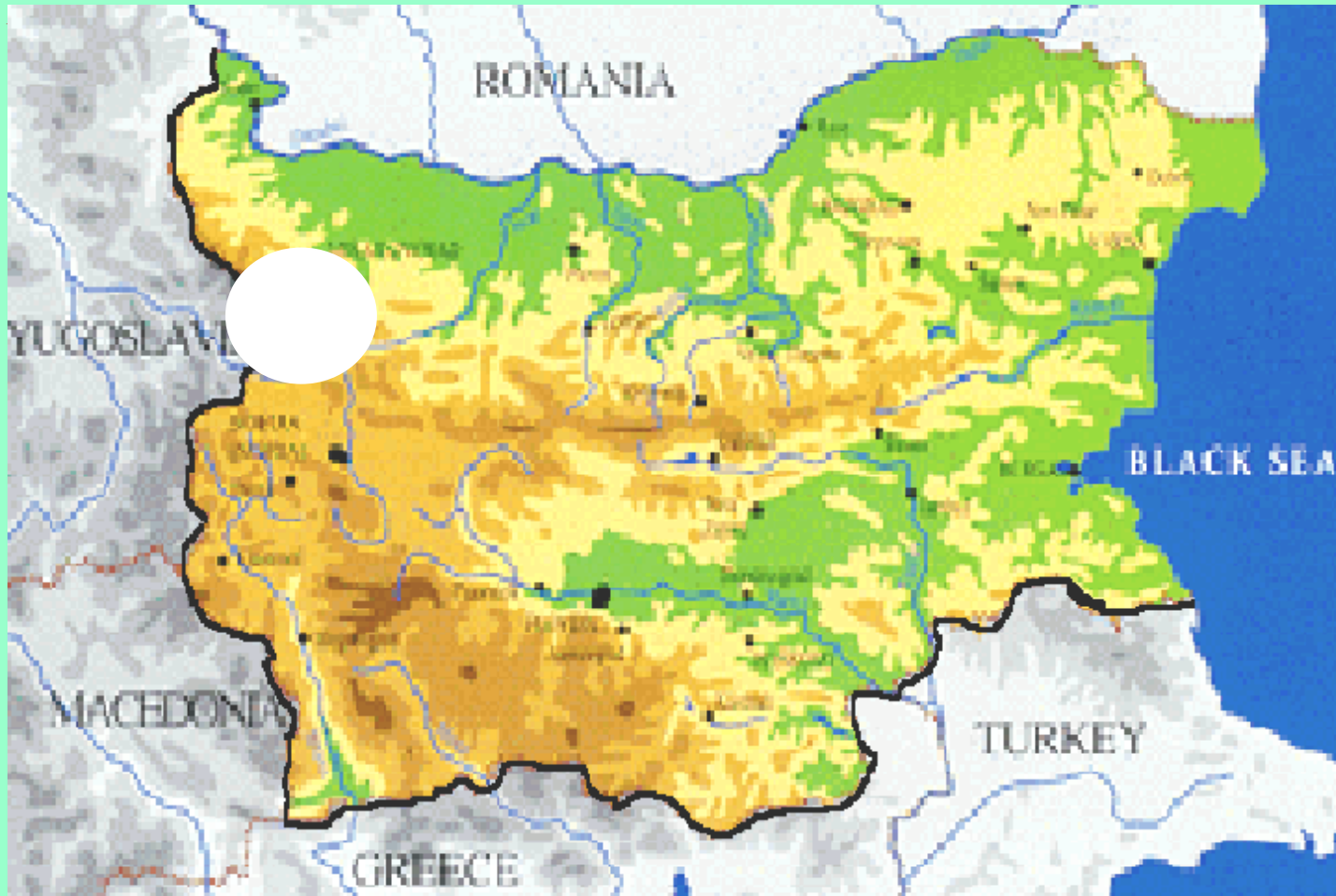
THE OBJECTIVES

- 7 Area inventory of the medicinal plant resources having high economic and nature conservation value.**
- 7 Defining the rules for sustainable use of these resources in the region of Western Balkan mountains range**

MAIN TASKS

- 7 Inventory of the species composition**
- 7 Inventory of the productivity and distribution of model species**
- 7 Assessment on the effect of forest management practices on the species studied**
- 7 Assessment of the nature conservation value of the species studied.**

The OBJECT



CRITERIA FOR SPECIES SELECTION

- 7 **Distribution within the forest area**
- 7 **Economic importance**
- 7 **Nature conservation value**
- 7 **Important for the local people and for the tourism**

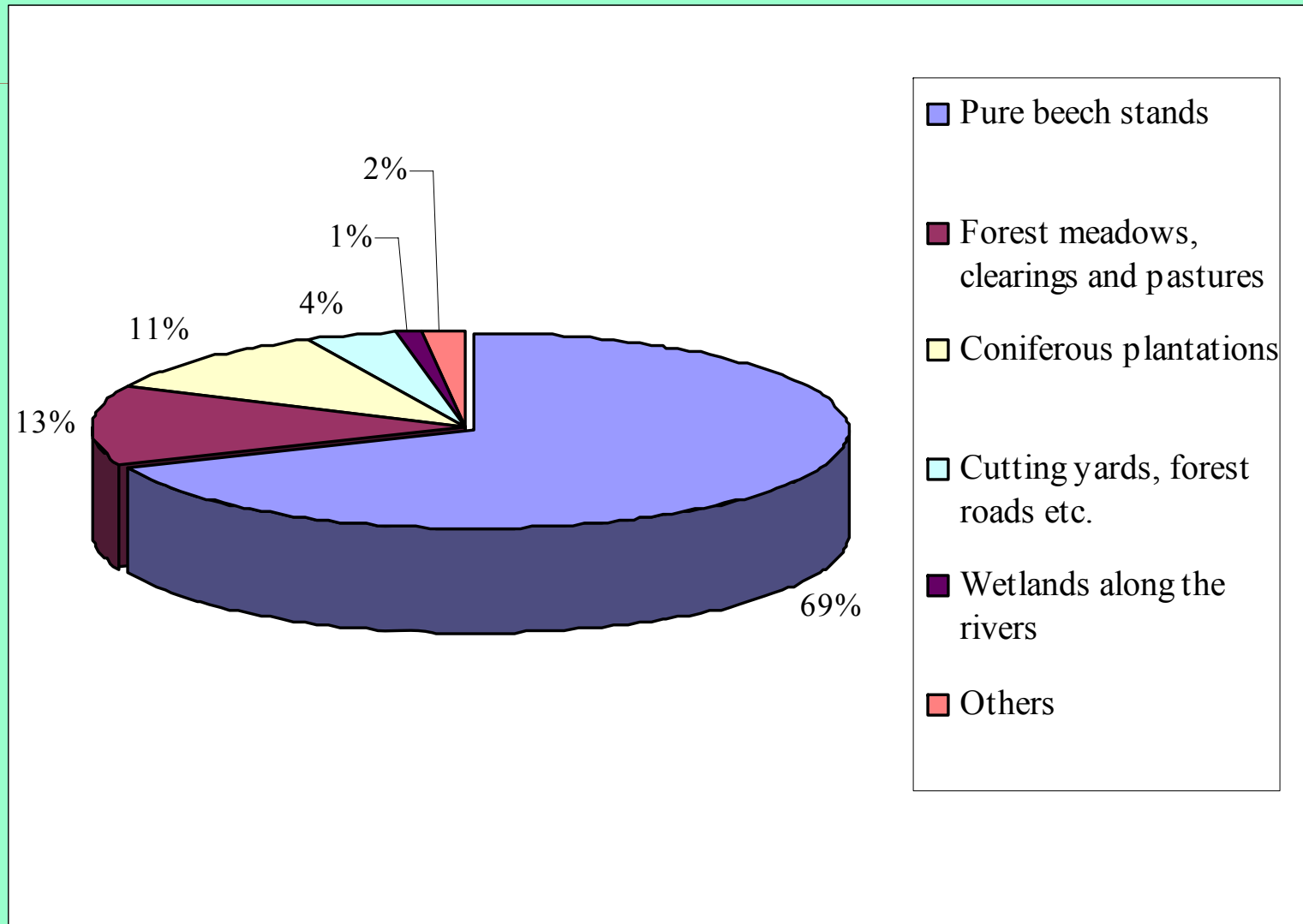
METHODS OF STUDY

- 7 Transect assessment;
- 7 Method of model individuals;
- 7 Phytosociological method
- 7 Biometrical and statistical methods

RESULTS

Total 170 medicinal and aromatic plant species established in the region of study;
Some plants are not used currently as MAPs but have a potential to be used.

Types of habitats



Species composition and potential productive area in the pure beech stands



- 7 *Pure beech stands*
- 7 Two subtypes – wet and dry beech forests. Total 47 MAPs are found. The first subtype is substantially richer.

Model species

- 7 *Allium ursinum* L.
- 7 *Arum maculatum* L.
- 7 *Asarum europaeum* L.
- 7 *Sanicula europaea* L.
- 7 *Galium odoratum* (L.) Scop.
- 7 *Dryopteris filix-mas* (L.) Schott

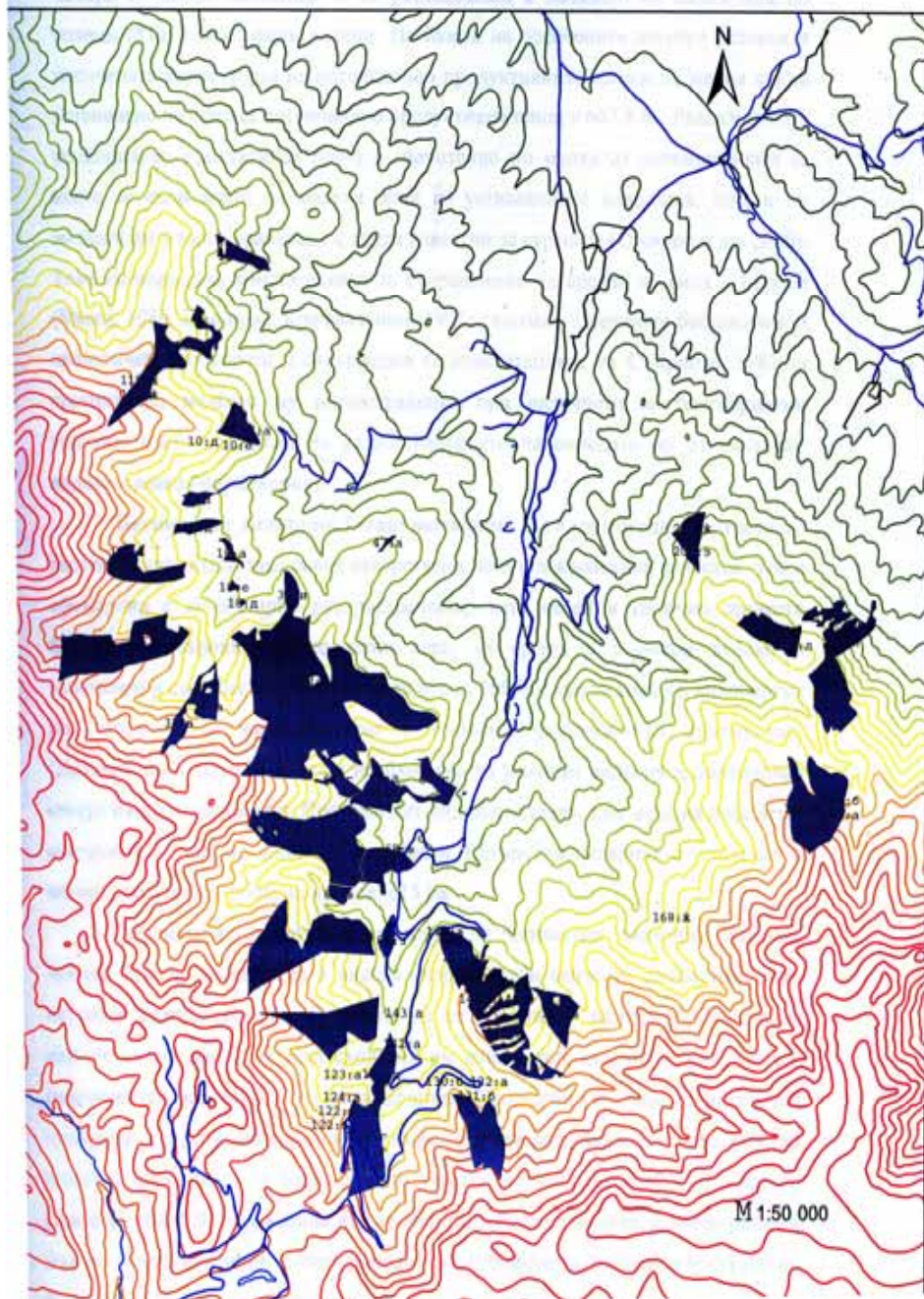


Allium ursinum – forms compact, but small and relatively isolated groups
Situated mostly on wet sites in the beech forests, on shadow exposition. Po
production area (PPA) is 0.11 ha.

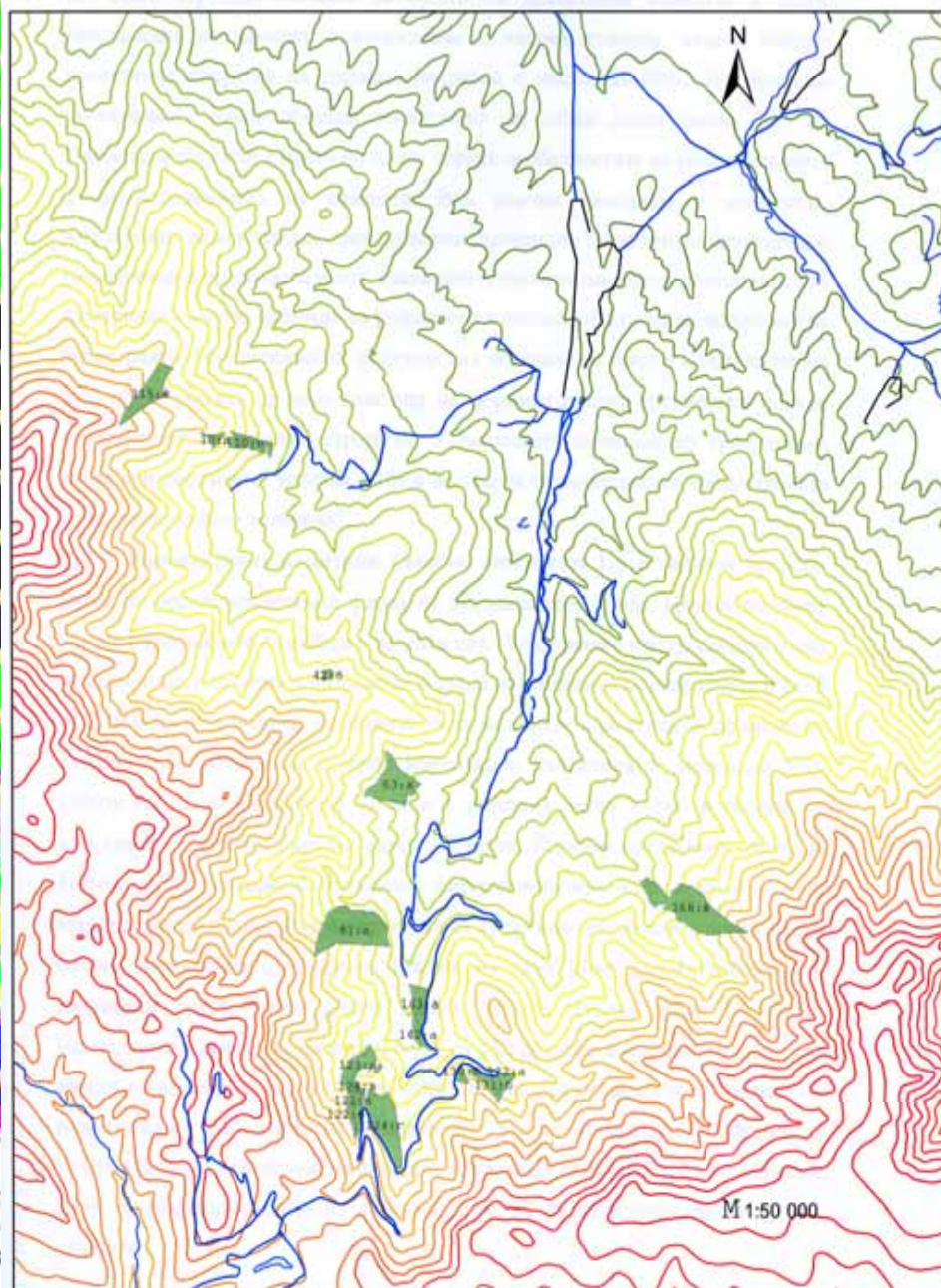


PPA of *Arum maculatum* L. is in all beech forests with dense canopies and on shadow expositions. It amounts about 200 ha, but the effective PPA is relatively smaller - 106.6 ha.

Карта на потенциално продуктивните площи за
Мечи лук (*Allium ursinum*)



Карта на потенциално продуктивните площи за
Петнист змиярник (*Arum maculatum*)



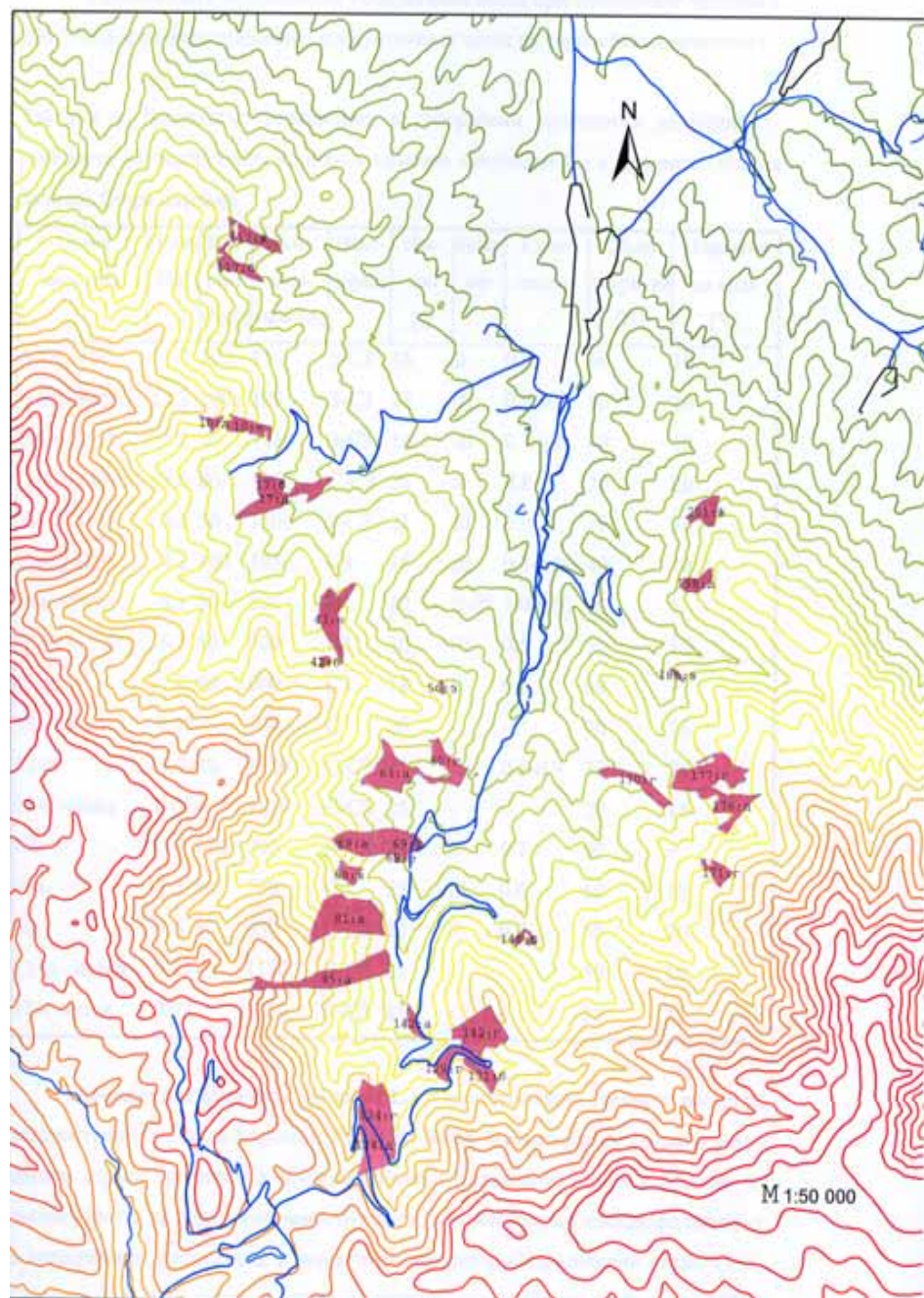


Asarum europaeum L.) – in mature and submature forests with canopy coverage of 0.8-0.9 and 2nd-4rd site classes on the lower and middle parts of slopes on northern expositions, at altitude 800-1100 m. PPA is 208.5 ha.

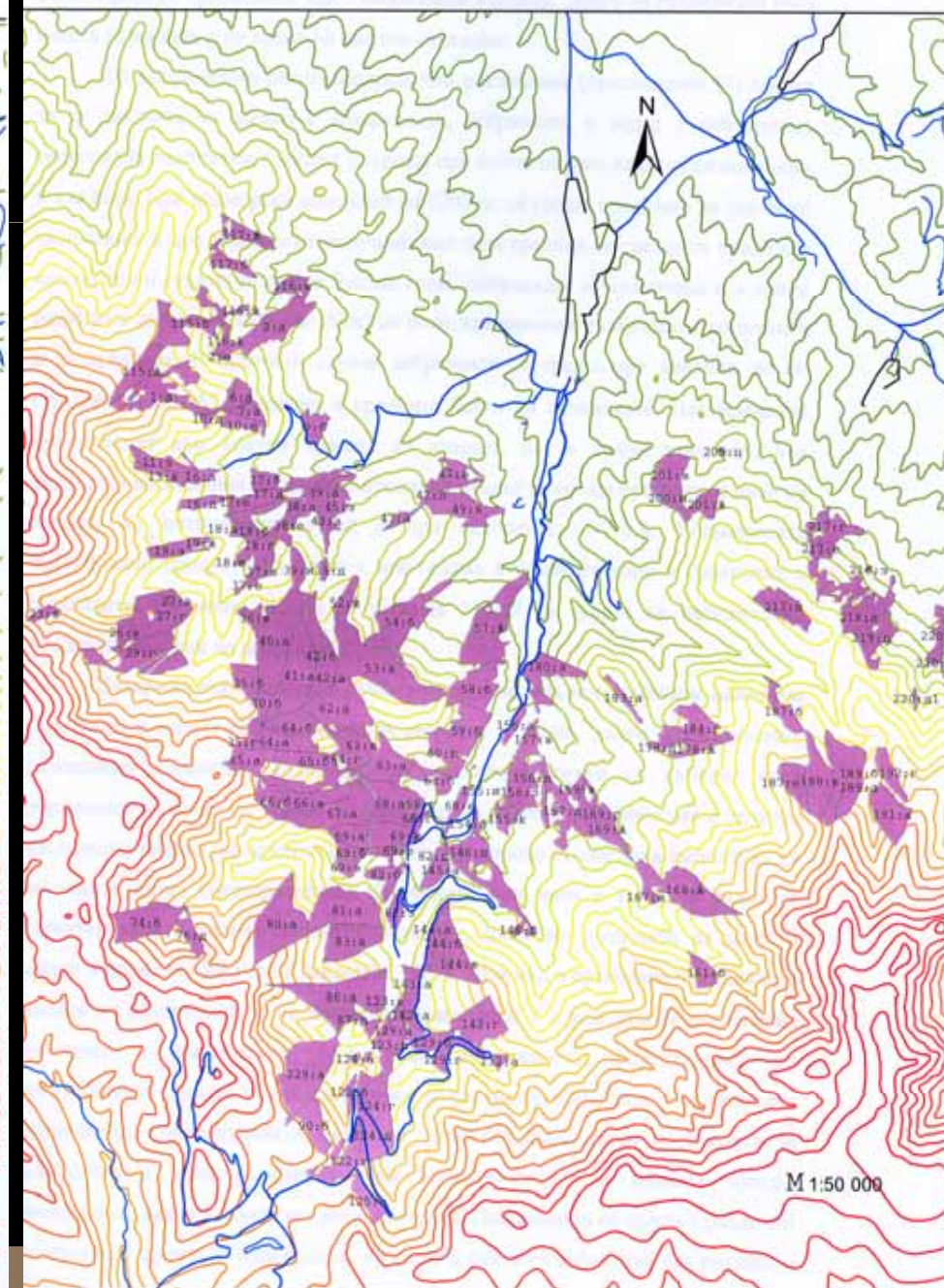


Sanicula europaea L. is ecologically highly tolerant species and is, therefore, widely distributed. PPA in the beech forests is the largest among the species studied – 1161.9 ha.

Карта на потенциално продуктивните площи за Европейски копитник (*Asarum europaeum*)



Карта на потенциално продуктивните площи за Дебрянка (*Sanicula europaea*)



Galium odoratum is a tollerant species, too. PPA of the species is in the young beech forests and on slightly drier sites and amounts 421.4 ha.



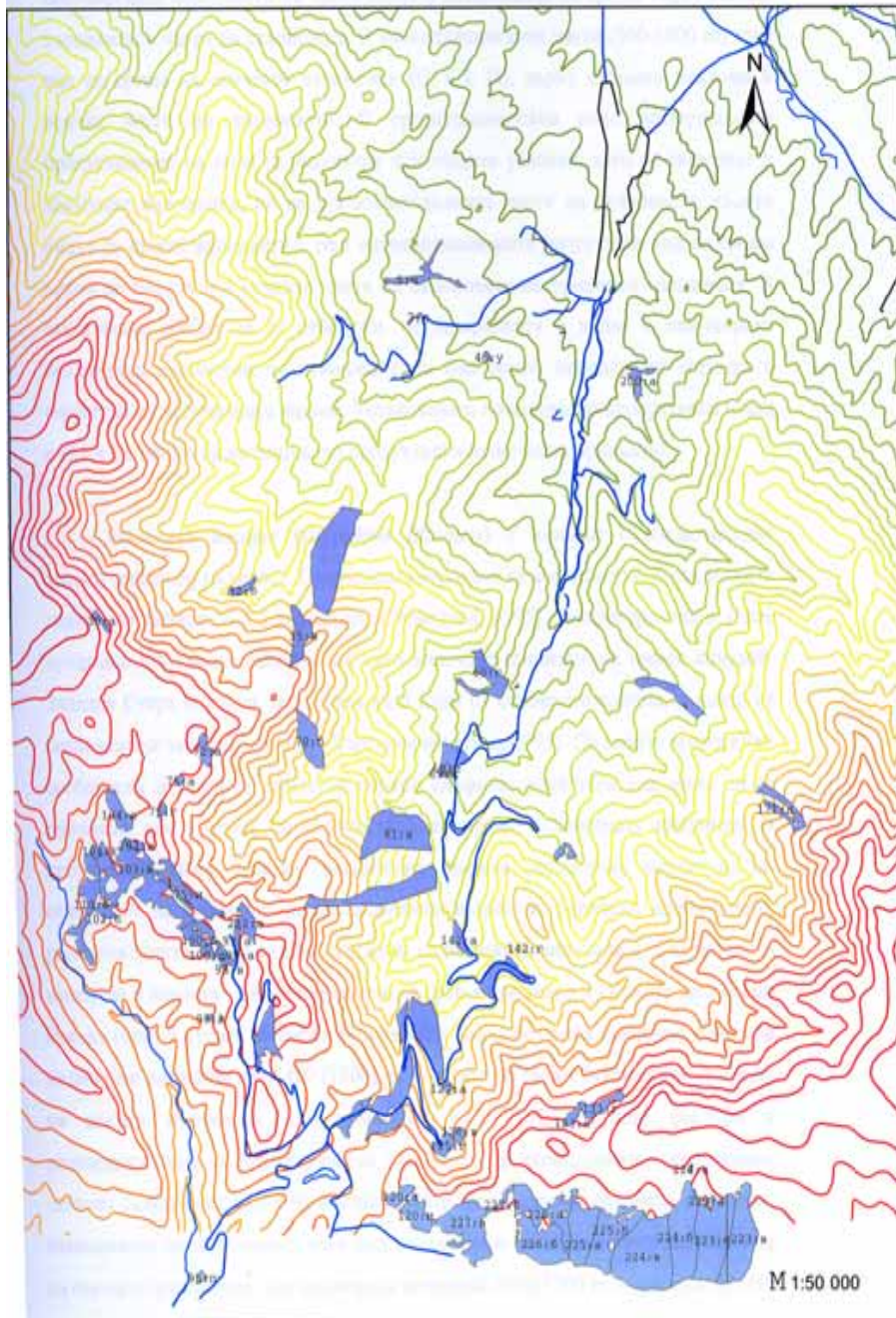


Dryopteris filix-mas

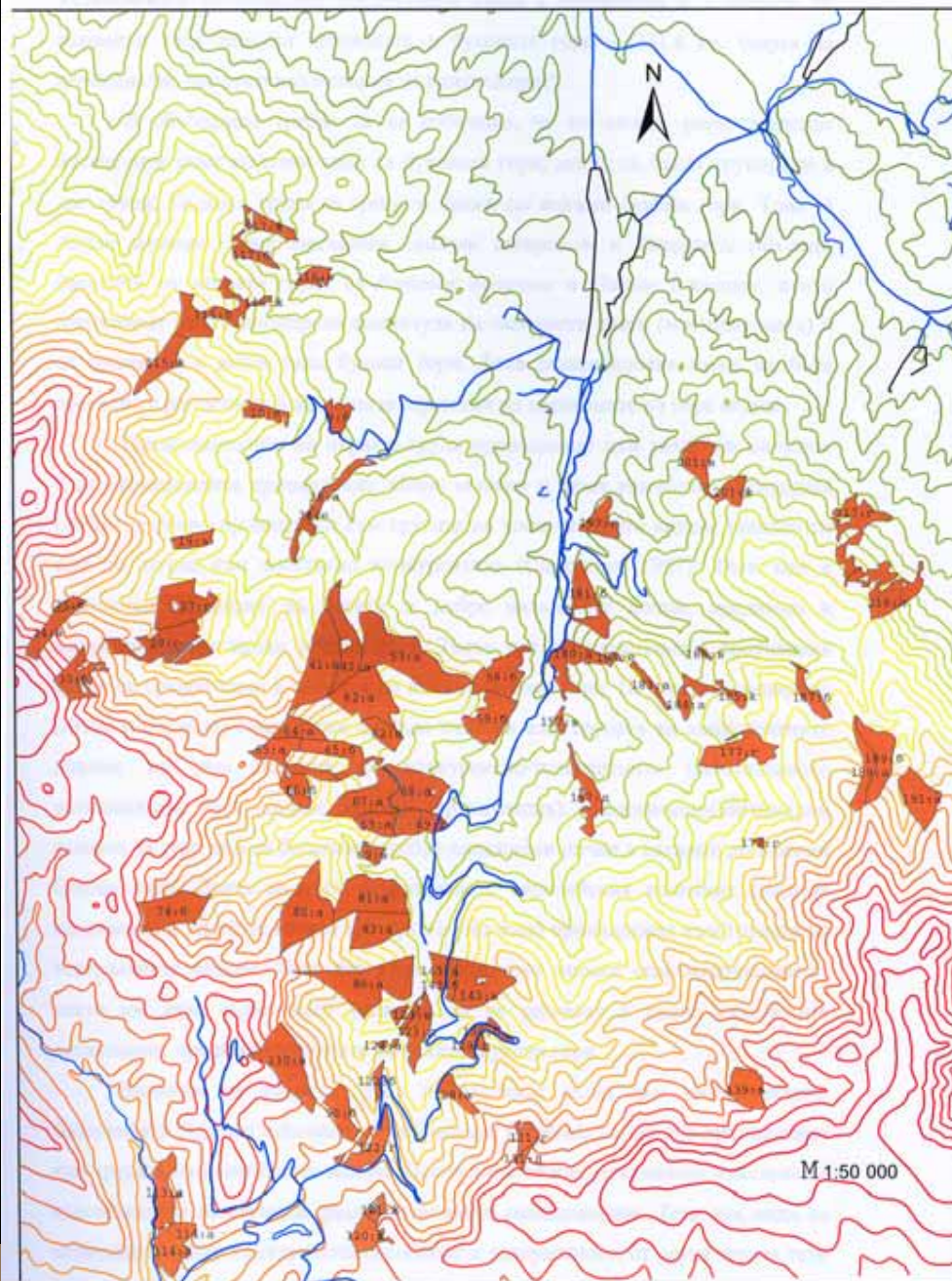
Dryopteris filix-mas is also ecologically tolerant species. PPA of this fern is the second one in the beech forests after that of *Sanicula europea* and is 771.8 ha.

Total PPA of the six species studied in the beech forests covers 3278 ha, or 61% of the pure beech formations.

Карта на потенциално продуктивните площи за
Лазаркиня (*Gallium odoratum*)



Карта на потенциално продуктивните площи за
Мъжка папрат (*Dryopterix filix-mas*)



Cutting yards and forest roads

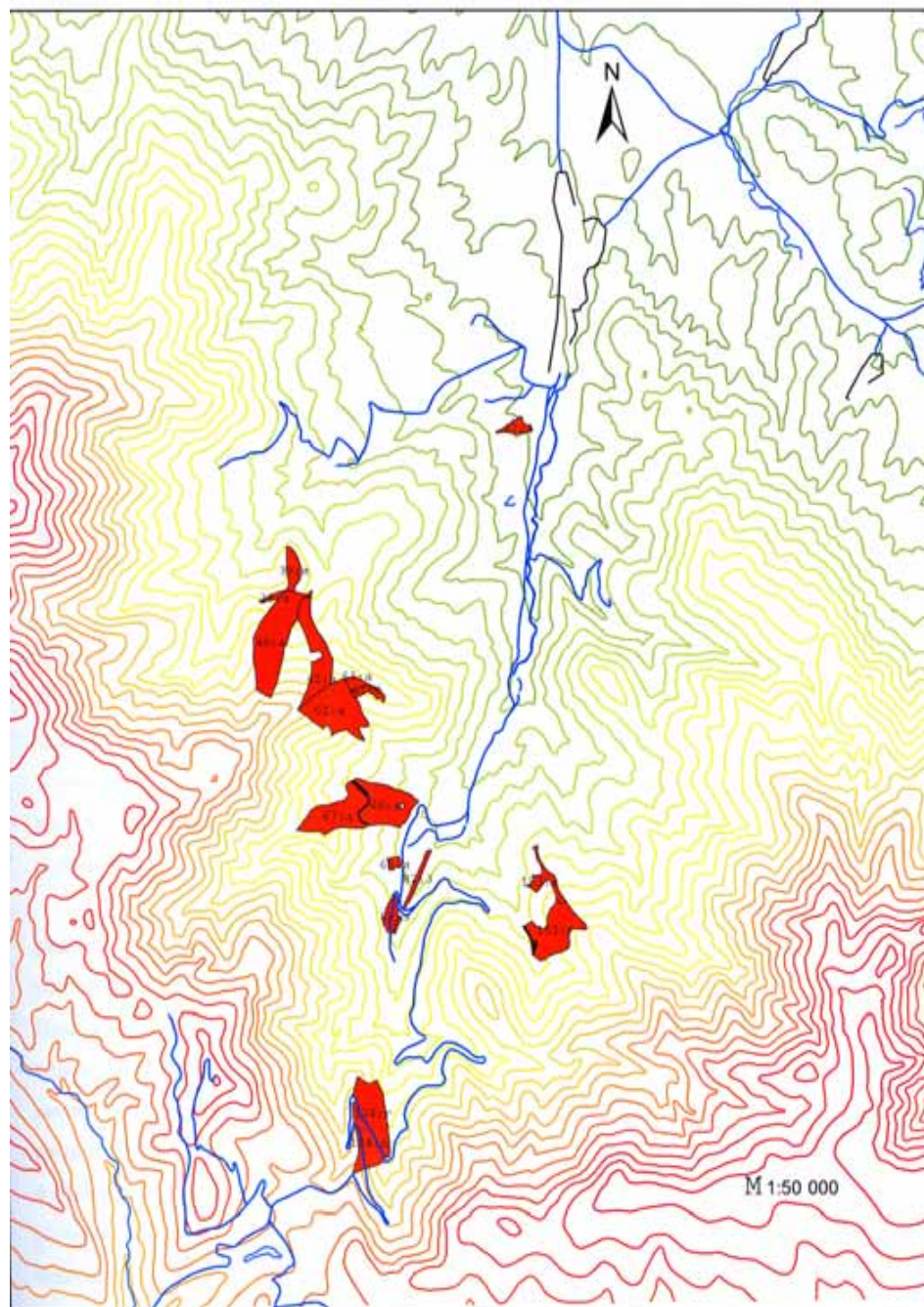


PPA of *Atropa belladonna* L. is situated mostly in the clearing spots resulting of fallen trees or of thinning activities. The effective PPA is 103 ha, or 2/3 of potential PPA (153.6 ha).

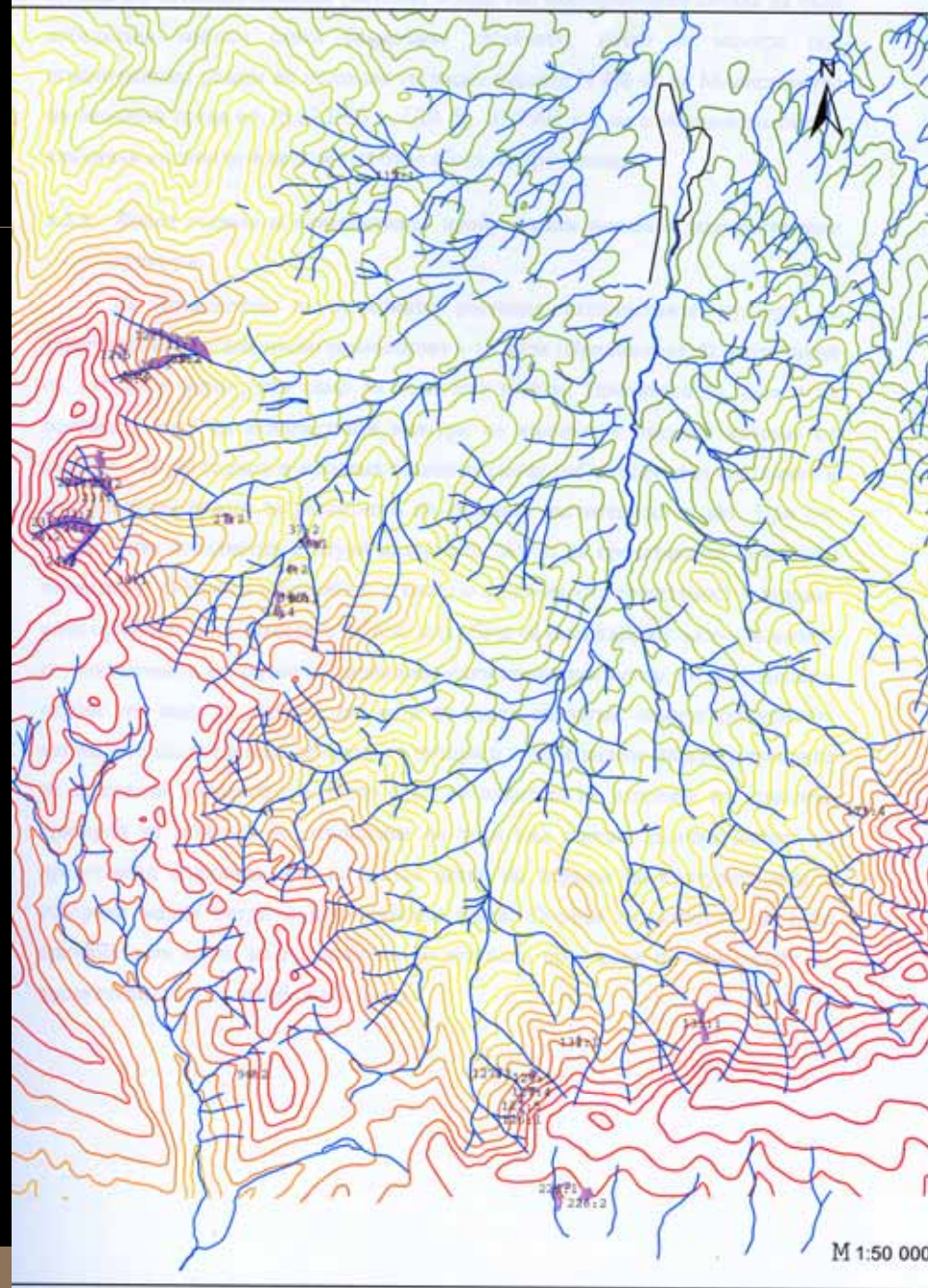


The raspberry (*Rubus idaeus*) grow along the forest roads and on cutting yards. The PPA of this species in the beech forests is 39.4 ha.

Карта на потенциално продуктивните площи за
Лудо биле (*Atropa beladonna*)



Карта на потенциално продуктивните площи
Обикновен здравец (*Geranium macrorhizum*)





**Wet habitats
along the rivers,
stone formations
(22 species)**

**Model species -
*Geranium
macrorrhizum* L.**

PPA - 37.4 ha.



Model species — *Hypericum perforatum*, represented by two types of localities — on the forest meadows and on the cutting yards. PPA covers 96.4 ha.

Effective PPA of the species in the beech forests – three groups:

- 7 Very high effective PPA - *Sanicula europaea*, *Galium odoratum*;
- 7 Very low effective PPA - *Allium ursinum*, *Geranium macrorrhizum*
- 7 Moderate effective PPA – the remaining species.

High-mountain meadows above the alpine timber line, coniferous stands and sub-alpine pastures.

7 Formation of *Juniperus sibirica*

7 Formation of *Vaccinium myrtillus*

7 Formation of *Vaccinium vitis-idaea*

7 Formation of *Fagus sylvatica*

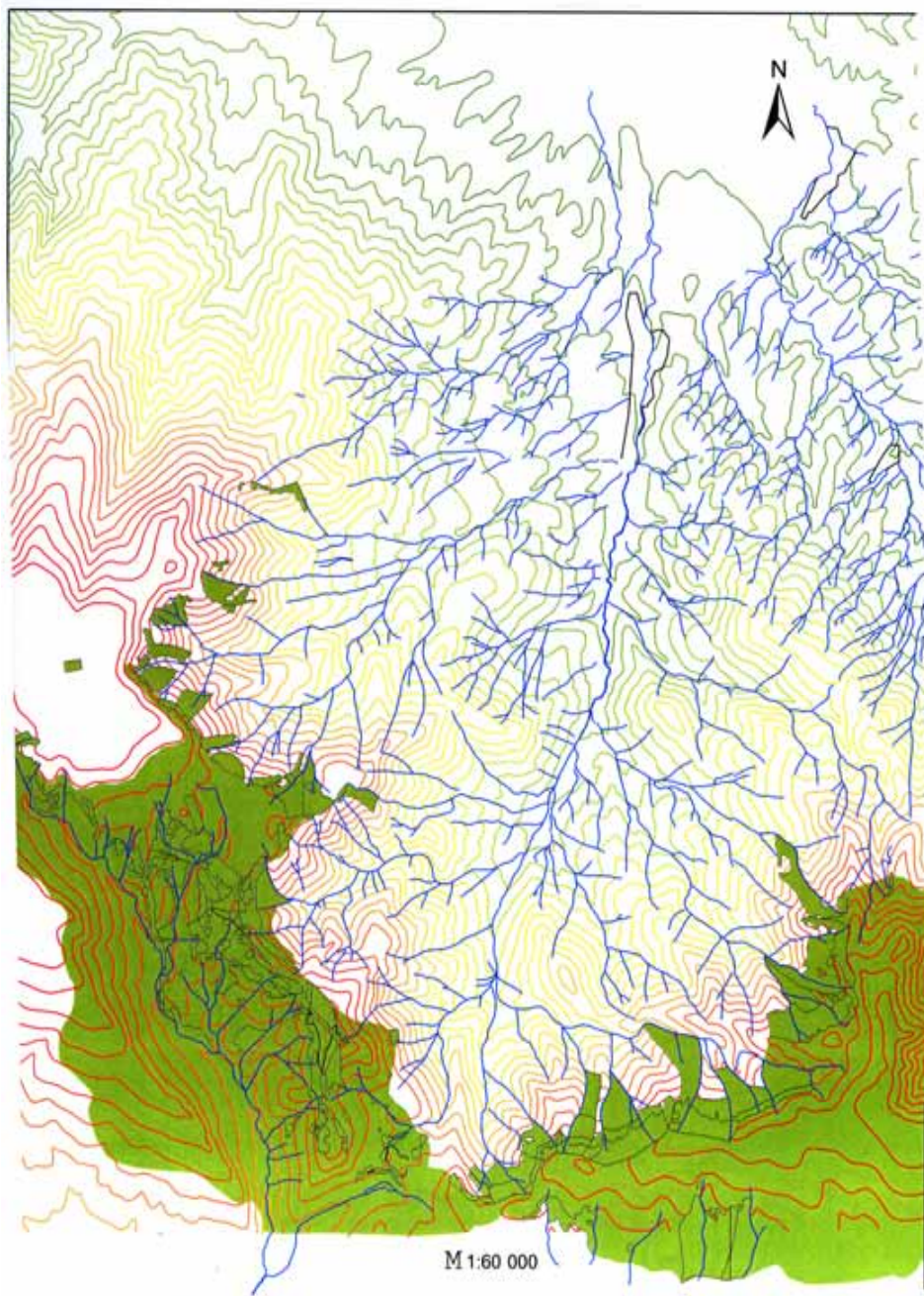
Total PPA of *Vaccinium myrtillus* is large and covers 1530 ha. The species occurrence differs in the different plant associations.



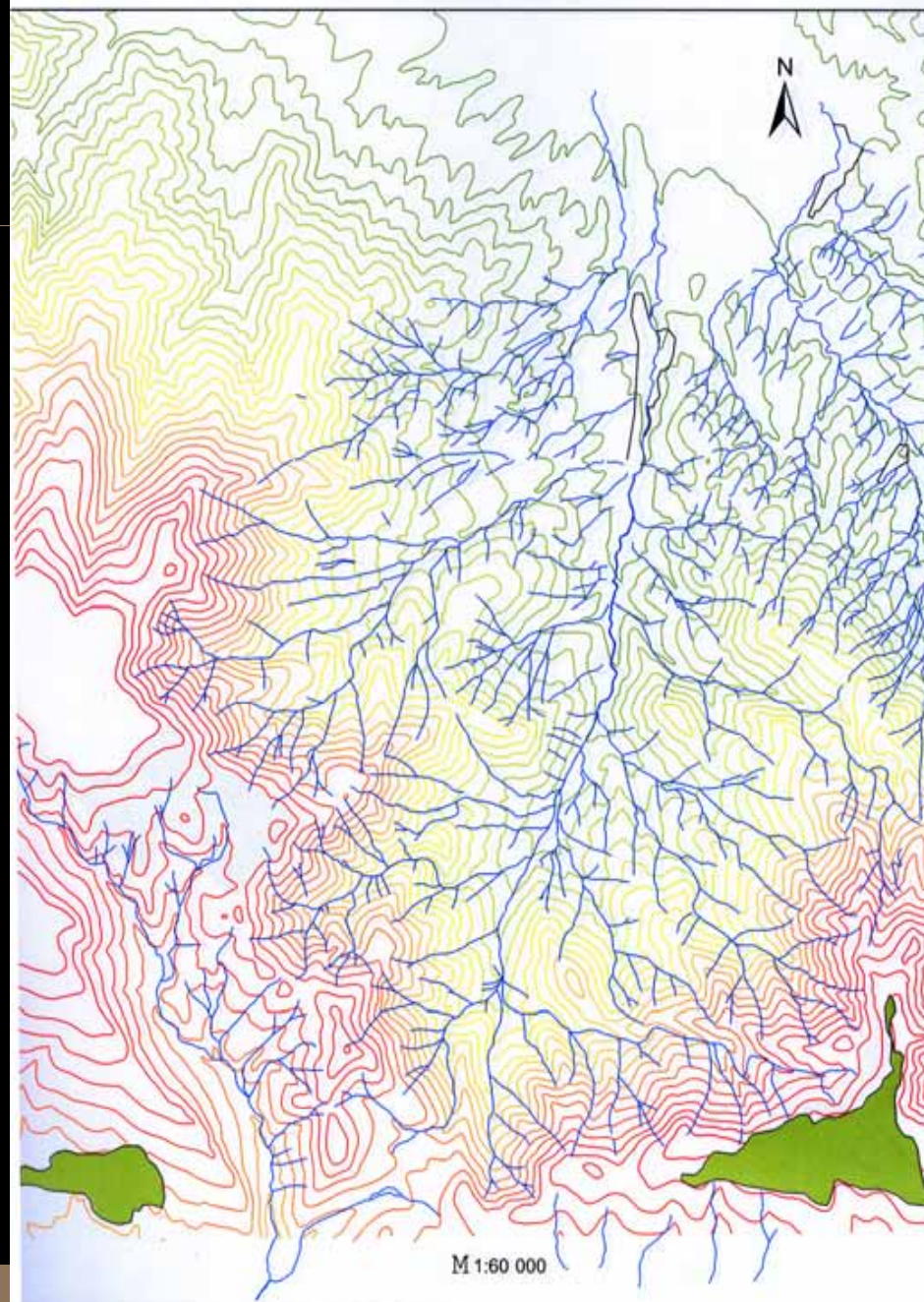
Vaccinium vitis-idaea is characterized by considerably low PPA - 120 ha.



Карта на потенциално продуктивните площи за
Черна боровинка (*Vaccinium myrtillus*)



Карта на потенциално продуктивните площи за
Червена боровинка (*Vaccinium vitis-idaea*)



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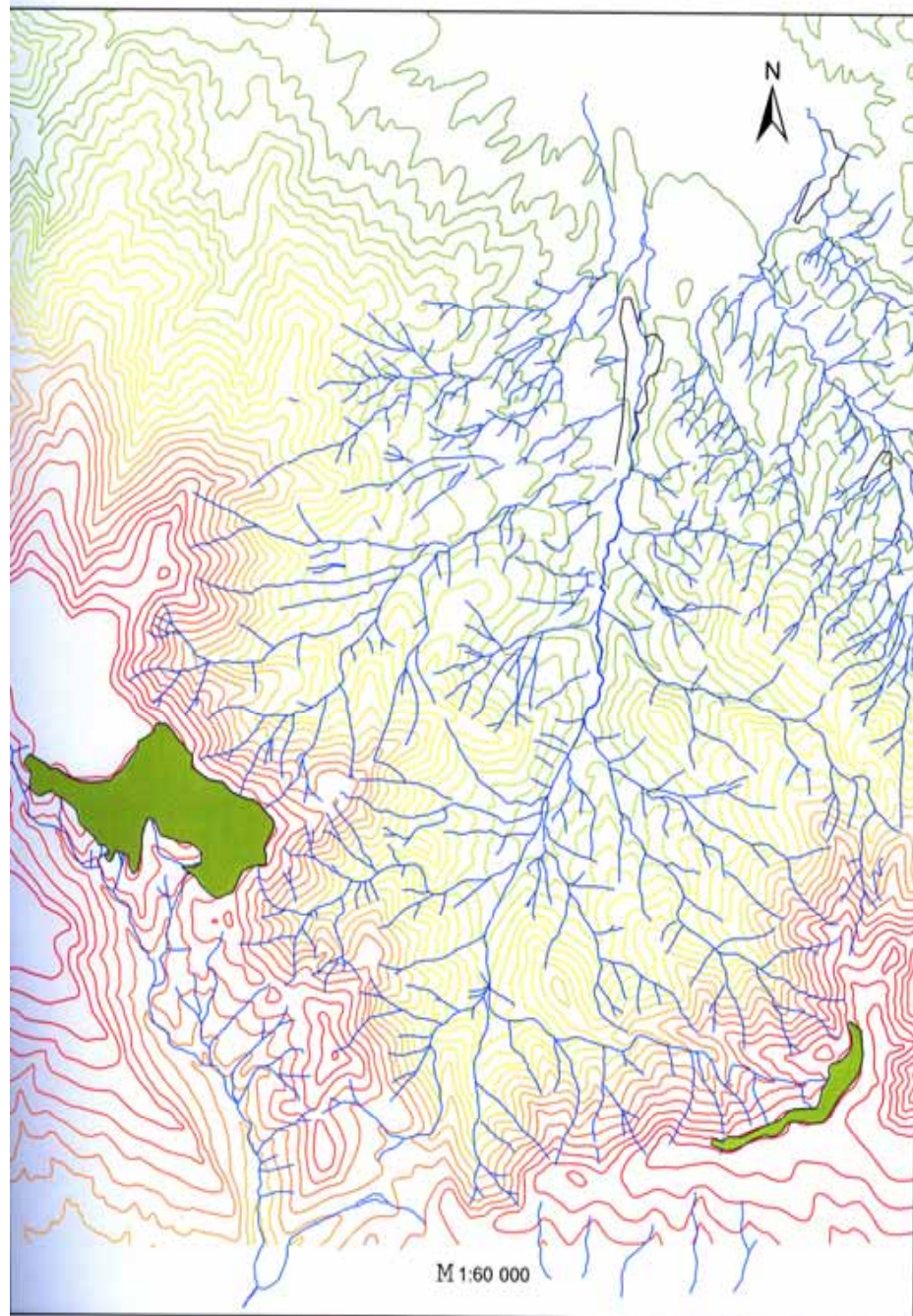


PPA of *Digitalis grandiflora* is
93 ha,

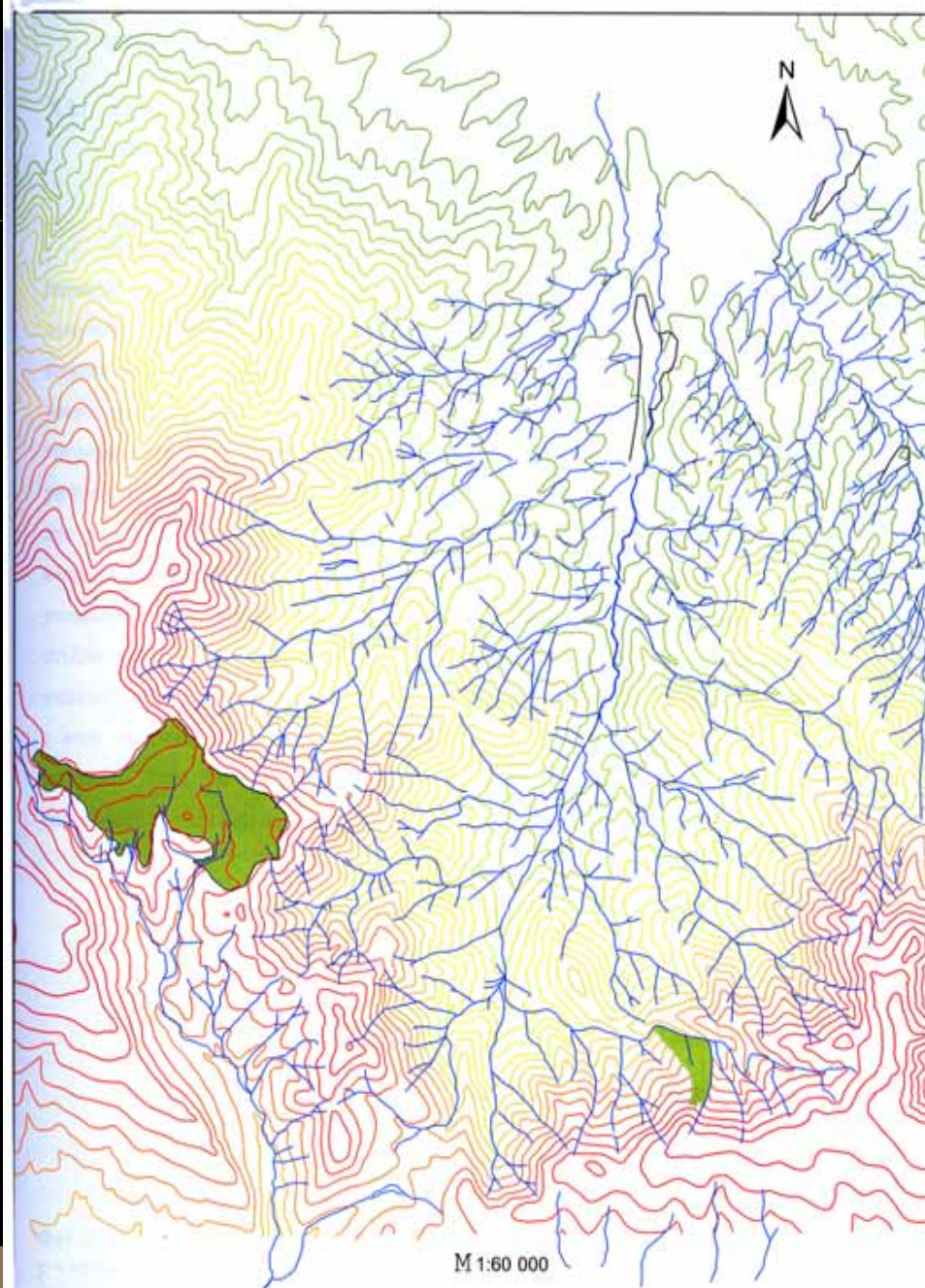


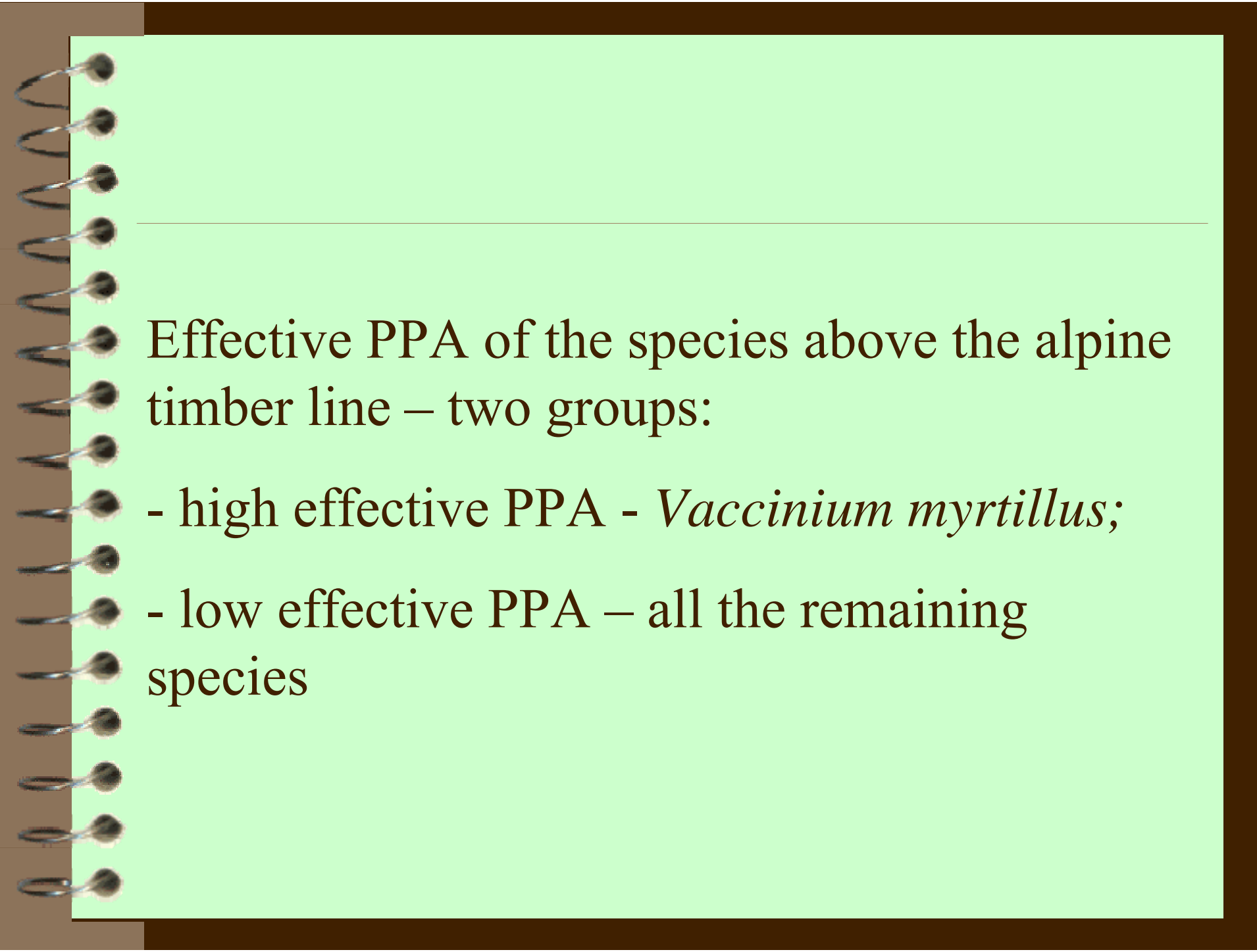
...and that of *Gentiana asclepiadea* -
123 ha.

Карта на потенциално продуктивните площи за
Едроцветен напръстник (*Digitalis grandiflora*)



Карта на потенциално продуктивните площи за
Горска тинтява (*Gentiana asclepiadea*)



A graphic of a spiral-bound notebook with a light green cover and a silver metal spiral binding on the left side. The notebook is open to a page with a light green background. A horizontal line is drawn across the page, approximately one-third of the way down from the top. The text is written in a dark brown, serif font.

Effective PPA of the species above the alpine timber line – two groups:

- high effective PPA - *Vaccinium myrtillus*;
- low effective PPA – all the remaining species

RAW MATERIAL PRODUCTIVITY

Species	Raw material	Average productivity
<i>Allium ursinum</i>	Stems	837 g/m ²
<i>Arum maculatum</i>	Bulbs	2.48 g/25 m ²
<i>Asarum europaeum</i>	Leaves	2.61 g/m ²
<i>Dryopteris filix-mas</i>	Rhizomes	1.76 g/25 m ²
<i>Galium odoratum</i>	Stems	3.97 g/m ²
<i>Sanicula europaea</i>	Stems	2.1 g/m ²
<i>Sanicula europaea</i>	Rhizomes	3.48 g/m ²



<i>Atropa belladonna</i>	Leaves	0.7 g/m ²
<i>Rubus idaeus</i>	Leaves	2.72 g/m ²
<i>Rubus idaeus</i>	Fruits	30.3 g/m ² .
<i>Geranium macrorrhizum</i>	Stems	217.6 g/m ²
<i>Hypericum perforatum</i>	Stems	9.55 g/m ²
<i>Vaccinium myrtillus</i>	Fruits	21g/m ²
<i>Vaccinium vitis-idaea</i>	Fruits	11.8 g/m ²
<i>Vaccinium vitis-idaea</i>	Leaves	23.2 g/m ²
<i>Digitalis grandiflora</i>	Stems	44.76 kg/25m ²
<i>Gentiana asclepiadea</i>	Stems	17.3 g/m ²

Recommendations for sustainable management

Species	Stock [kg/ha]	Rotation period	Norms
<i>Allium ursinum</i>	18.95	-	No use
<i>Arum maculatum</i>	11.75	4 years	50 %
<i>Asarum europaeum</i>	0.941	6 years	30 %
<i>Dryopteris filix- mas</i>	17.41	5-7 years	70 %
<i>Galium odoratum</i>	0.89	1 year	75 %
<i>Sanicula europaea</i> (stems)	2.06	2 years	75 %
<i>Sanicula europaea</i> (rhizomes)	3.65	3-4 years	50 %
<i>Atropa belladonna</i>	11.18	2 years	80 %

Recommendations for sustainable management (continued)

<i>Rubus idaeus</i> (leaves)	1.988	2 years	70-80 %
<i>Rubus idaeus</i> (fruits)	25.24	Each year	100 %
<i>Geranium macrorrhizum</i>	1.55	-	No use
<i>Hypericum perforatum</i>	6.33	2 years	80 %
<i>Vaccinium myrtillus</i>	14.5	Each year	100 %
<i>Vaccinium vitis-idaea</i>	2.8	Each year	100 %
<i>Digitalis grandiflora</i>	4.82	2-3 years	70 %
<i>Gentiana asclepiadea</i>	9.05	3 years	70 %

Effect of forest management practices on the distribution and productivity of MAPs.

- 7 Specific effect of the different forest management systems on the diversity and stock of MAPS. The effect strongly depends on two factors: 1) the species and its ecological requirements and 2) stand characteristics of the habitat.
- 7 The most friendly management system is the group shelterwood system and group selection system because the diversity of MAPs after their application is higher and the effect of these systems last for a shorter period.

Nature conservation importance of the beech forests regarding the MAPs

- 7 Two of the most typical habitats in the beech forests studied are included in the Habitat Directive 92/43/EEC and NATURA 2000.
- 7 Almost 50 % of the MAPs established in the region of study are subjected to a quota system of use. Most of these species are typical for the beech forests.

A graphic of a spiral-bound notebook with a brown cover and a light green page. The spiral binding is on the left side. A thin horizontal line is drawn across the page, just above the text. The text "Thank you for your attention!" is centered on the page in a dark brown, serif font.

Thank you for your attention!