Working Paper

Small Siberian Forest Atlas

S.Nilsson, A.Shvidenko and K.Blauberg

Editors

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Contents

Foreword

This is the time Siberia's forest sector has recently gained considerable international interest. IIASA, the Russian Academy of Sciences, and the Russian Federal Forest Service, in agreement with the Russian Ministry of the Environment and Natural Resources, signed agreements in 1992 and 1994 to carry out a large-scale study on the Siberian forest sector. The overall objective of the study is to focus on policy options that would encourage sustainable development of the sector. The goals are to assess Siberia's forest resources, forest industries, and infrastructure; to examine the forests' economic, social, and biospheric functions; with these functions in mind, to identify possible pathways for their sustainable development; and to translate these pathways into policy options for Russian and international agencies.

The first phase of the study concentrated on the generation of intensive and consistent databases for the total forest sector of Siberia and Russia. The study has now moved into its second phase, which encompasses assessment studies of the greenhouse gas balances, forest resources and forest utilization, biodiversity and landscapes, non-wood products and functions, environmental status, transportation infrastructure, forest industry and markets, and socio-economic problems. This report, by the Study's core-team, is a study with bearing on several of the above-mentioned quantitative assessment studies.

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1. Introduction

The IIASA Siberian Forest Study has developed an ecoregional database for Russia and Siberia. The basic data have been collected by the IIASA core-team (S. Nilsson, A. Shvidenko and K. Blauberg) and by the Russian collaborating network (group leaders are Drs. D. Efremov, P. Khomentovsky, G. Korovin, V. Roshkov, V. Sedykh, V. Sokolov, V. Strakhov and A. Sheingauz)

The basic unit of the database is a so-called ecoregion. There are 167 ecoregions in all of Russia, of which 65 are in Siberia and the Far East. Currently, the complete data set is only available for Siberian ecoregions.

The ecoregions were established according to the following rules:

- An ecoregion should include an area relevant for the evaluation of sustainable regional biosphere development. Biological indicators, such as net primary productivity, phytomass density, etc., should be similar.

- Climatic and forest growth conditions should be homogeneous enough to provide homogeneity of forest vegetation (similar species composition, forest types and productivity). Ecoregions are contained within single forest vegetation provinces and correspond with climatic and vegetation subzones (according to Kurnaev 1973).

- Mountainous and flat lands are separated.

- The level and nature of anthropogenic influences and disturbances are similar.

- Boundaries of ecoregions have to coincide with the boundaries of included Forest Enterprises, and not cross the boundaries of administrative units (oblast, kraj, etc.) so that aggregations by administrative regions (oblast, kraj, etc.) are possible.

The ecoregional database is further described by Shvidenko and Raile (1996). It is a component of a major database system developed by the study's core-team at IIASA and to this overall system is also a GIS-component linked.

The objective of this report is to illustrate some of the forest characteristics of Siberia in a map-form at an ecoregional level based on the inventory from 1993. The mapping work by the GIS-system developed within the study was carried out by Olga Rigina (Russia) and Eva Rovainen (Sweden) during their stay at IIASA in the summer of 1995 under the supervision of Prof. Peter Duinker (Canada).

2. Definitions

A number of different forest classifications are cited in Russia and some are defined here. Forest Fund (FF) represents all forests and all land allocated for forest purposes. The Forest Fund is divided into Forest Land (FL) and Non-Forest Land (NFL). Forest Land is designated for forest growth and includes Forested Areas (FA).

Forested Areas (FA) are covered by forests with a stocking of 0.4 or more for young stands and 0.3 and more for older stands.

All forest resources are, in addition to the above classification, also divided into three groups (based on the social purposes and the utilization):

Group I   =   Protective forests that mainly fulfill environmental and social functions and with very strong limitations on the industrial harvest.

Group II   =   Mainly protective forests with restricted industrial use.

Group III   =   Forests with several functions but the major function is production of industrial wood.

3. Maps

In the following a number of selected maps of different forestry characteristics of Siberia are presented together with short comments. It should be pointed out that in this small atlas only a limited number of the different parameters of the total parameters of the database are presented. This section contains general information on Siberia (West and East Siberia, and the Far East).
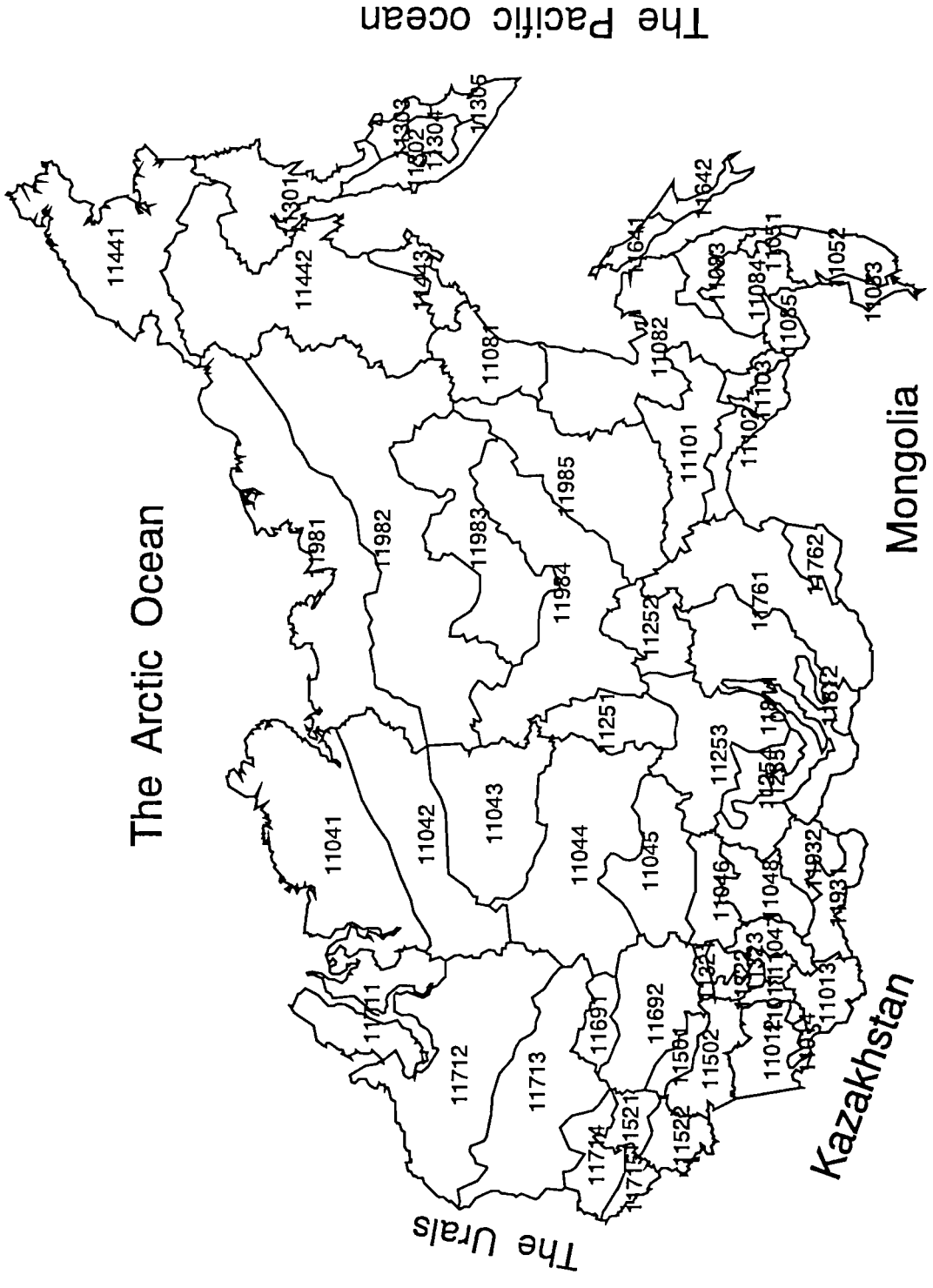
In Map 3.1 the localities of the individual ecoregions of Siberia are identified. Map 3.2 describes the ecological subzones of Siberia distributed over ecoregions. Their zonation is based on the work by Kurnaev (1973). The division between mountainous and plain areas is illustrated in Map 3.3. The classification used for the macro relief description is based on a classification developed by Shishov et al. (1985). Map 3.4 presents the state of the permafrost in Siberia. Map 3.5 presents the areas of the Forest Fund, under state forest management, which are not available for exploitation. The non-exploitable areas of the Forest Fund under state forest management include:
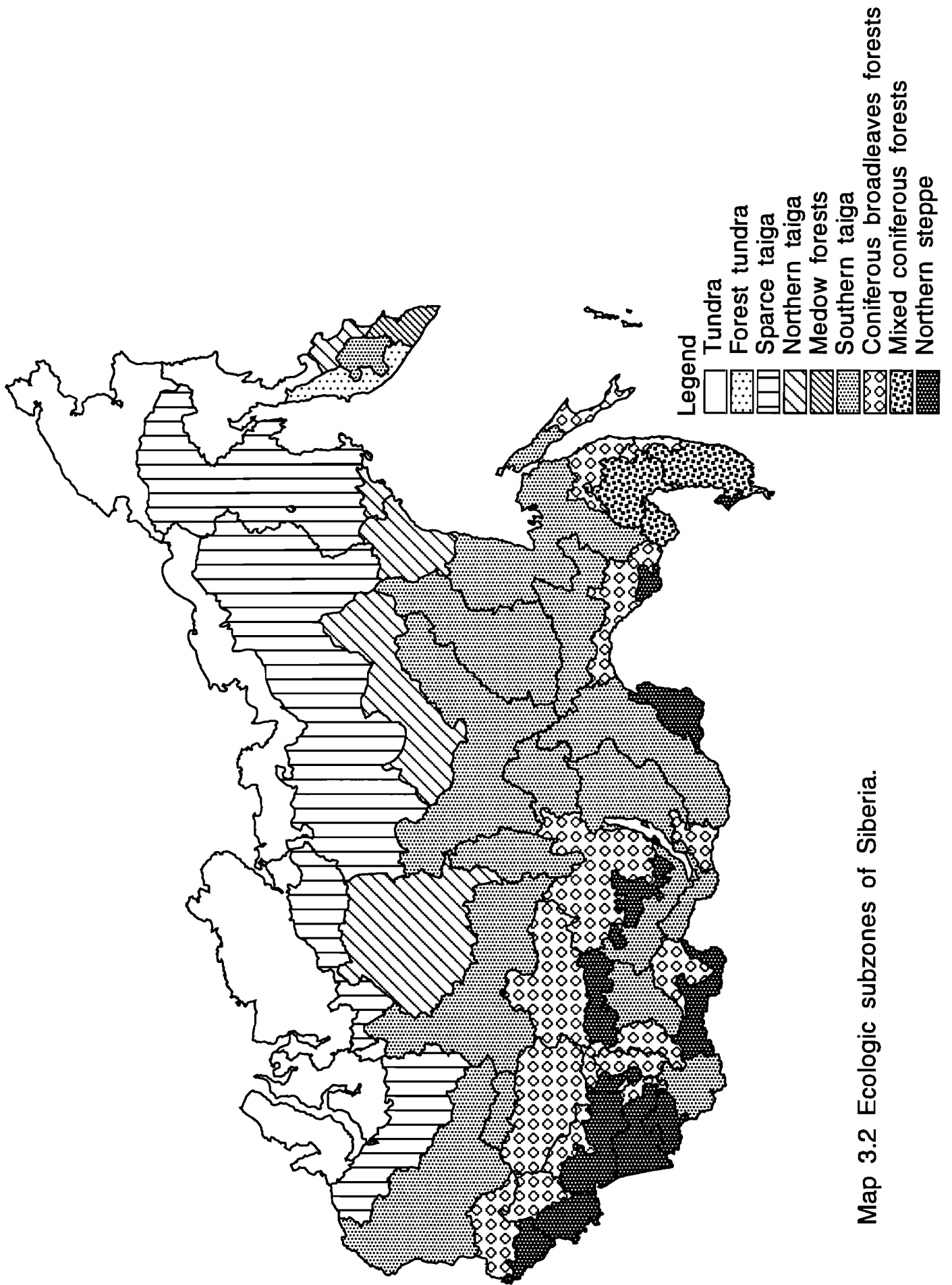
- Forests of protective categories in which final harvest is prohibited due to the current forest legislation.

- Specially protected forest areas, in which forest harvest is prohibited.

- Non-commercial tree species.

- Mature and over-mature stands with a growing stock of less than 50 m^3/ha in the Asian part of Russia, and 40 m^3/ha in the European part.

Map 3.6 shows the proportion (in percentage) of the Forest Fund, which is non-exploitable. From this map it can be seen that the dominating part of the northern taiga and substantial parts of the middle taiga are not exploitable. Map 3.7 illustrates the density of the roads within the forest sector, which include:
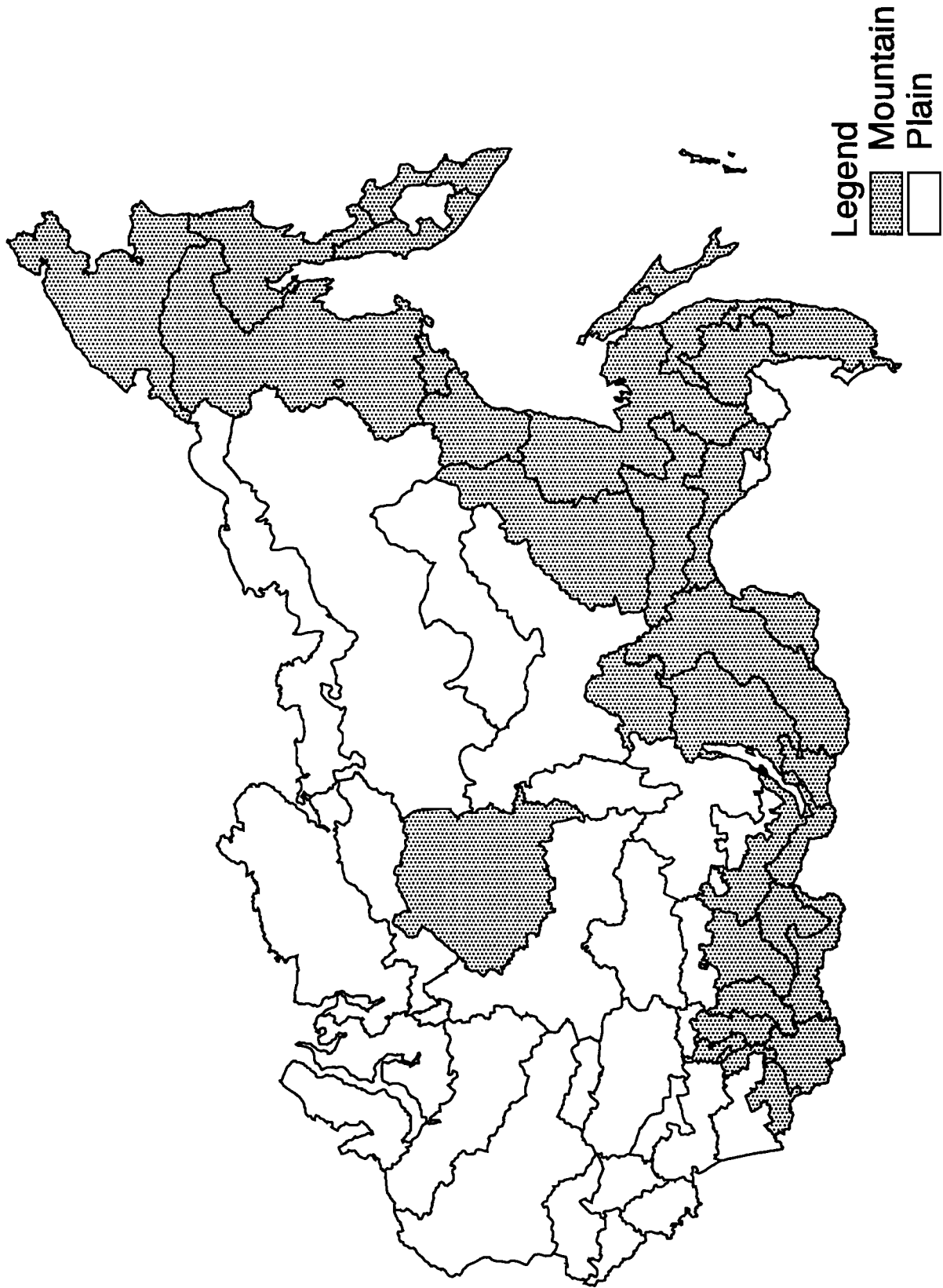
- Public roads and railways.

- Forest roads of Class I, which are main forest roads connecting forest roads of Class II and III with public roads.

- Forest roads of Class II, which are roads constructed for access to harvesting areas and roads connecting different forest areas inside a Forest Enterprise.

- Forest roads of Class III, which are roads of special purpose, like roads for fire protection.

Map. 3.1. Siberian ecoregions. Numbers represent the number of ecoregions according to IIASA's database.

Legend

Tundra
Forest tundra
Sparce taiga
Northern taiga
Medow forests
Southern taiga
Coniferous broadleaves forests
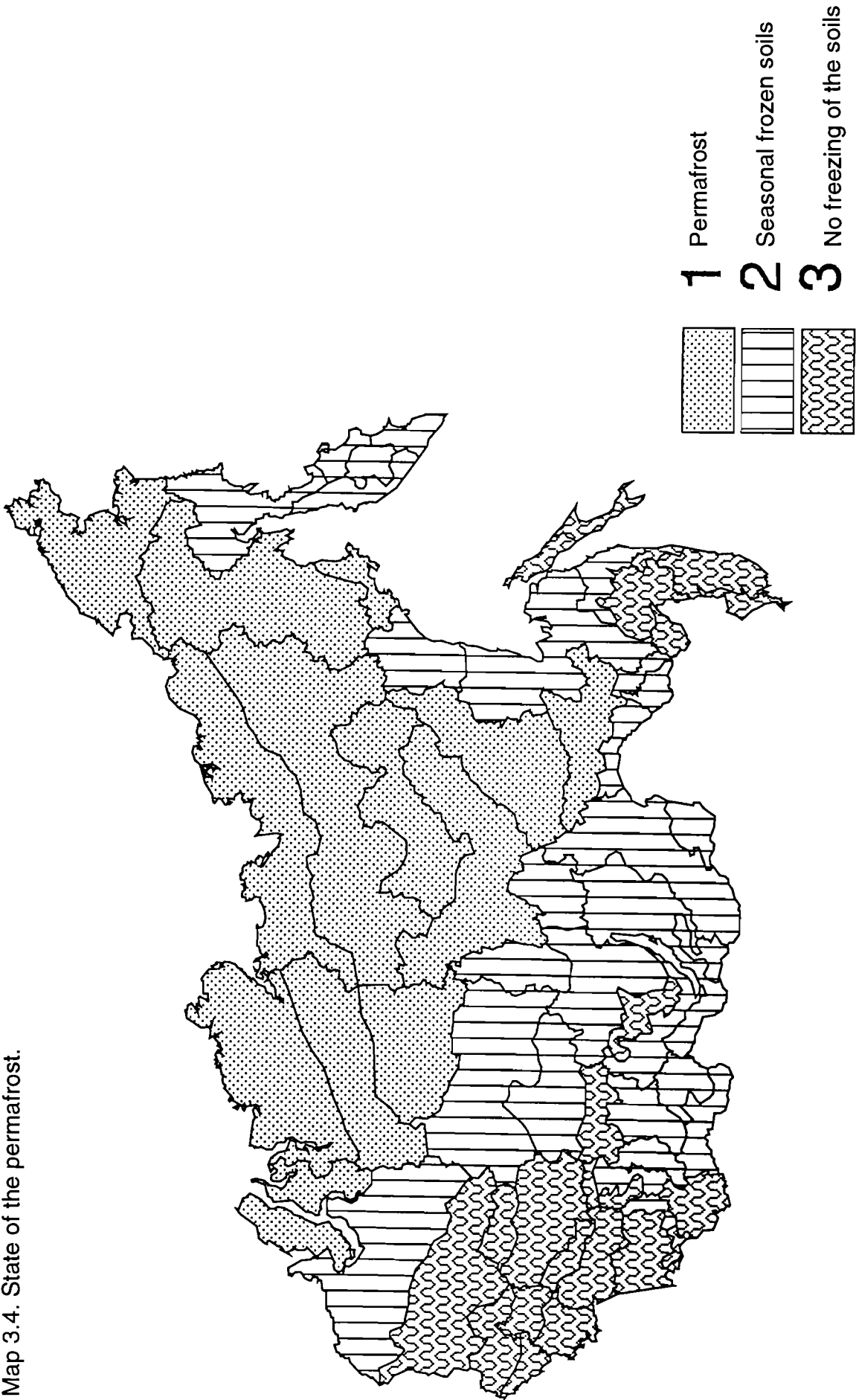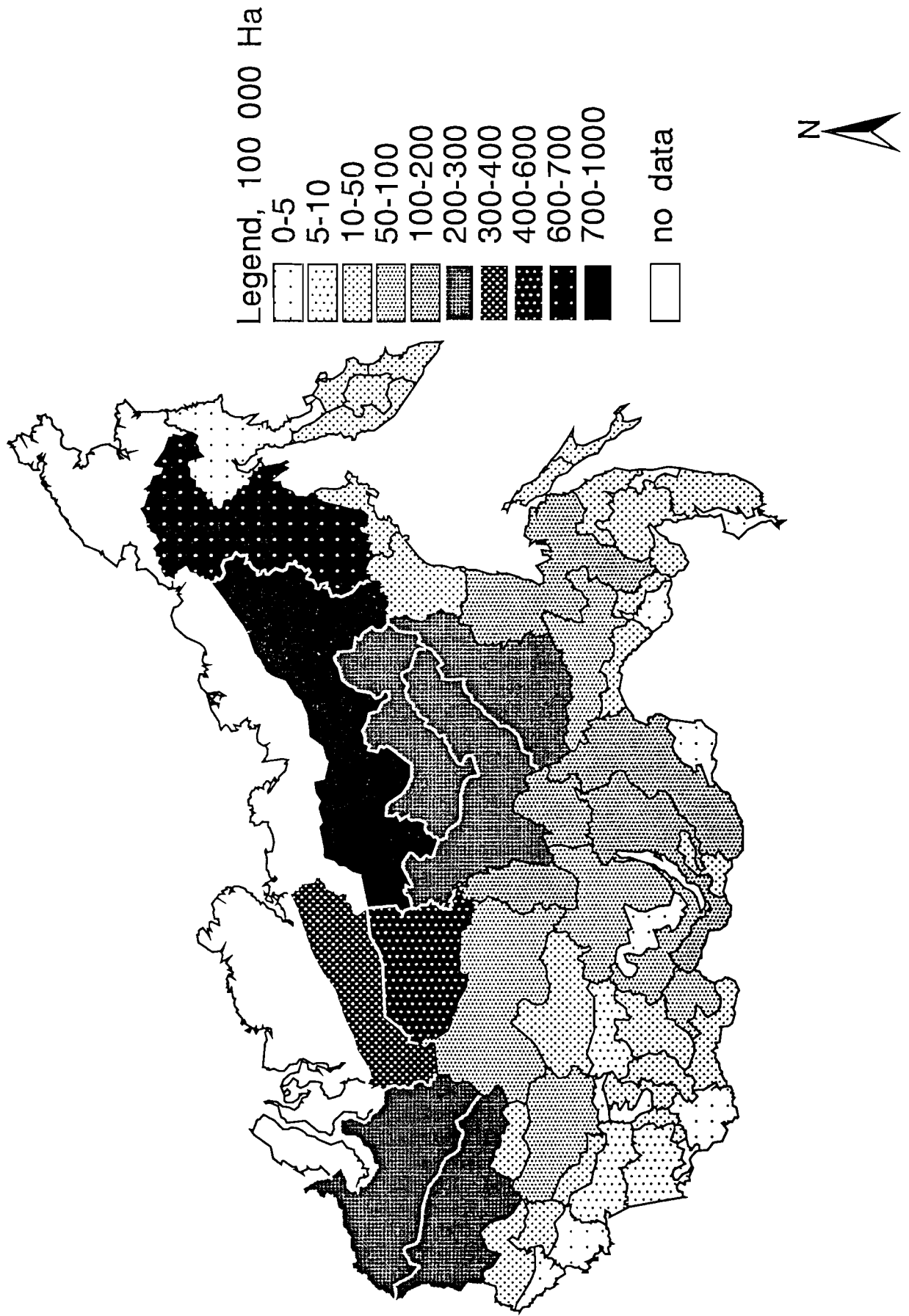Mixed coniferous forests
Northern steppe

Map 3.2 Ecologic subzones of Siberia.

Map 3.3 Description of mountainous areas and plains.

Map 3.4. State of the permafrost.

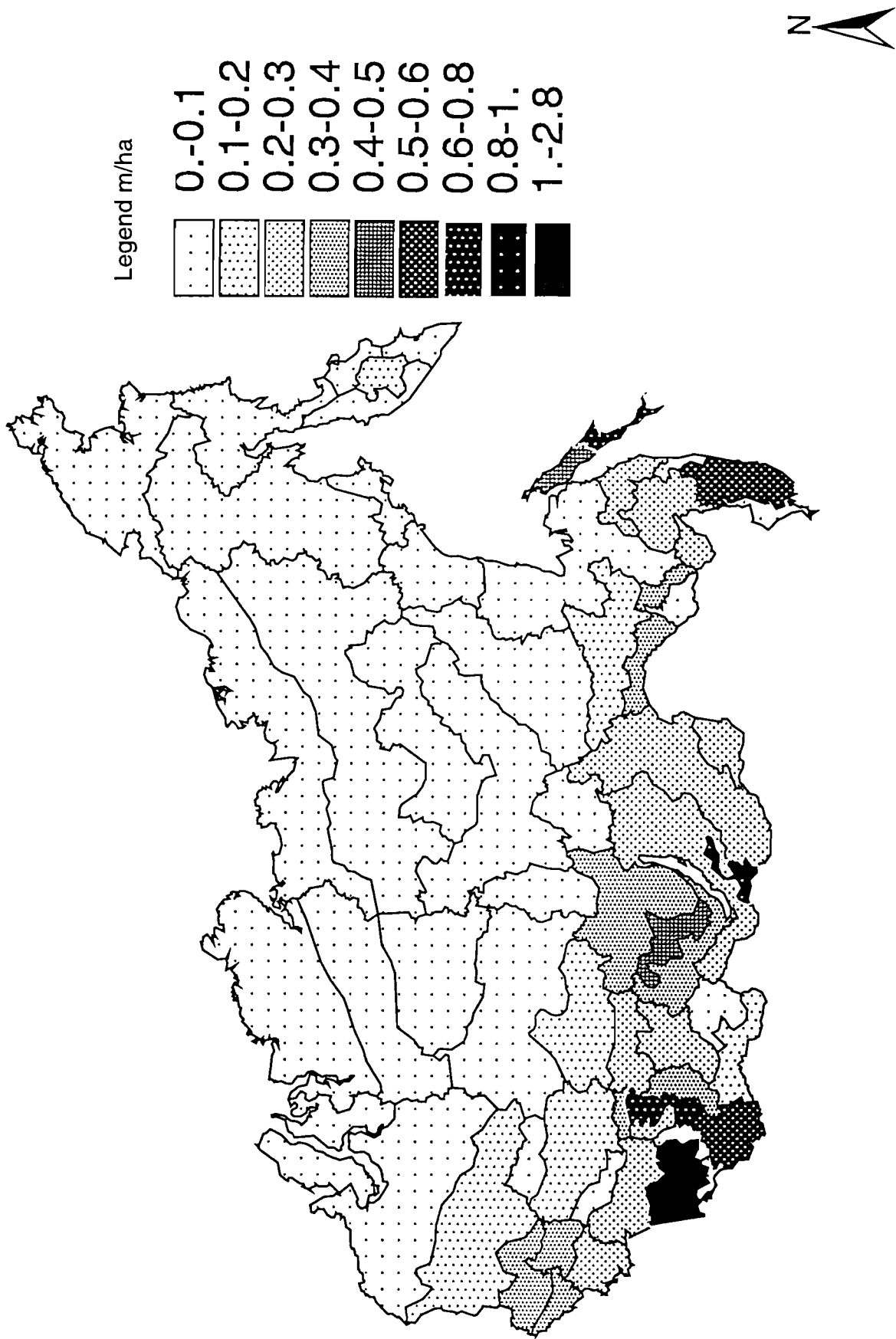

1   Permafrost

2   Seasonal frozen soils

3   No freezing of the soils

7

Map 3.5. Non-exploitable forests of the Forest Fund.

Legend, 100 000 Ha

- 0-5
- 5-10
- 10-50
- 50-100
- 100-200
- 200-300
- 300-400
- 400-600
- 600-700
- 700-1000

no data

N

8

Map 3.6. Proportion of non-exploitable areas of the Forest Fund expressed in percentage.

Ecoreg
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100

9
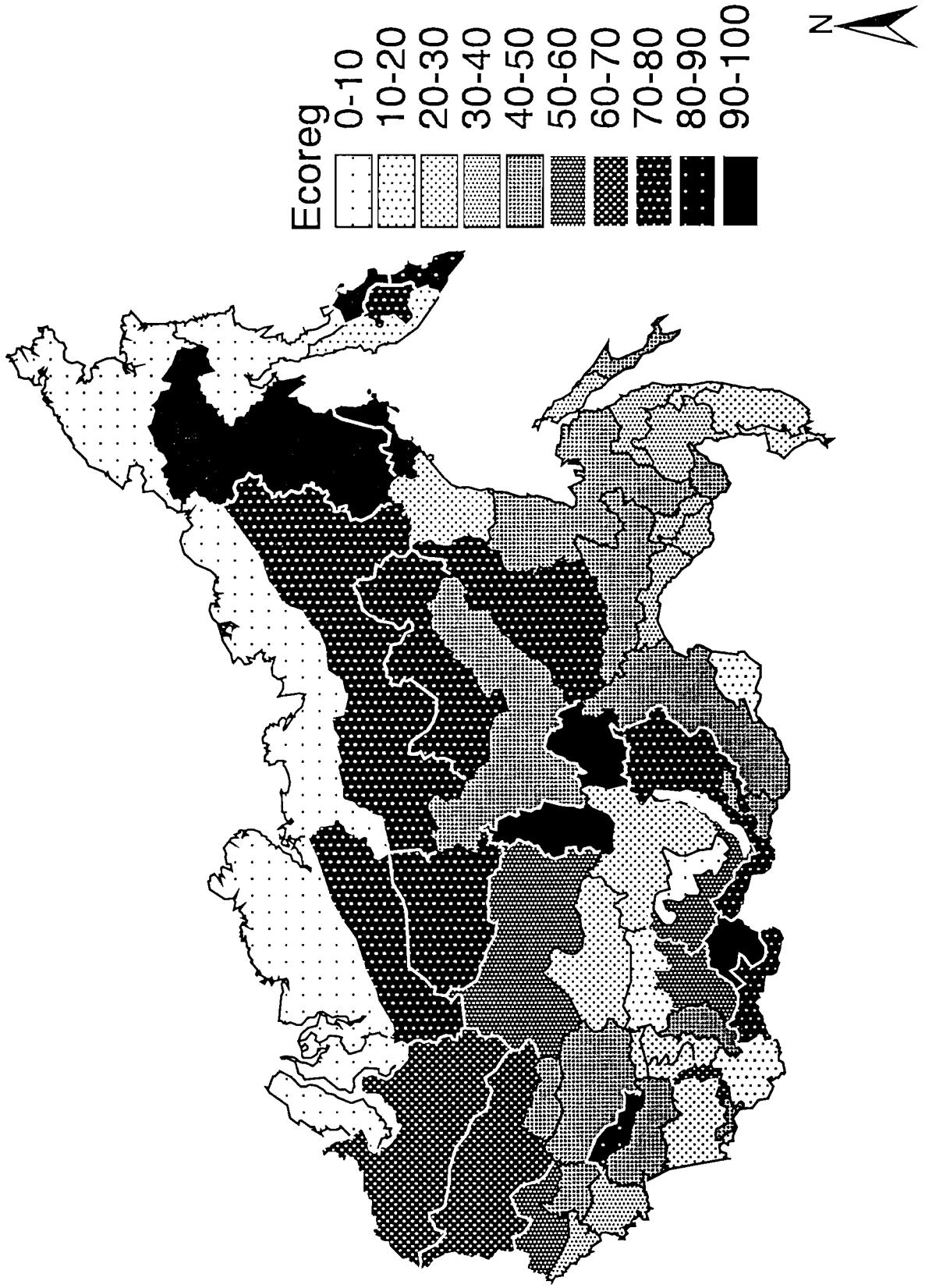
Map 3.7. Density of roads and railways of the Forest Fund.

Legend m/ha

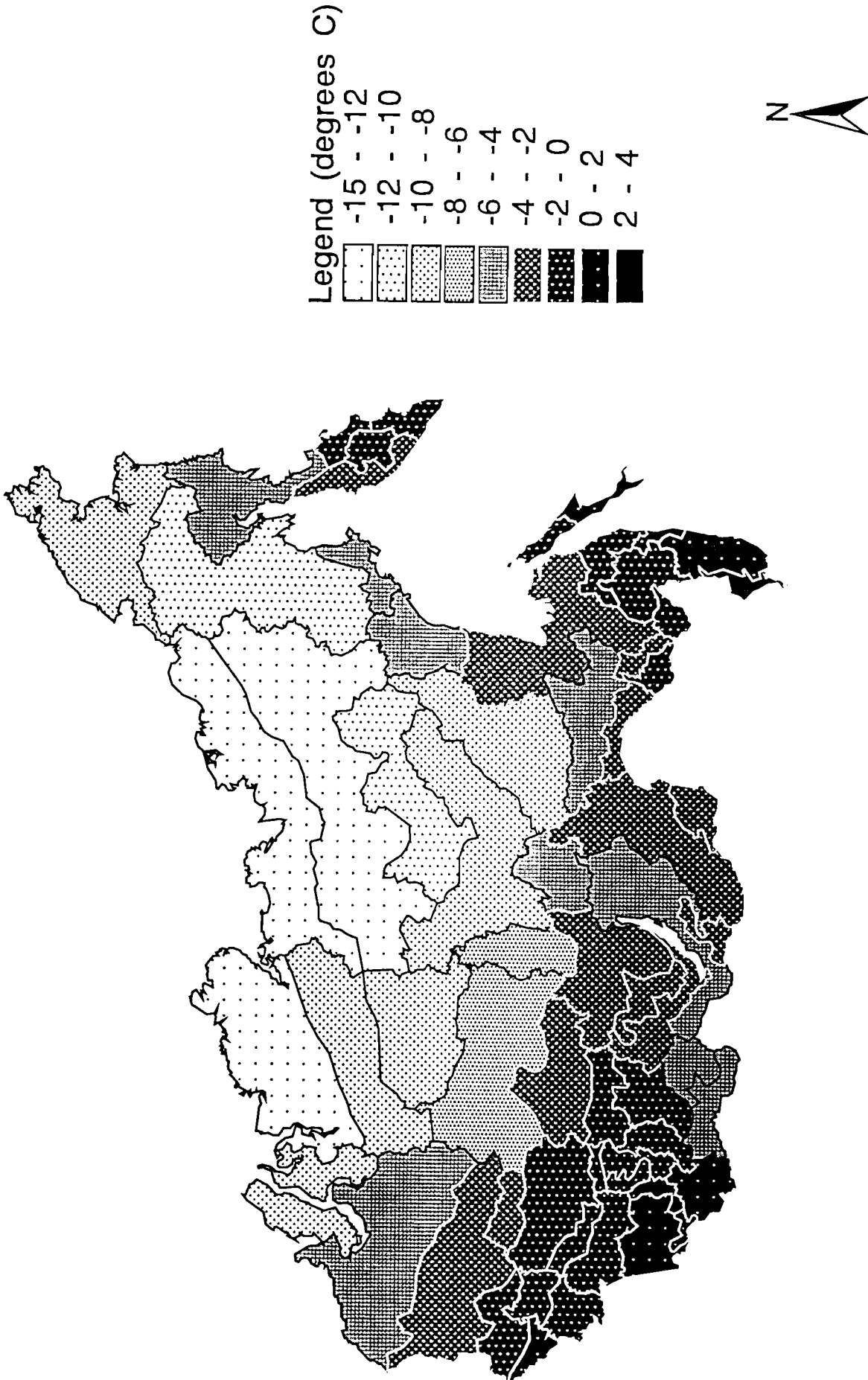|	
	0.-0.1
	0.1-0.2
	0.2-0.3
	0.3-0.4
	0.4-0.5
	0.5-0.6
	0.6-0.8
	0.8-1.
	1.-2.8

N

4. Climate Conditions

Map 4.1 shows the average annual precipitation. The highest precipitation takes place in the most southern fringes of Siberia, in the southeastern part of the Far East, and in Kamchatka. West Siberia has a medium precipitation. The northern central Siberia, on the border to the outer zone, is a dry area with an annual precipitation of 200-300 mm per year. The average annual air temperature is illustrated in Map 4.2. Map 4.3 shows the average annual soil surface temperature, which of course very well corresponds with the map of the air temperatures. From a bioproductivity point of view, the length of the vegetation period is important. Map 4.4 shows the number of days having an average air temperature exceeding 5° C. Another measure on the growth capacity is the sum of the degrees times days with an air temperature exceeding 5° C, which is illustrated in Map 4.5. Of importance is also how the precipitation is distributed within the vegetation period, which is illustrated in Map 4.6.
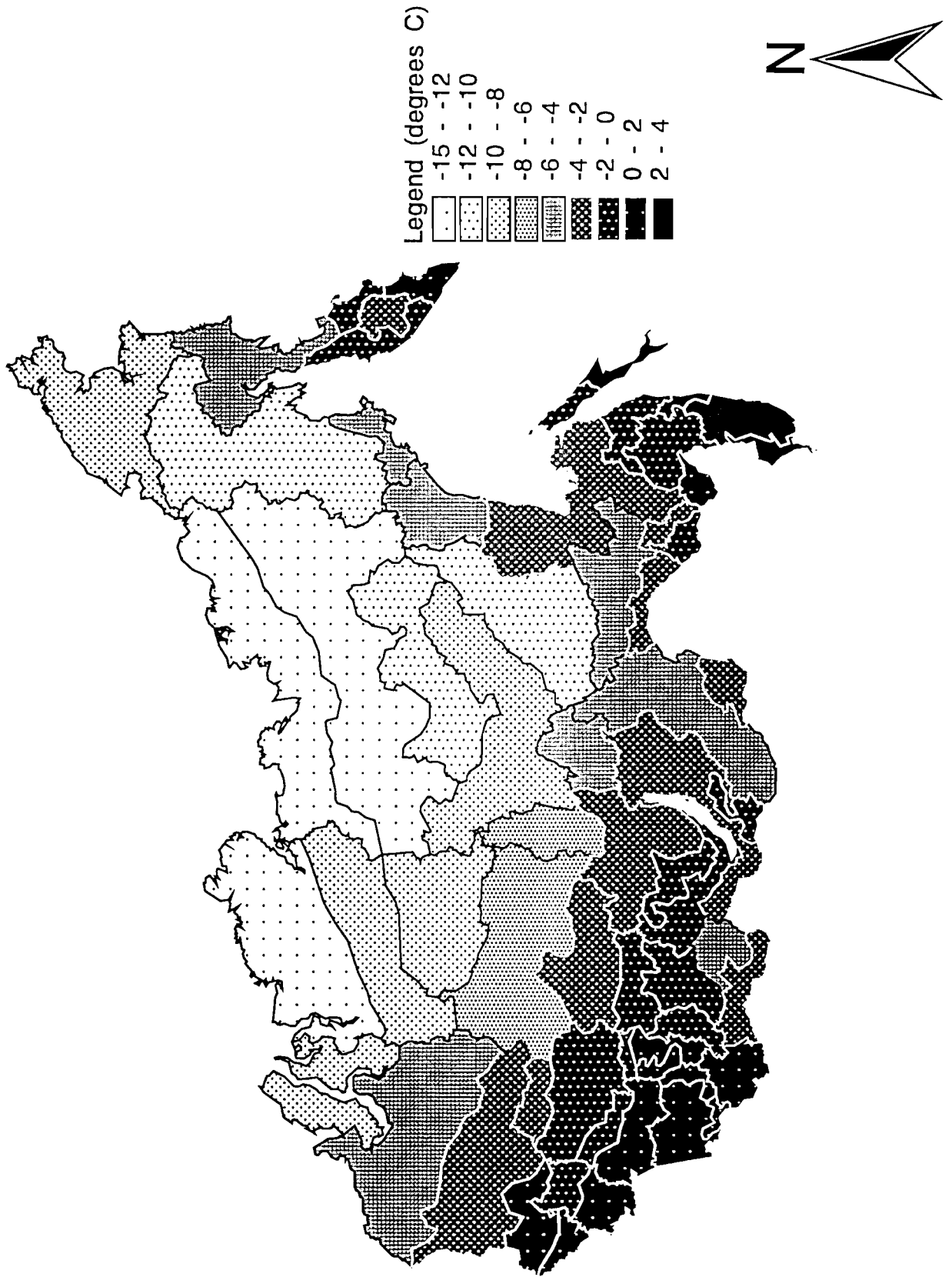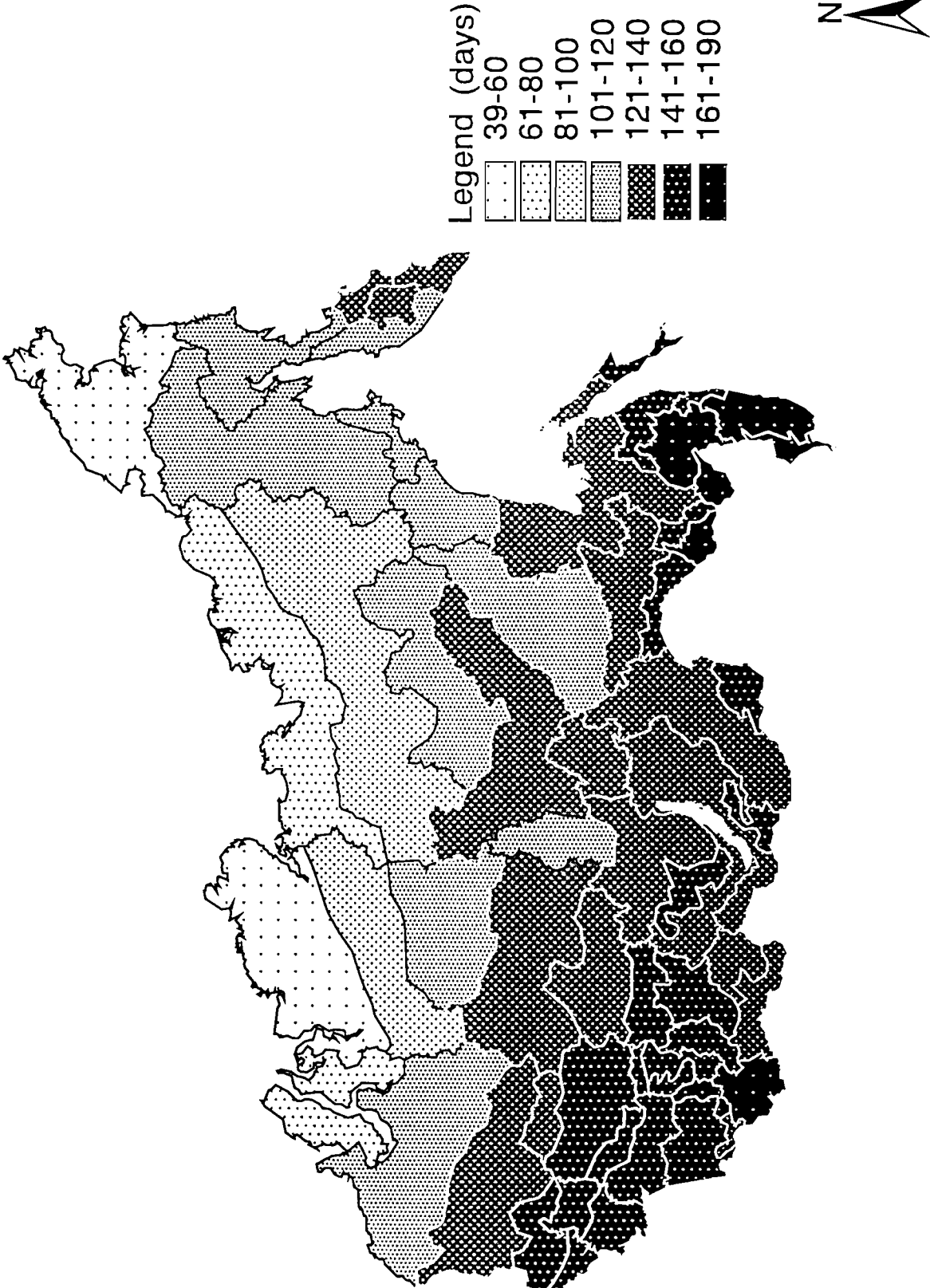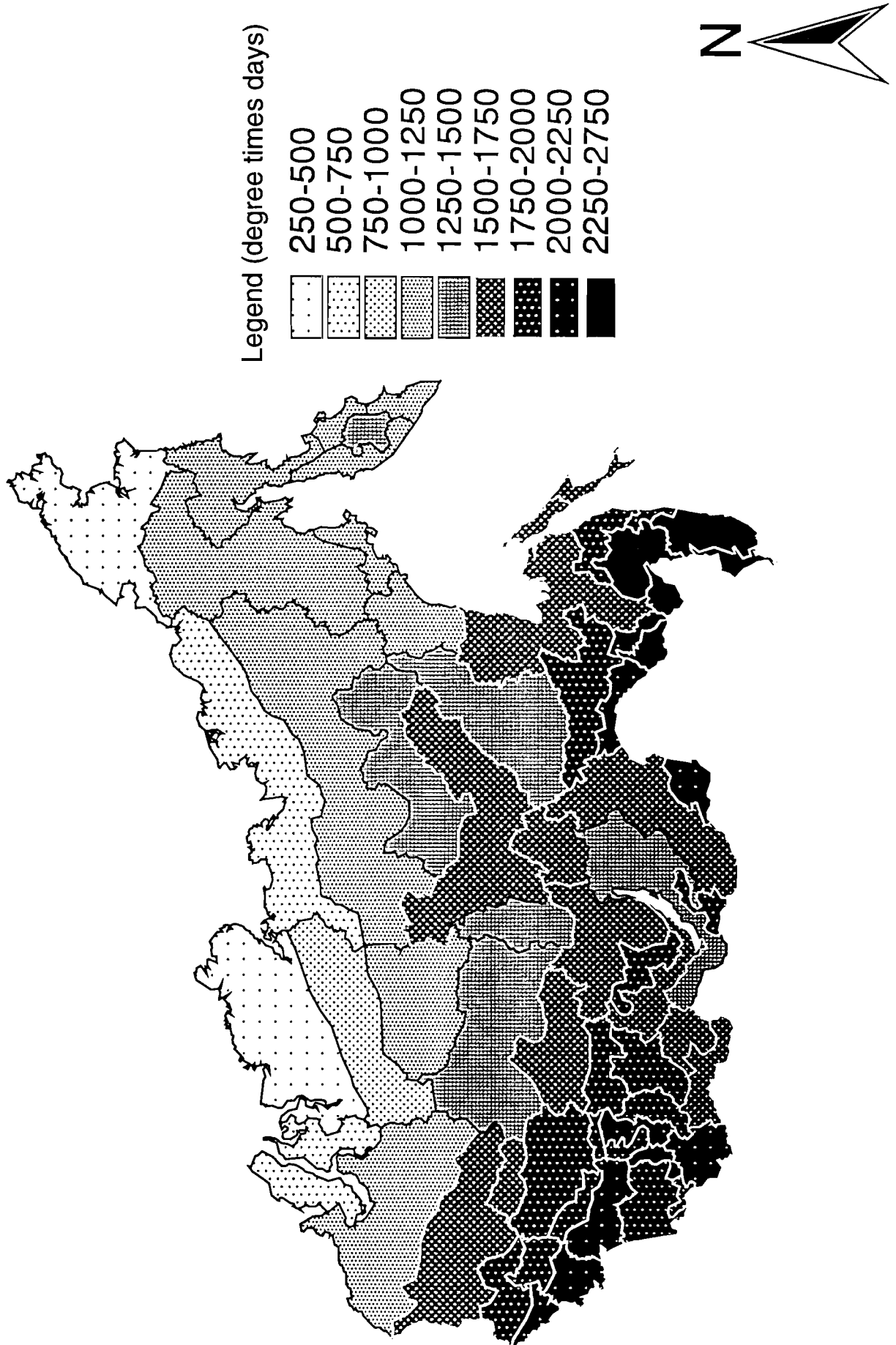
Map 4.1. Average annual total precipitation.
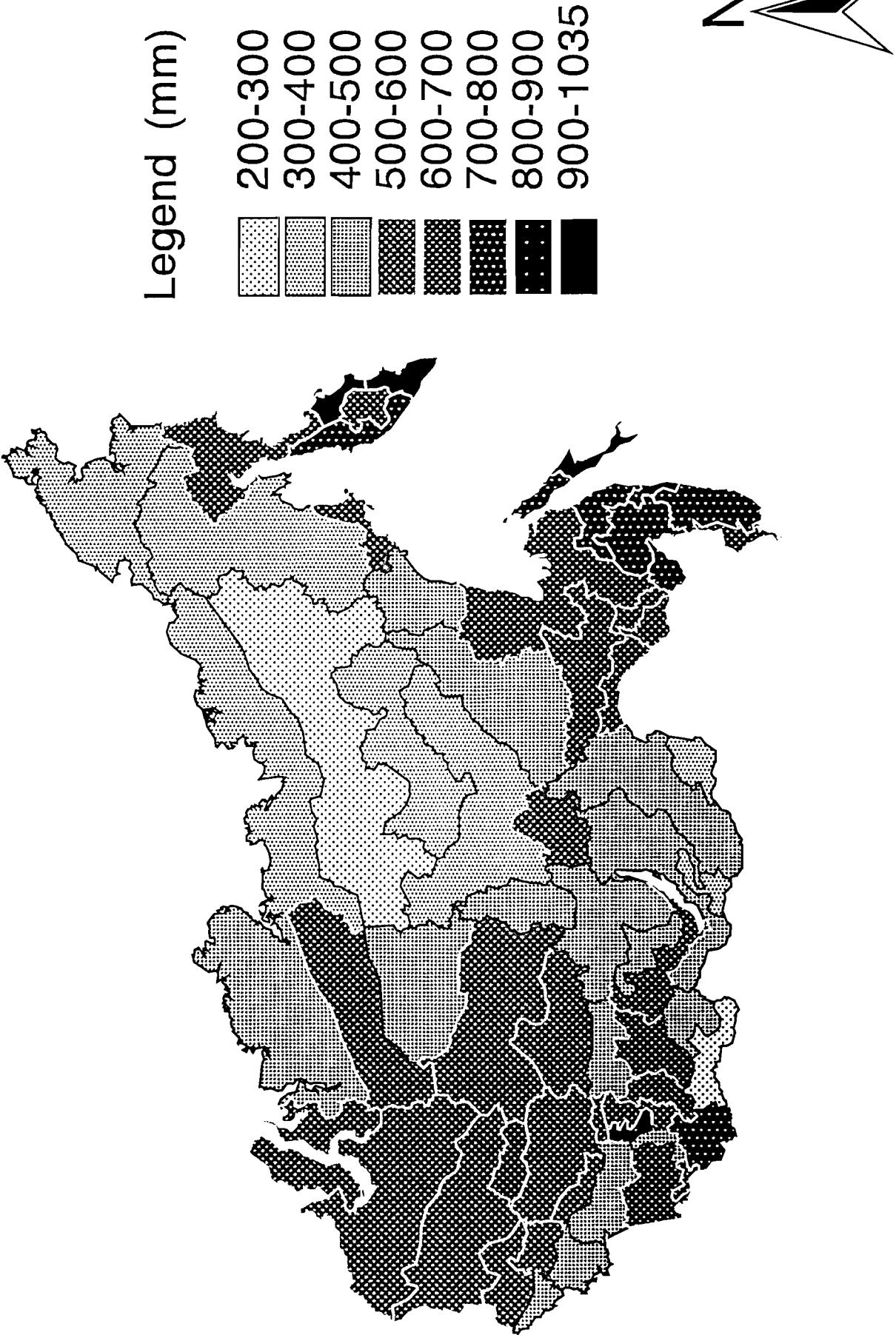
Legend (mm)

▫	200-300
▫	300-400
▫	400-500
▨	500-600
▨	600-700
▨	700-800
▨	800-900
■	900-1035

N

Map 4.2. Average annual air temperature.

Legend (degrees C)

- -15 - -12
- -12 - -10
- -10 - -8
- -8 - -6
- -6 - -4
- -4 - -2
- -2 - 0
- 0 - 2
- 2 - 4

Map 4.3. Average annual soil surface temperature.

Legend (degrees C)

-15 - -12
-12 - -10
-10 - -8
-8 - -6
-6 - -4
-4 - -2
-2 - 0
0 - 2
2 - 4

N

Map 4.4. Number of days with average temperature > 5° C.

Legend (days)

- 39-60
- 61-80
- 81-100
- 101-120
- 121-140
- 141-160
- 161-190

Map 4.5.　Degree times days with an average temperature > 5° C.

Legend (degree times days)

- 250-500
- 500-750
- 750-1000
- 1000-1250
- 1250-1500
- 1500-1750
- 1750-2000
- 2000-2250
- 2250-2750

N

Map 4.6. Distribution of precipitation during the vegetation period.

Legend (mm)
- <100
- 100-200
- 200-300
- 300-400
- 400-500
- 500-600
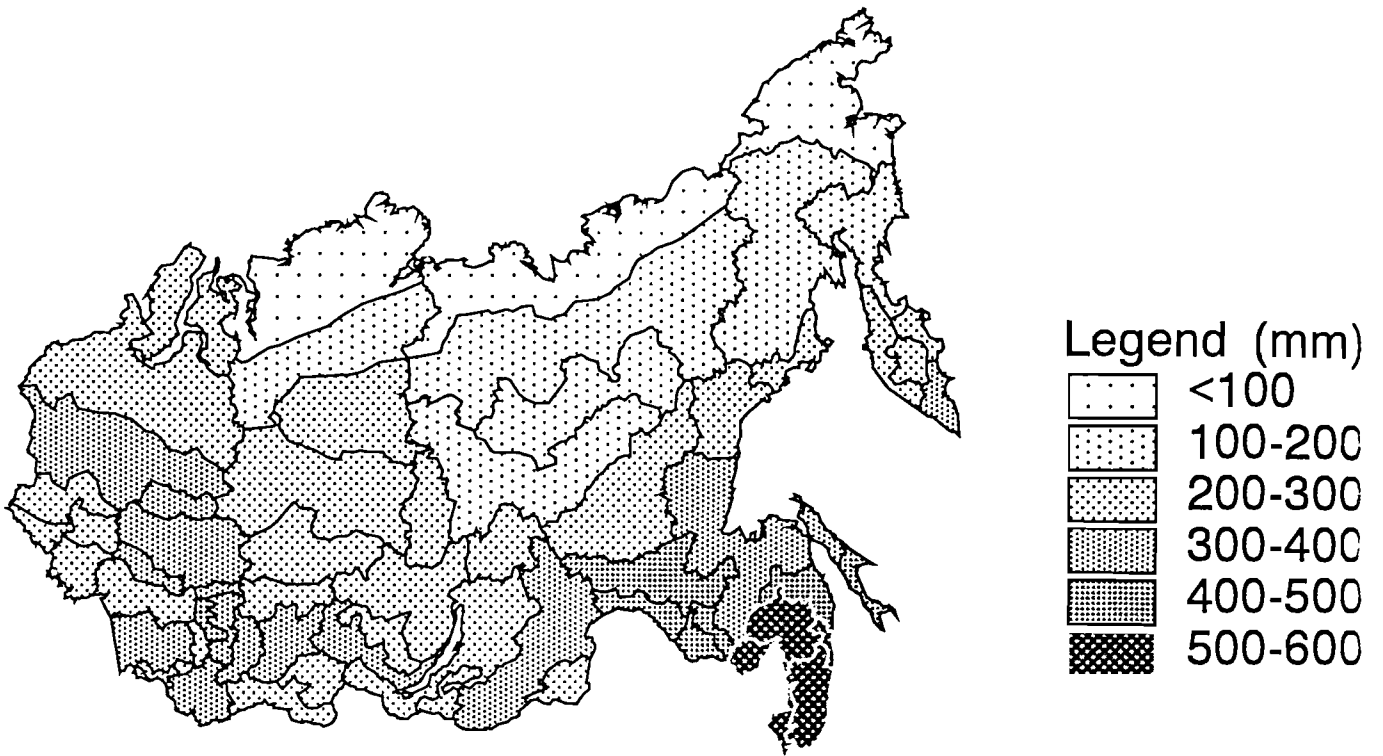
Total precipitation during the period when temperature > 5° C.

Legend (days)
- 39-60
- 61-80
- 81-100
- 101-120
- 121-140
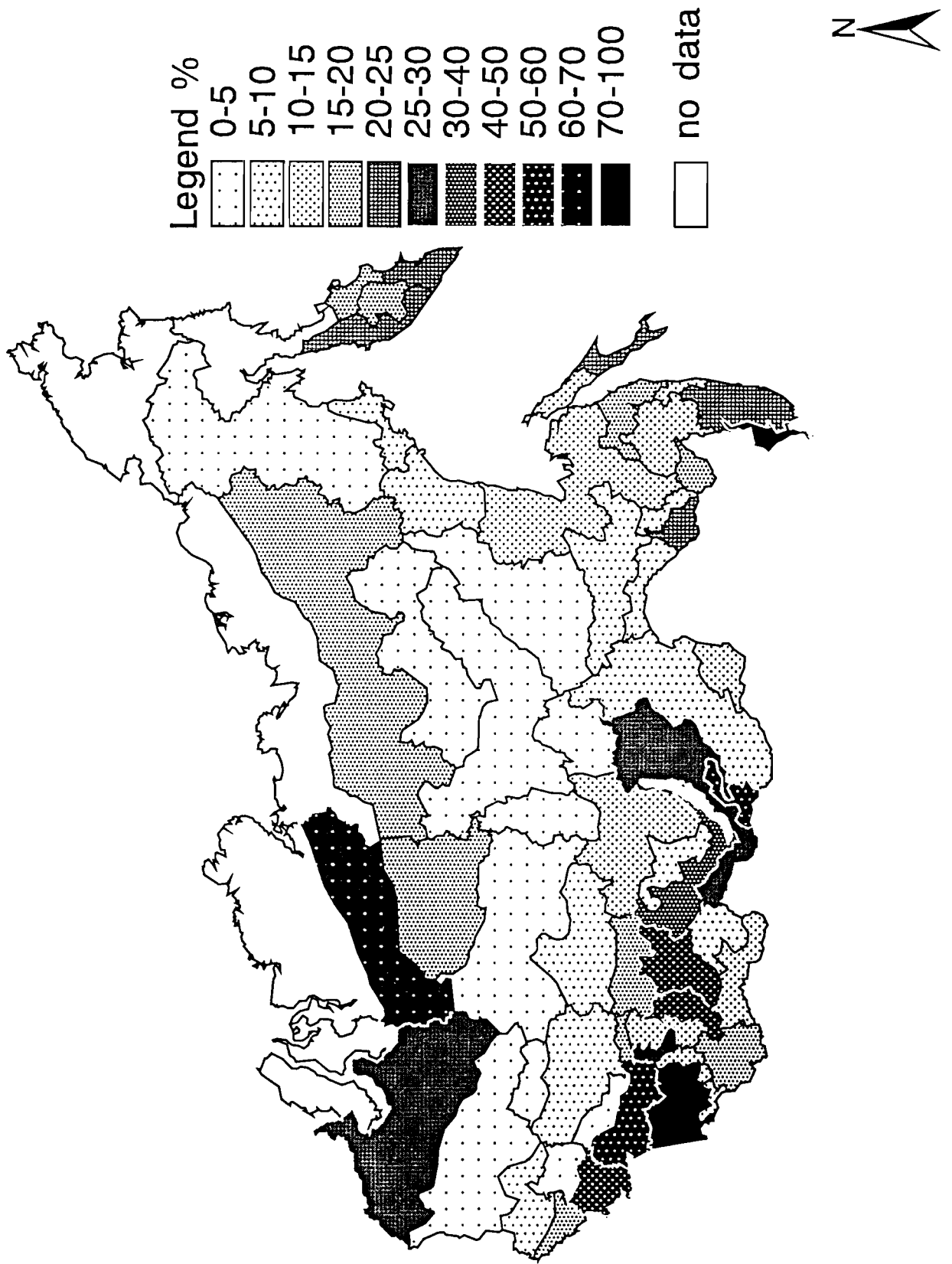- 141-160
- 161-190
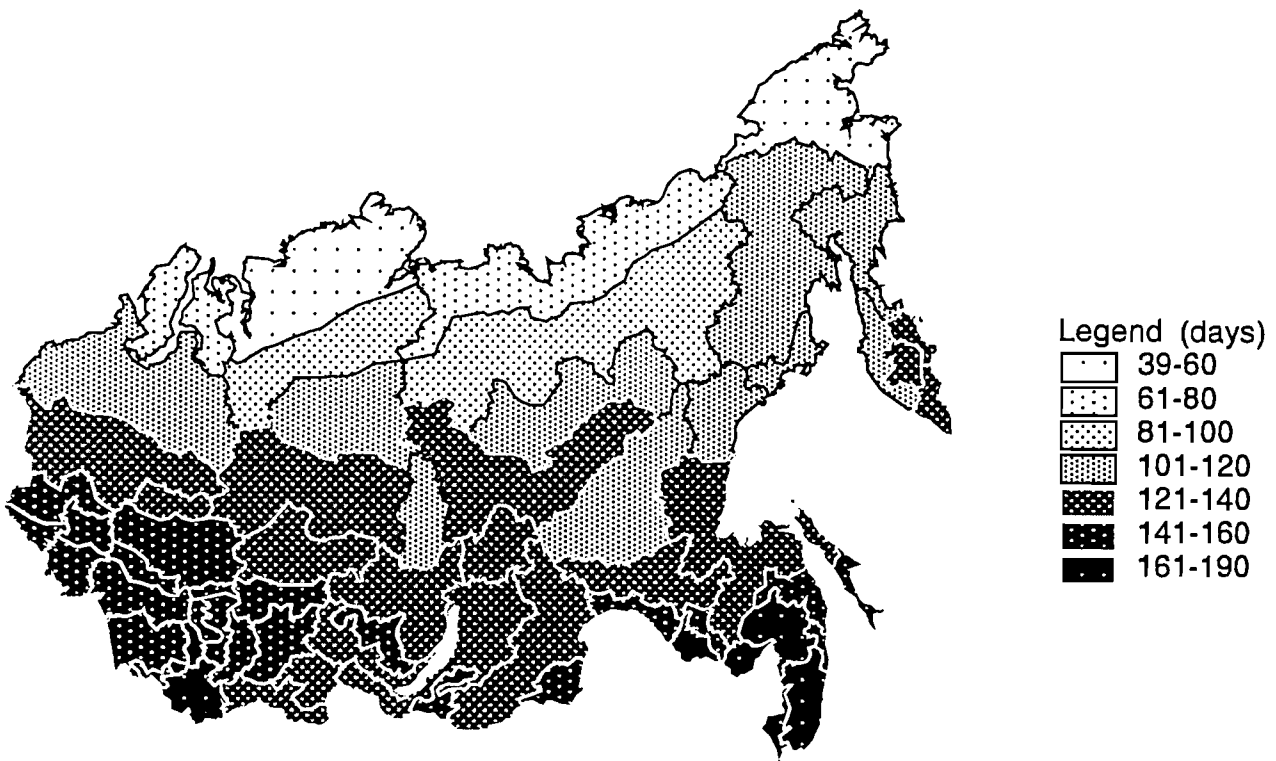
Number of days with average temperature > 5° C.

5. Forest Classification

In Map 5.1 the proportion of the Forested Area (closed forests) of the Forest Fund is illustrated. The Forested Area constitutes a high proportion in most of Siberia except in the north, northeast and in the southwestern regions. In Maps 5.2 to 5.4 the proportions of the Forested Areas in the different forest groups (protective groups) are presented. The majority of the protected groups are in the southern part of Siberia and in the unproductive north. The middle part of Siberia has a very low extent of protective groups. The distribution of the proportions of the total Forest Fund on the three protective groups is presented in Map 5.5.
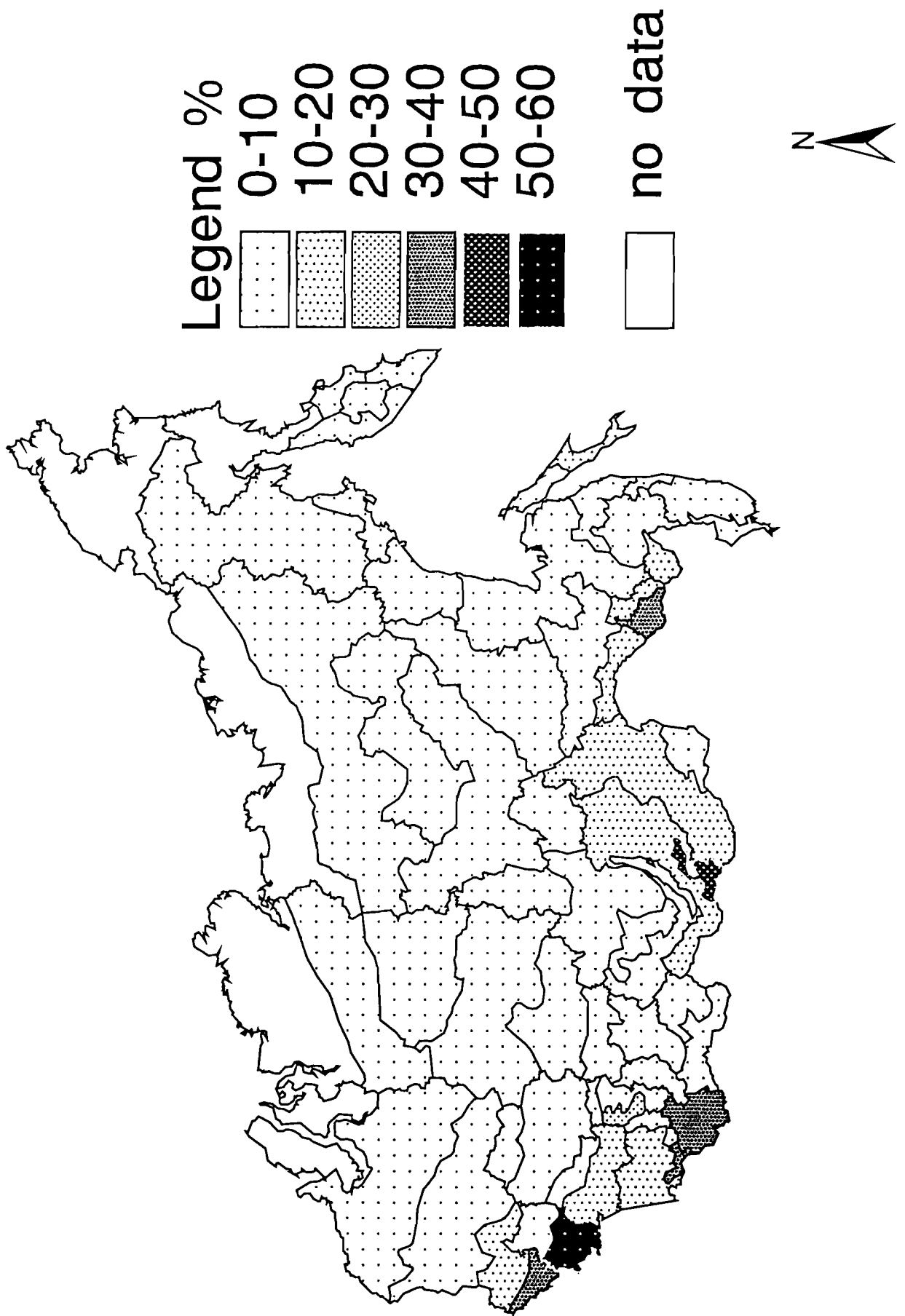
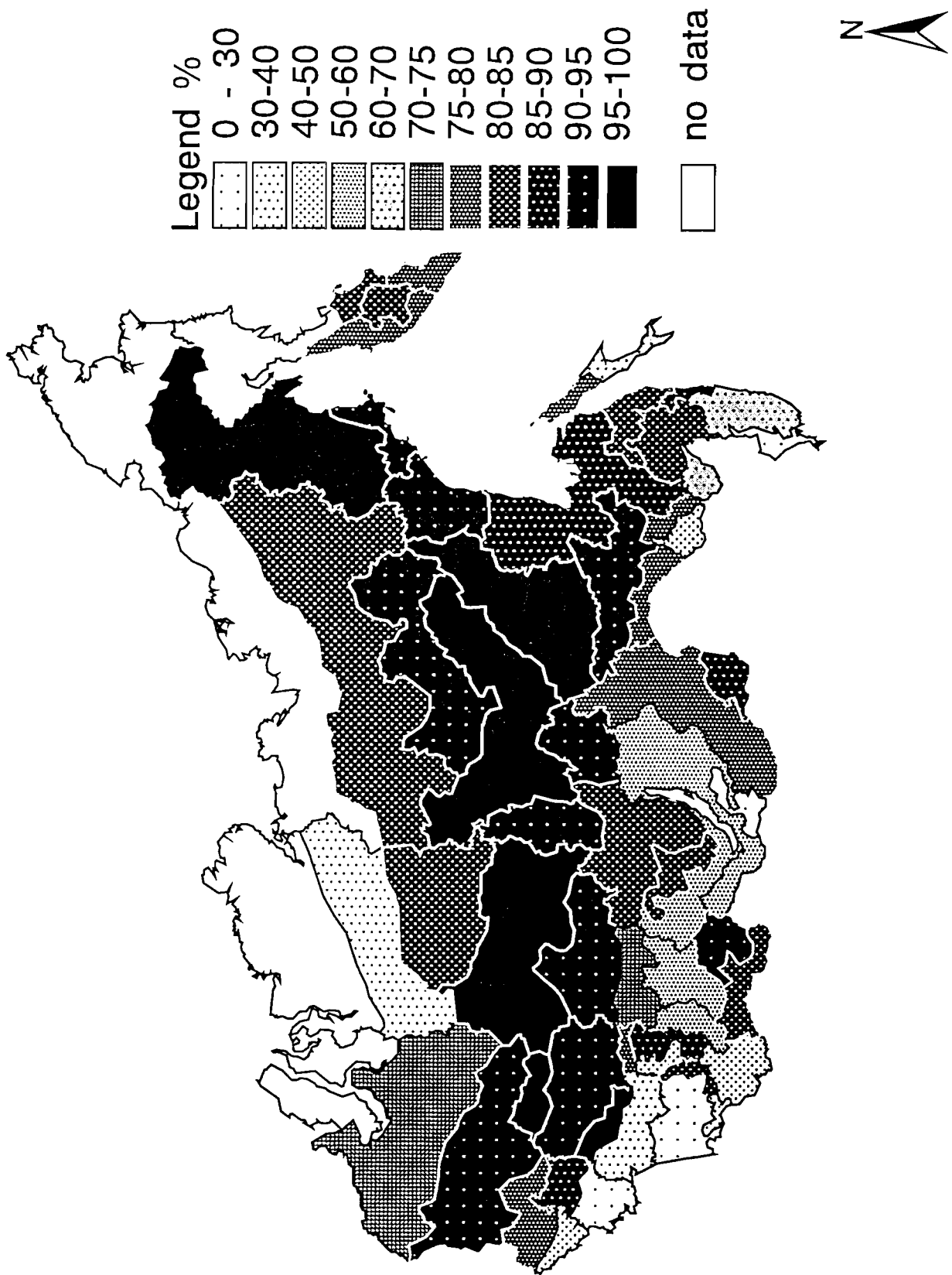Map 5.1. Proportion of Forested Area (percentage) of the Forest Fund area.
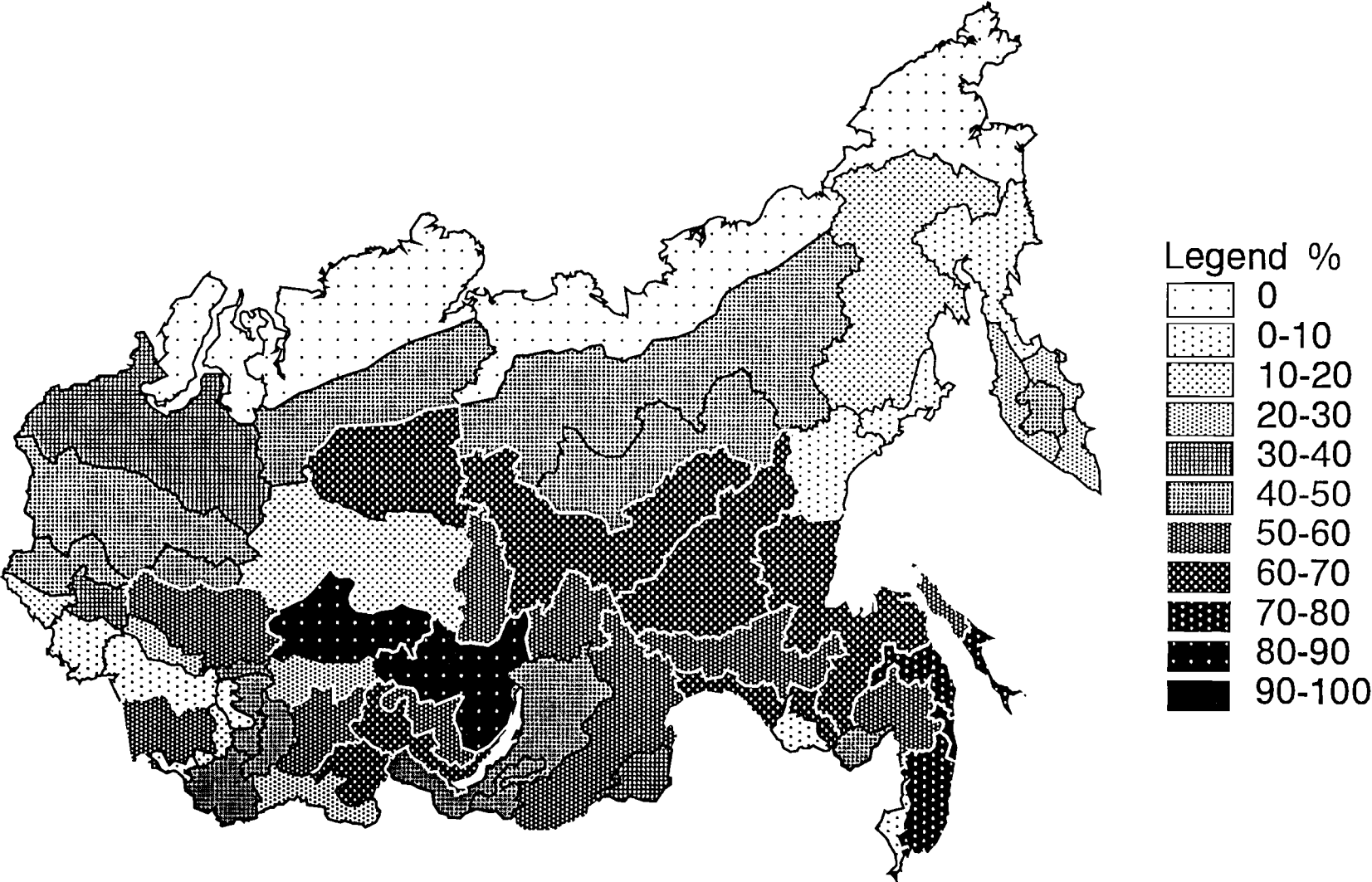
Legend %
0
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100

N

Map 5.2. Proportion of Forested Area in Group I.

Legend %
0-5
5-10
10-15
15-20
20-25
25-30
30-40
40-50
50-60
60-70
70-100

no data

N

Map 5.3. Proportion of Forested Area in Group II.

Legend %

⬚	0-10
⬚	10-20
⬚	20-30
▨	30-40
▨	40-50
■	50-60

☐ no data

N

Map 5.4. Proportion of Forested Area in Group III.

Legend %
- 0 - 30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-75
- 75-80
- 80-85
- 85-90
- 90-95
- 95-100

no data

N

Map 5.5. Proportion of the total Forest Fund area in the three protection groups.

Group I

Group II

Legend %
- ☐ 0-10
- 10-20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100

☐ no data

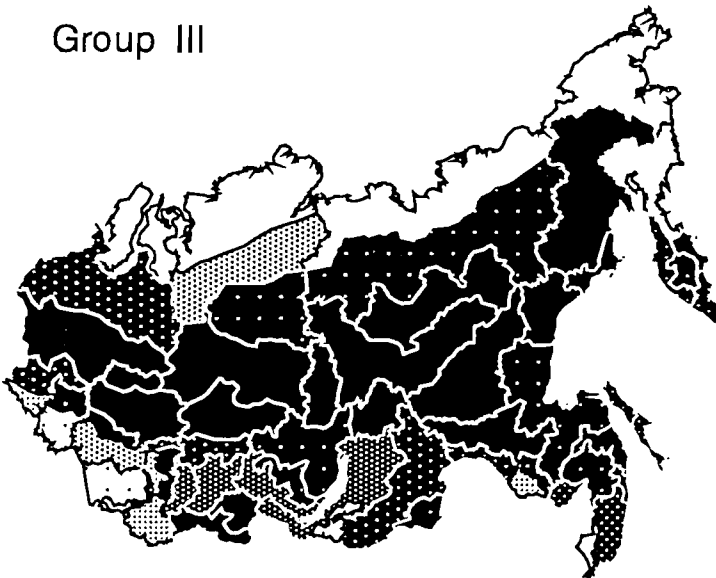## Group III

N
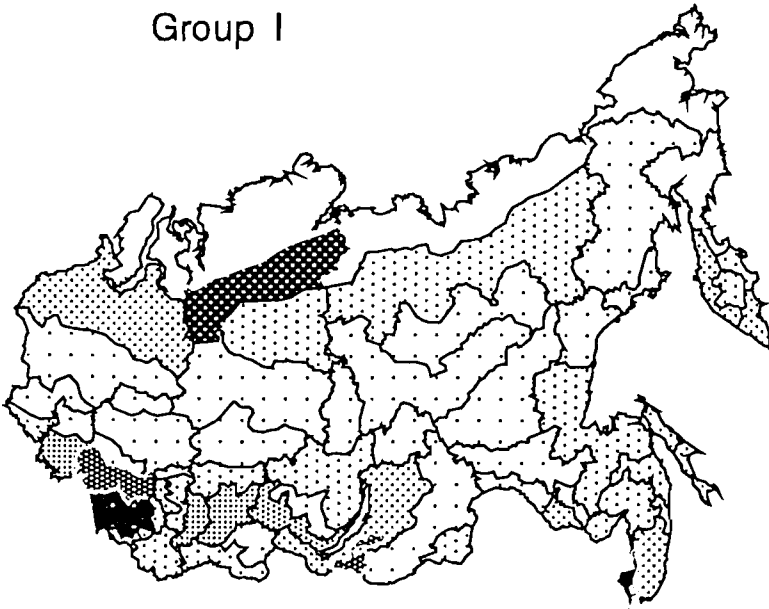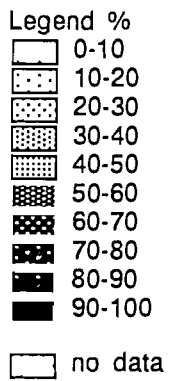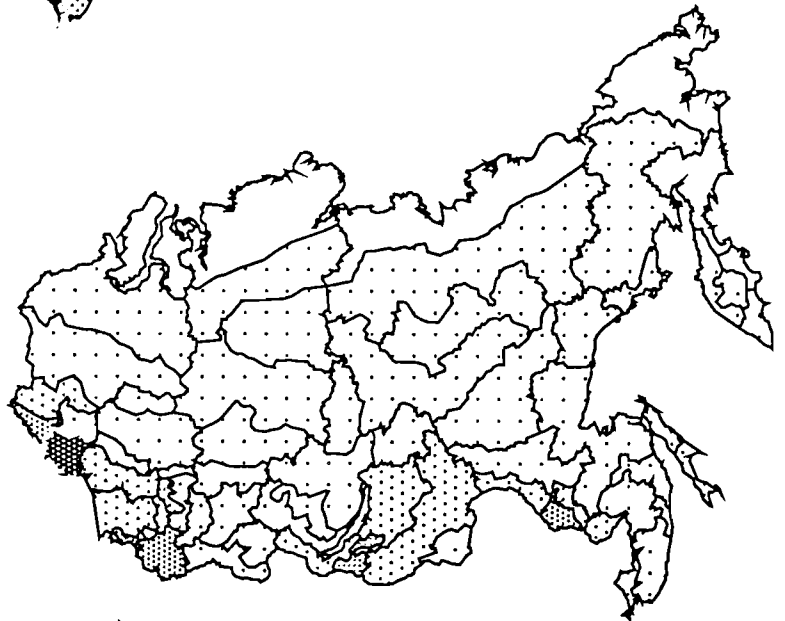
# 6. Forest Cover from Origin Point of View

The distribution of forests by categories of the origin by dominant species occupying more than 10% of the ecoregion's Forested Area is presented in the following maps. The classification used for the origin of the forests is the following:

- Virgin forests - forests which have not been influenced by catastrophic events like forest fires, insect and disease outbreaks, etc., during the last rotation periods.

- Natural forests - forests which have been influenced by catastrophic natural events which caused partial destruction of the stands. But the stands have not been subject to any forest management or any other negative anthropogenic impacts.

- Anthropogenic forests - forests which are a result of anthropogenic disturbances (mainly harvesting).

Map 6.1 shows the proportions of the coniferous forests distributed over the groups of forest origin. Map 6.2 shows the similar distribution for soft deciduous species.

Map 6.1. Proportion of coniferous forest of Forested Areas, classified as a) anthropogenic, b) natural, and c) virgin.
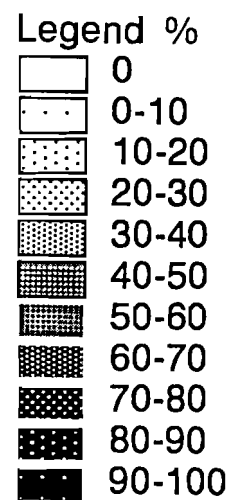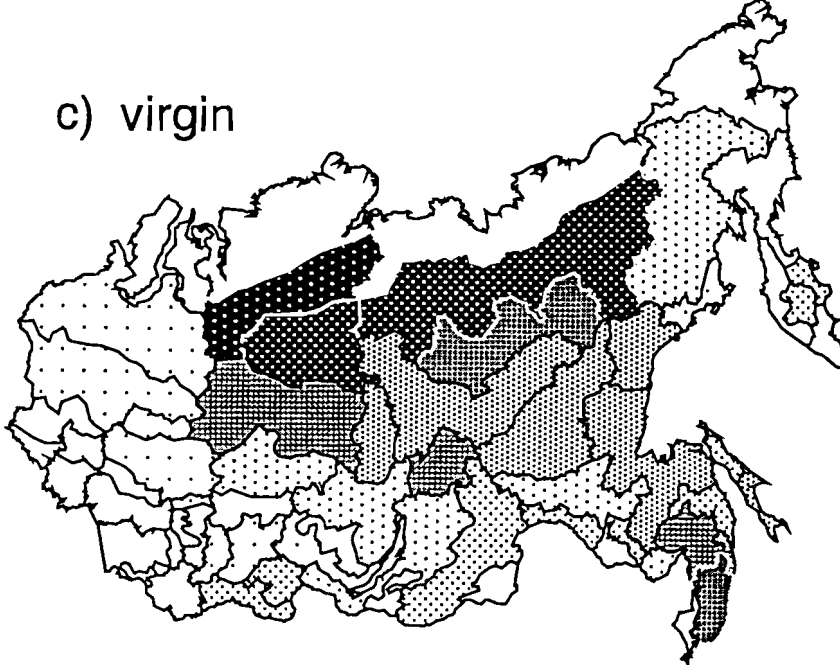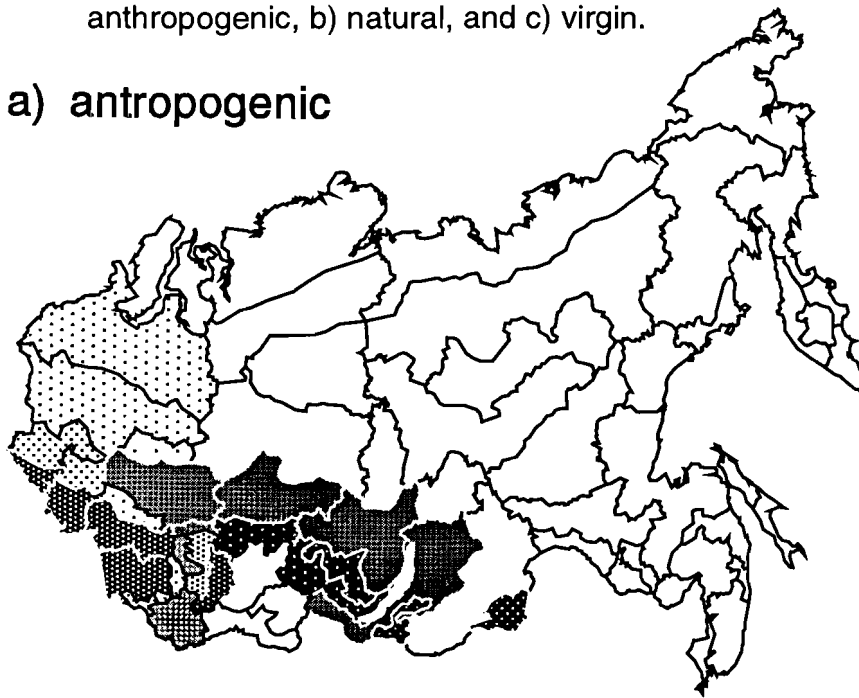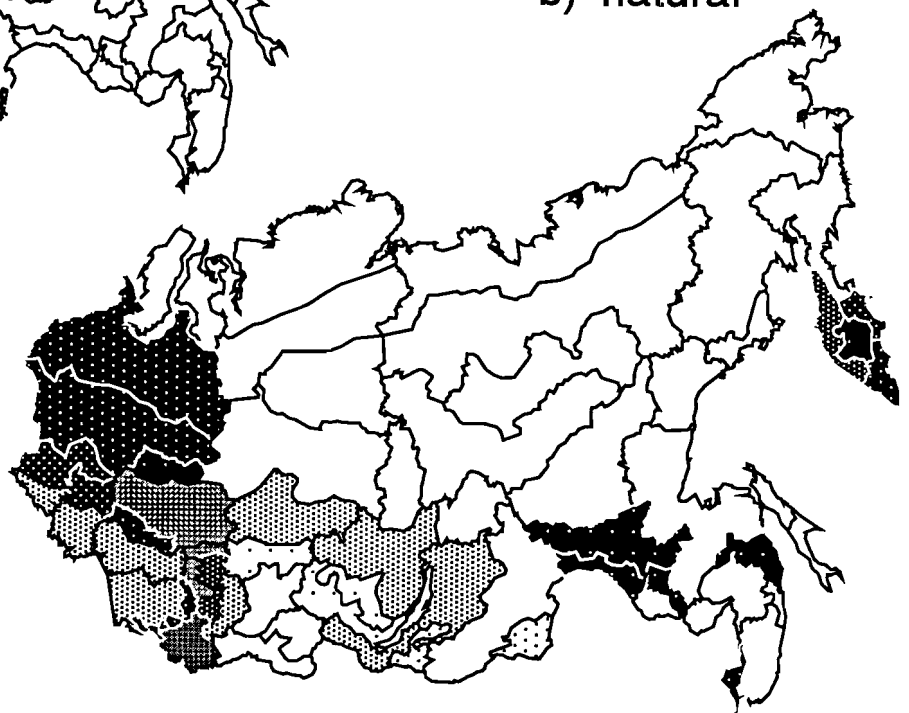
a) antropogenic

b) natural

c) virgin

Legend %
	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

25
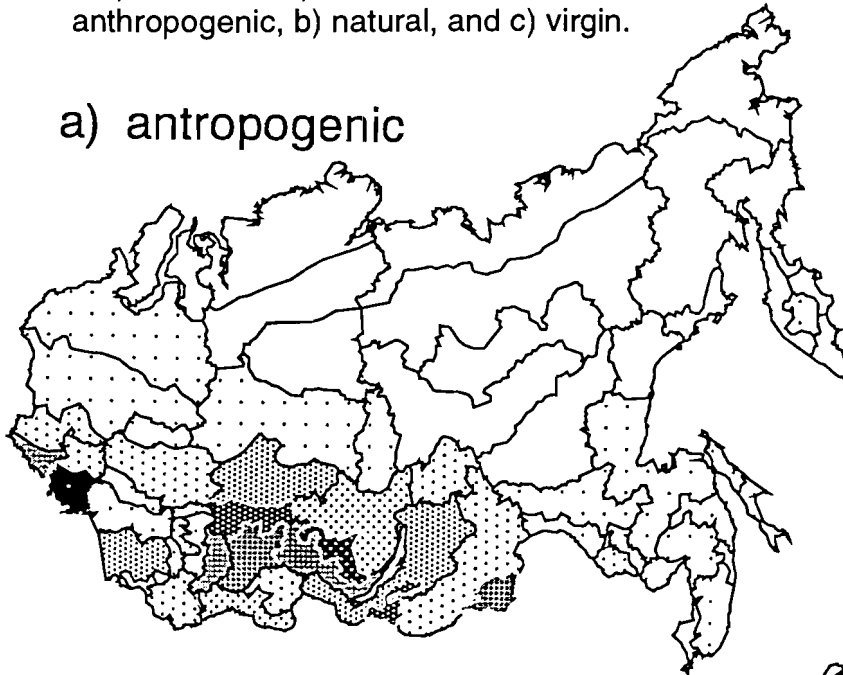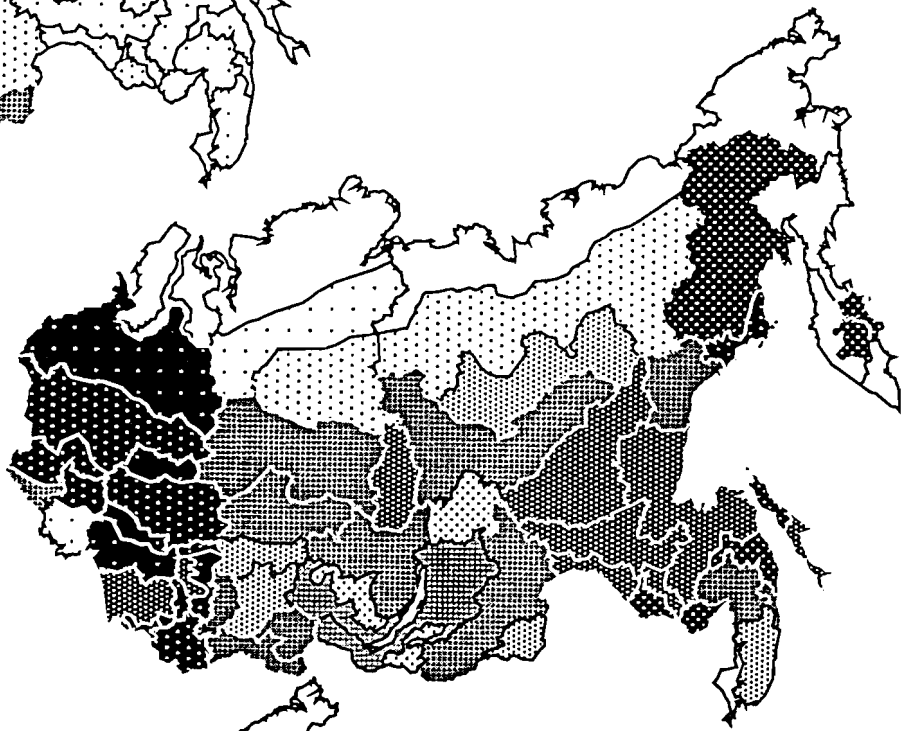
Map 6.2. Proportion of soft broadleaved forests of Forested Areas classified as a) anthropogenic, b) natural, and c) virgin.

a) antropogenic

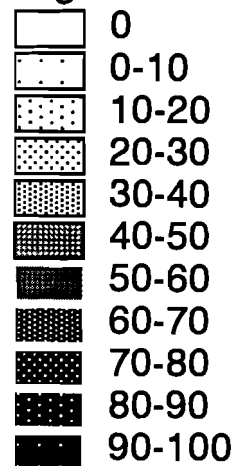## b) natural

c) virgin

Legend %

|	
☐	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
■	90-100

26

7. Species Distributions

Map 7.1 shows the distribution of the Forested Areas dominated by coniferous species (dominating species). Maps 7.2 to 7.6 show the distribution of individual dominating coniferous species. The distribution of dominating soft deciduous species in Forested Areas is illustrated in Map 7.7. Maps 7.8 and 7.9 show the distribution of dominating birch and aspen in the Forested Areas. The distributions of dominating hard deciduous species in the Forested Areas are shown in Map 7.10. Map 7.11 shows the distribution of shrubs in the Forested Areas. Maps 7.12 to 7.21 present the effective areas of species groups and individual species as proportions of the Forested Areas. The so called "effective area" is a measure, which tries to estimate the more true ecological importance of individual species in a forest. If only the measure "dominant species" is taken into account, an underestimate of the presence of different species in the forests will be the result. Therefore, the proportion of each species within the total composition of the forests has been multiplied by the area of the specific forests and by that we achieve what we call "effective area" which is higher than the area of "dominant species". In the following, the calculations are illustrated by an example:
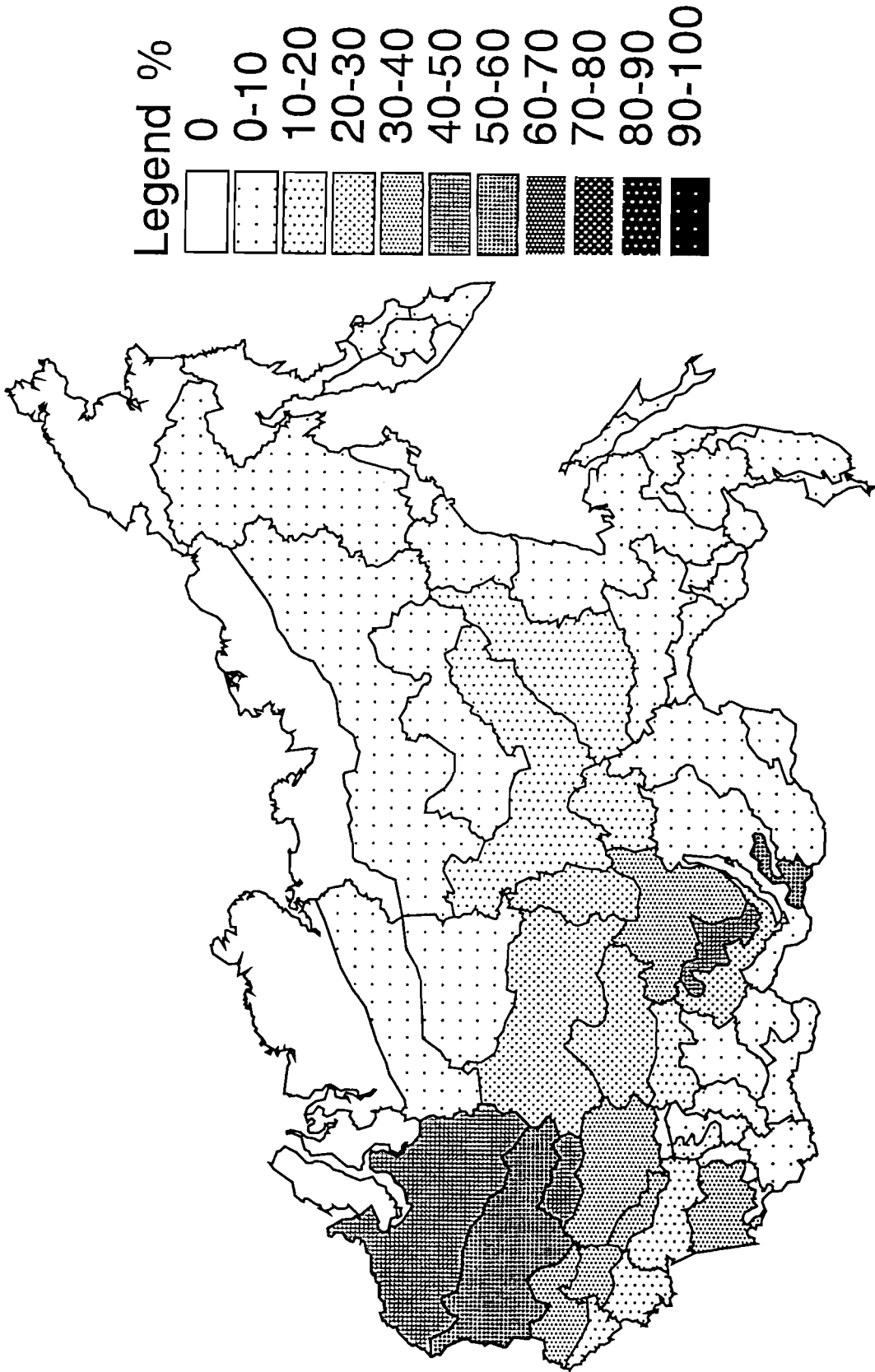
- Pine-dominated stands - 70% pine, 100,000 ha spruce-dominated stands with small amounts of pine - 20% pine, 100,000 ha

- Deciduous-dominated stands with small amounts of pine - 30% pine, 100,000 ha.

Thus, 0.7 x 100,000 = 70,000 ha effective area of pine in pine-dominated stands, 0.2 x 100,000 = 20,000 ha effective area of pine in spruce stands, and 0.3 x 100,000 = 30,000 ha effective area of pine deciduous stands. This gives us a total "effective area" of 120,000 ha of pine instead of 70,000 ha of pine if the "dominant species" classification is used.
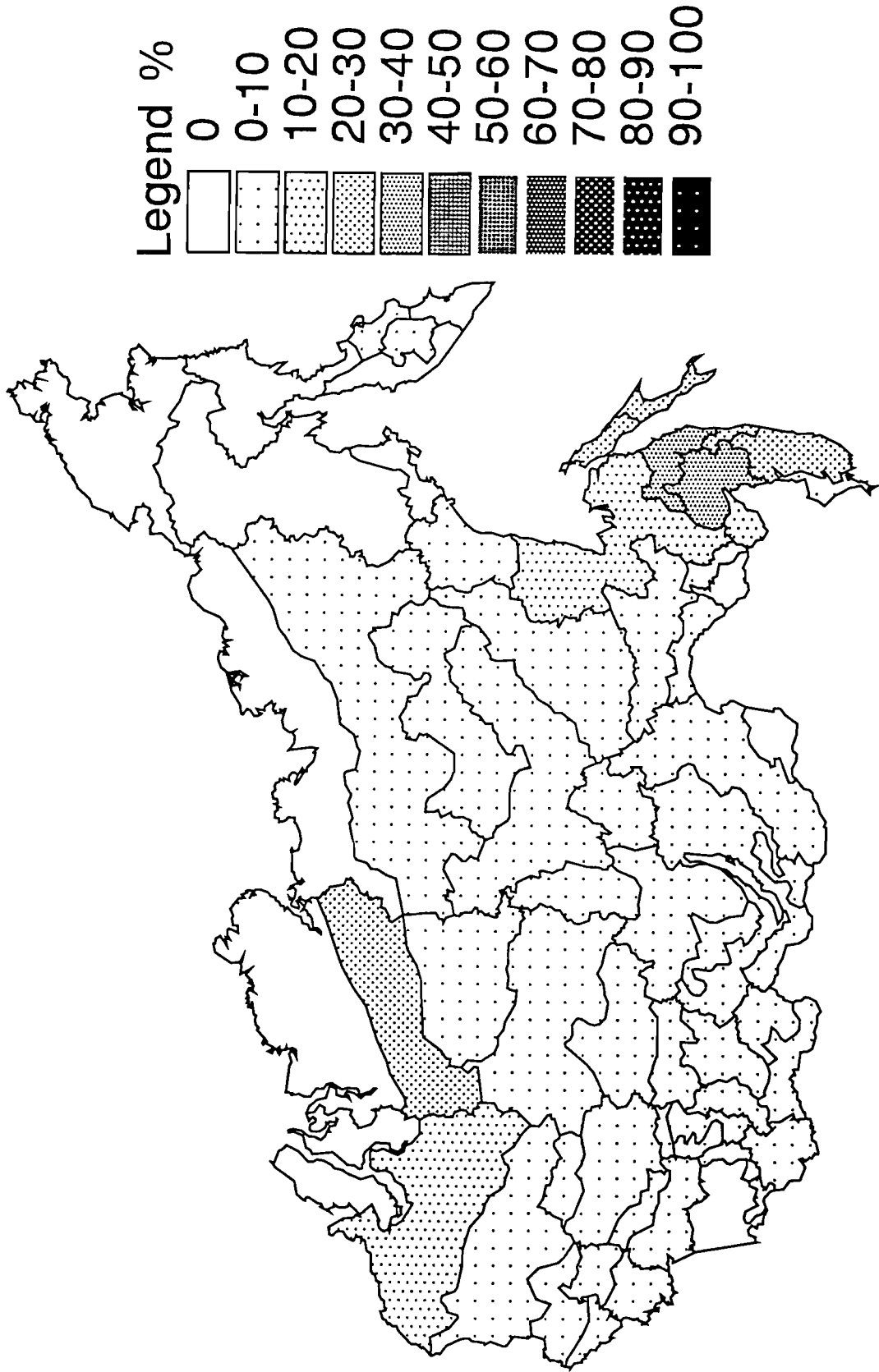
27

Map 7.1. Percentage of Forested Areas dominated by coniferous species.

Legend %

0
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
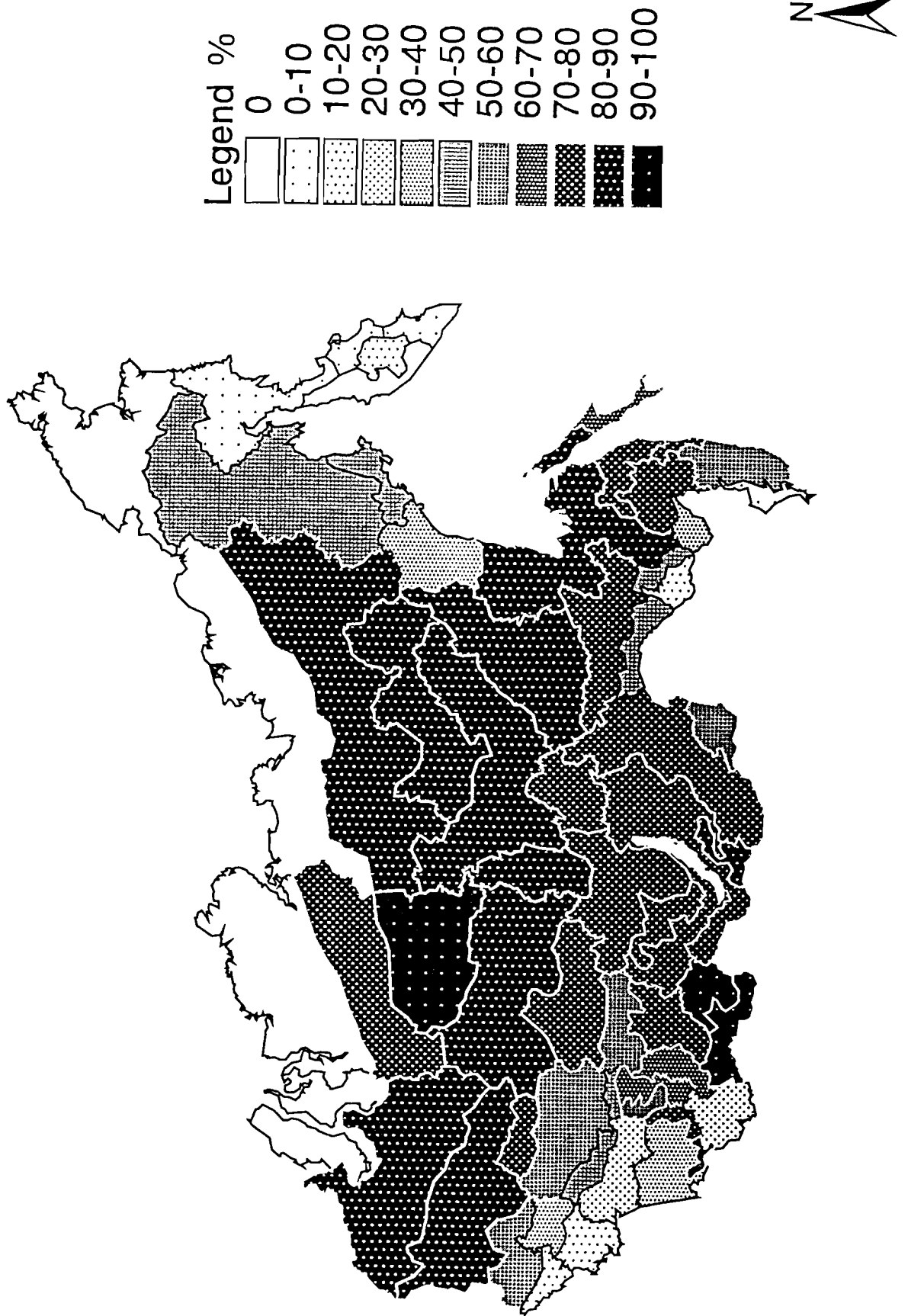
Map 7.2. Percentage of Forested Areas dominated by pine.

Legend %

☐	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N

Map 7.3. Percentage of Forested Areas dominated by spruce.

Legend %

	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N
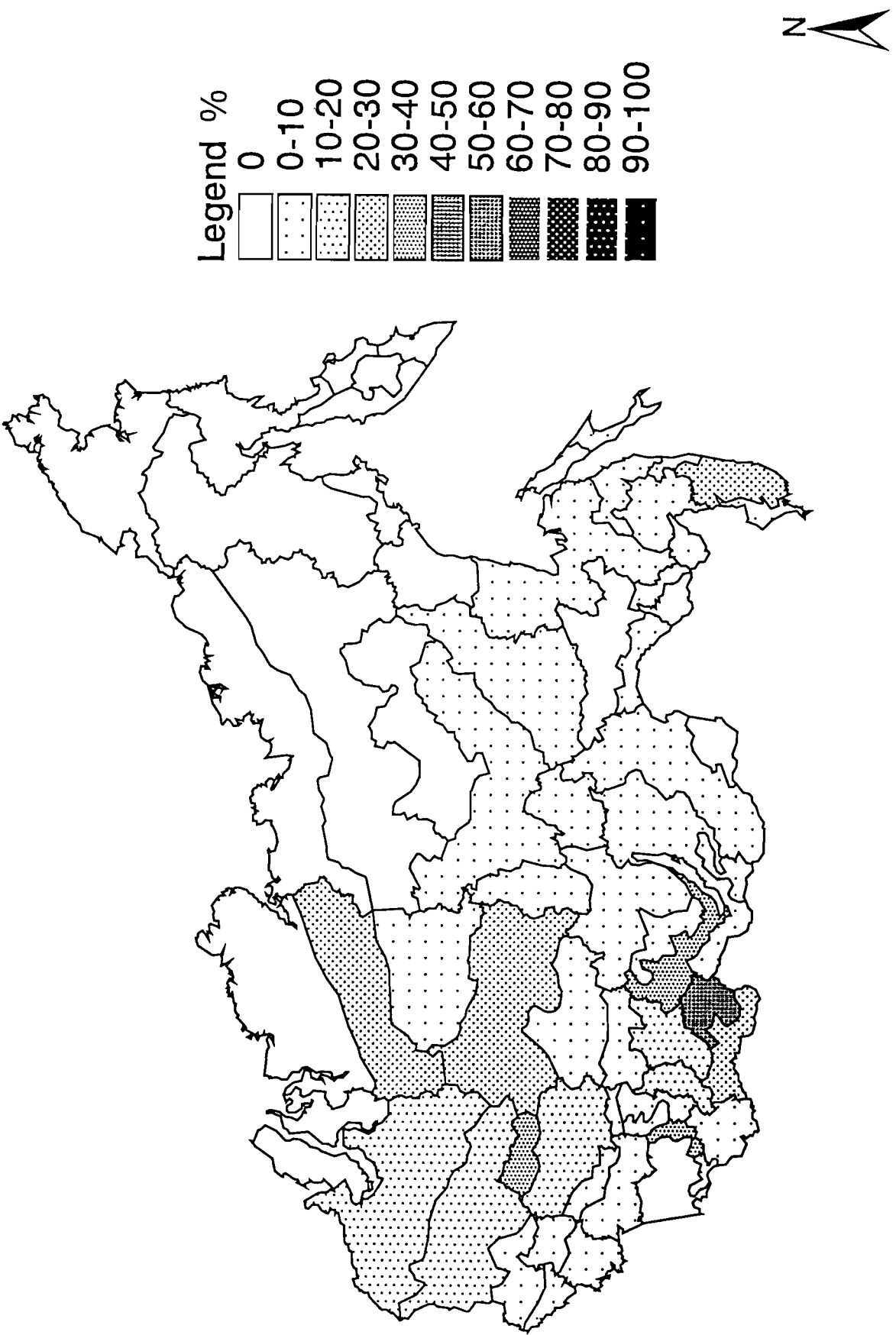
Map 7.4. Percentage of Forested Areas dominated by larch.
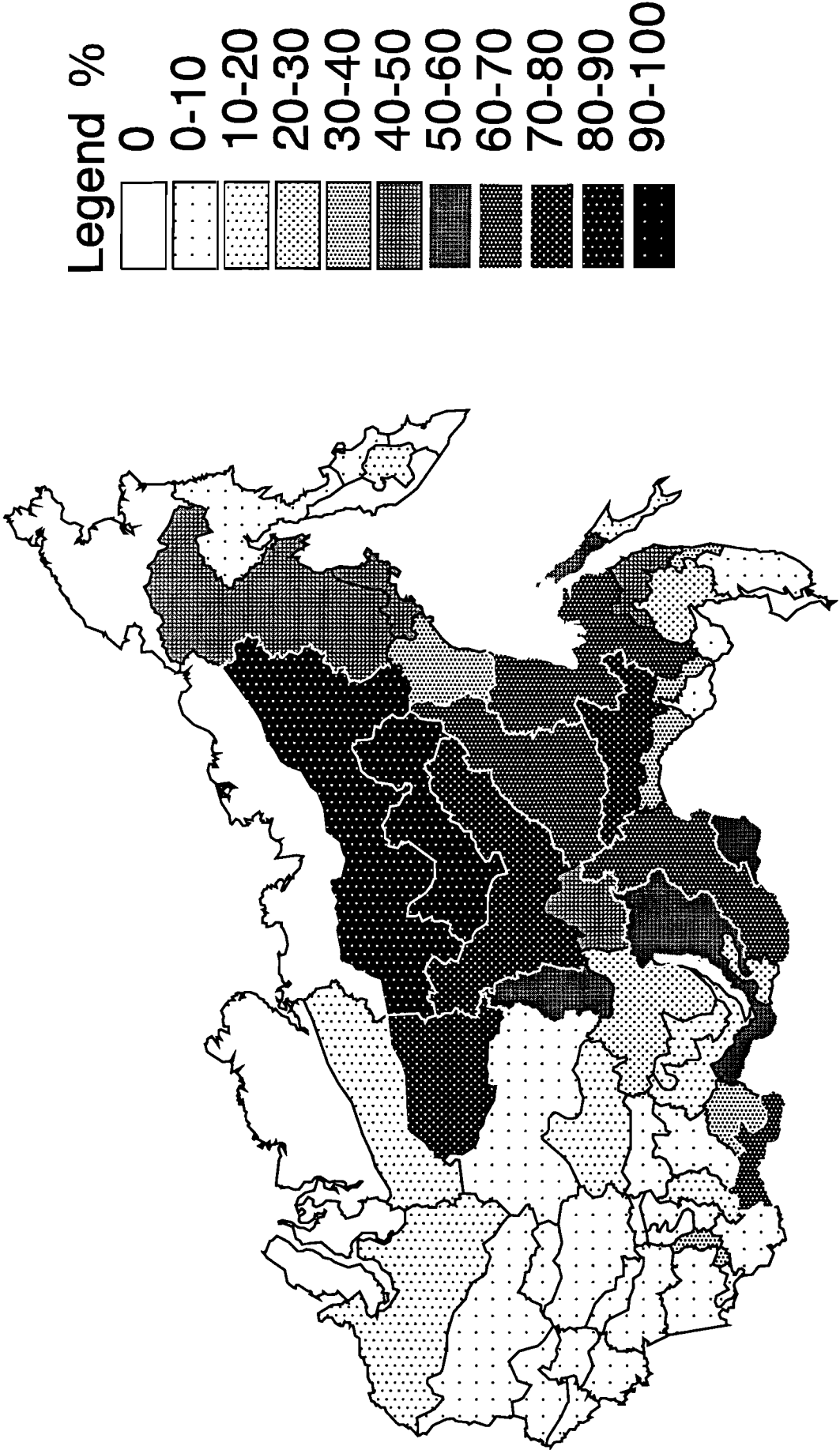
Map 7.5. Percentage of Forested Areas dominated by fir.

Legend %

0
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100

N
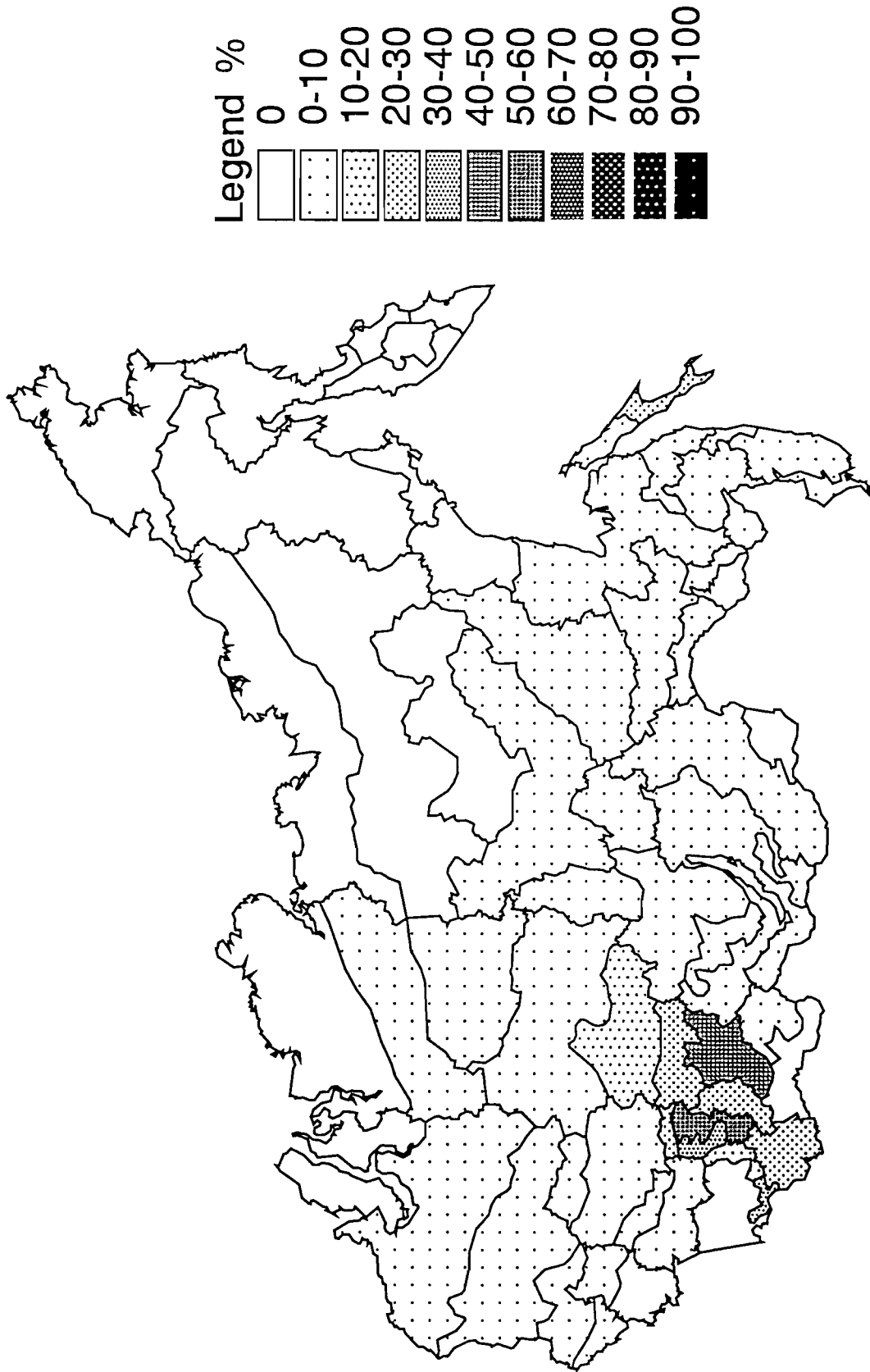
Map 7.6. Percentage of Forested Areas dominated by cedar.

Legend %

0	
0-10	
10-20	
20-30	
30-40	
40-50	
50-60	
60-70	
70-80	
80-90	
90-100	

N

Map 7.7. Percentage of Forested Areas dominated by soft deciduous species.

Legend %

	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N
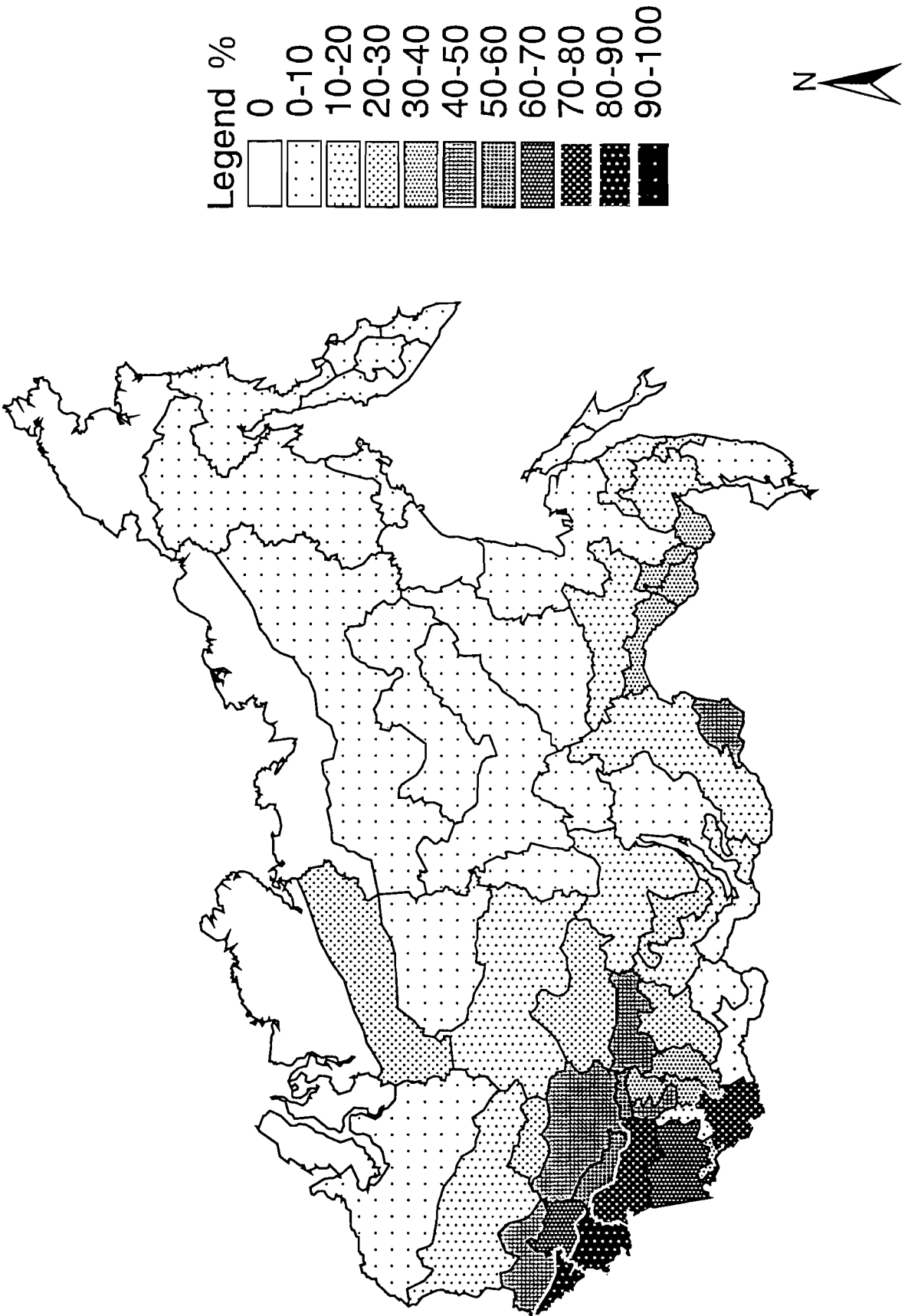
Map 7.8. Percentage of Forested Areas dominated by birch.

Legend %

	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100
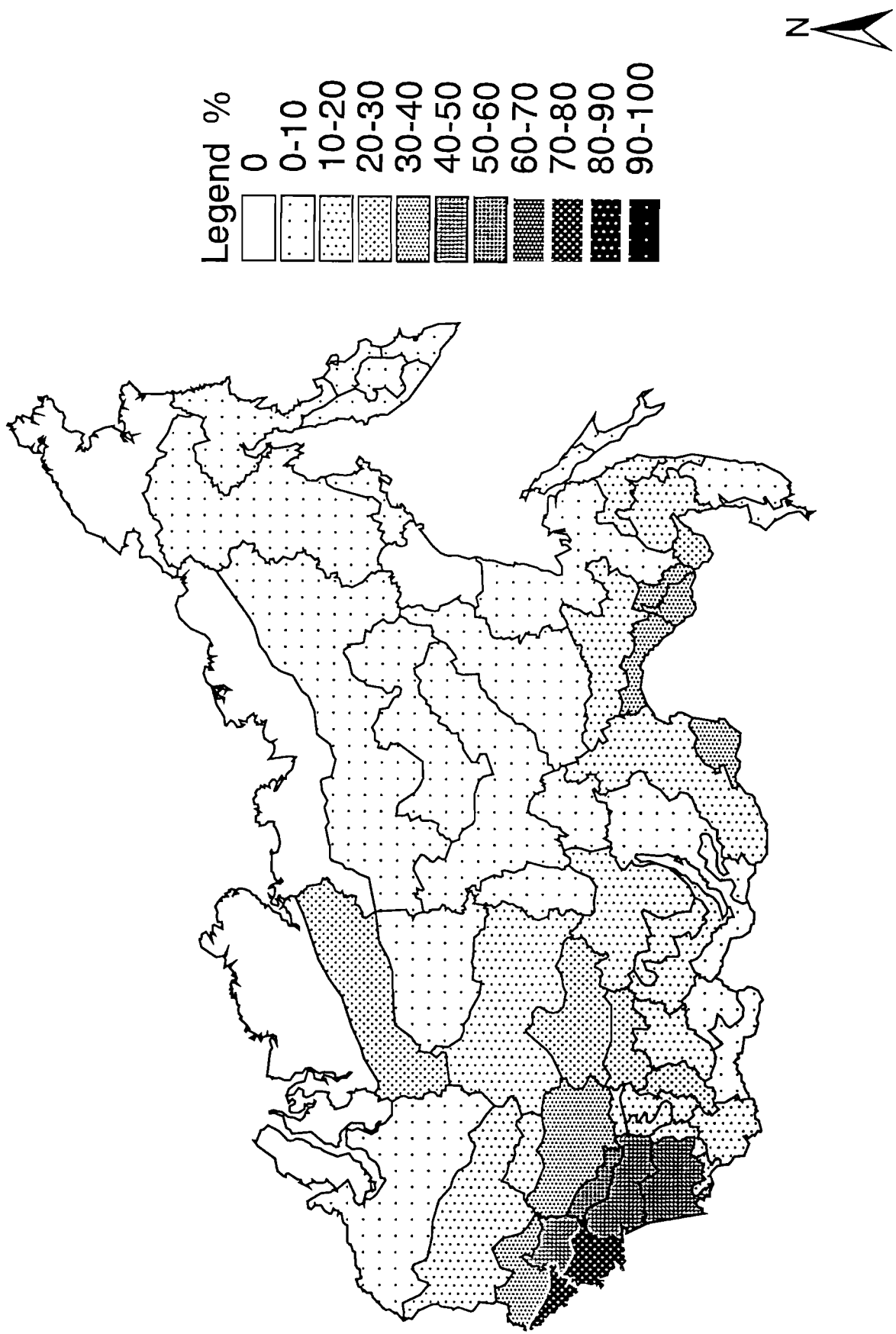
Map 7.9. Percentage of Forested Areas dominated by aspen.

Legend %

0
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
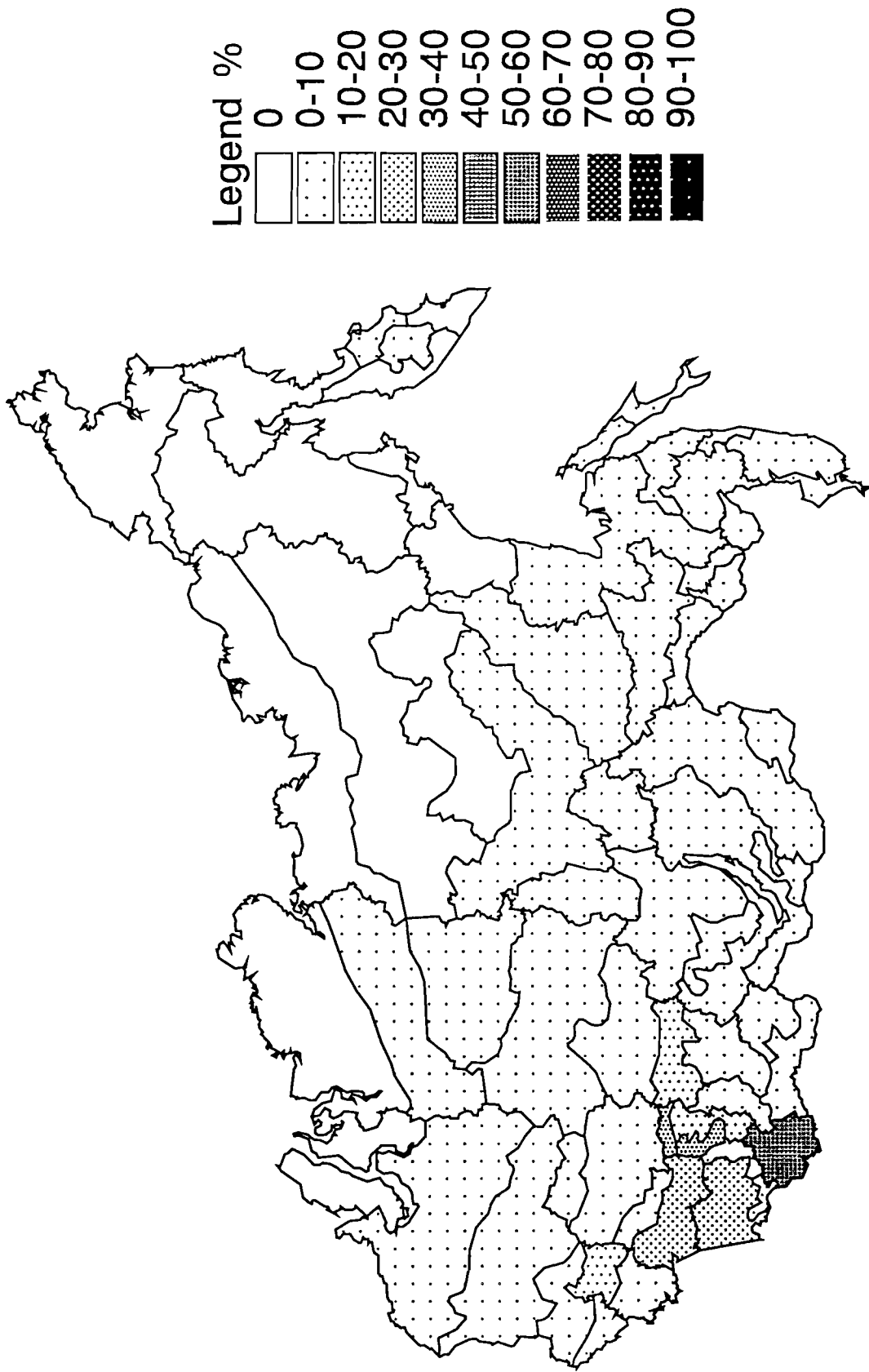
Map 7.10. Percentage of Forested Areas dominated by hard deciduous species.

Legend %

	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N
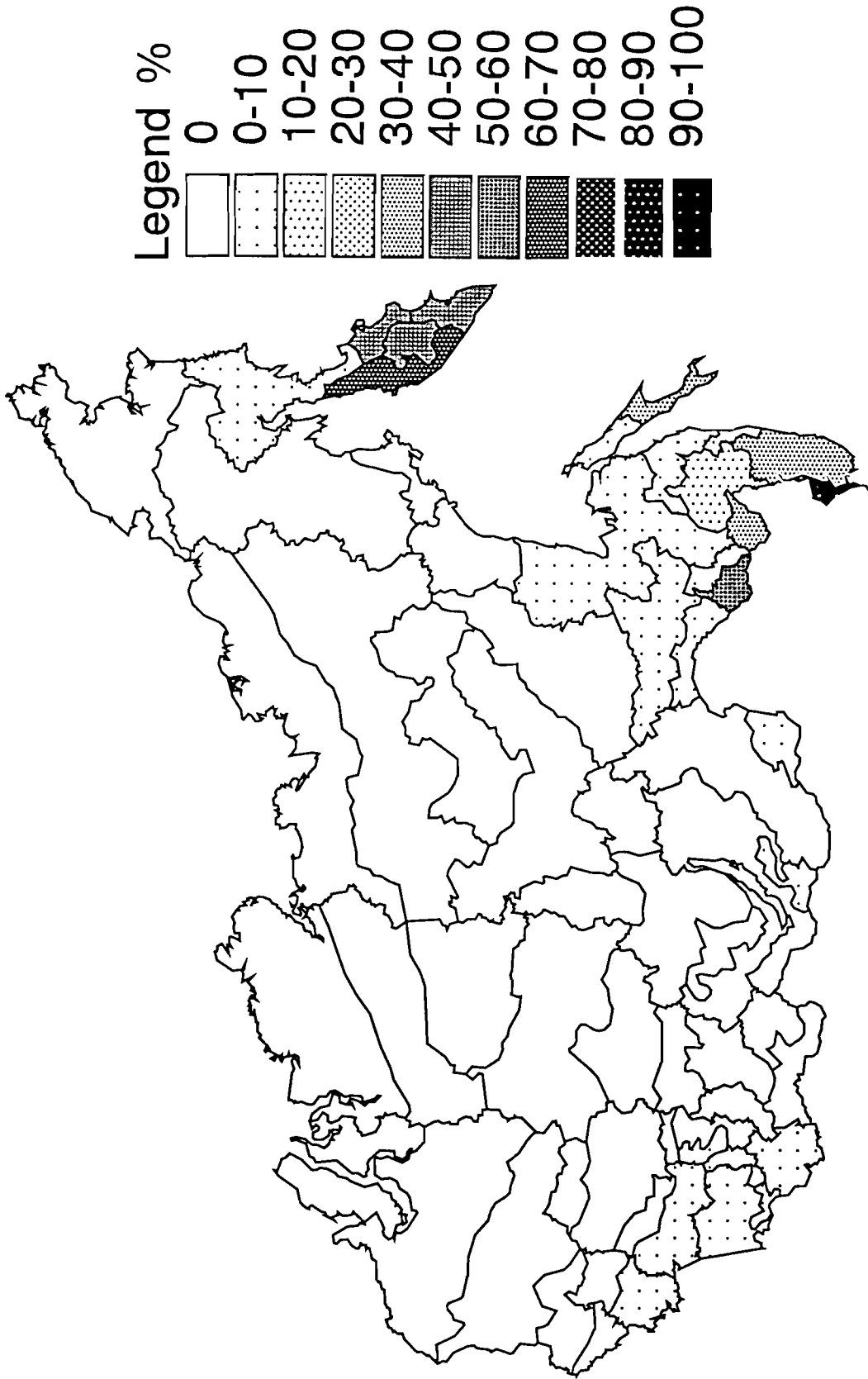
Map 7.11. Percentage of Forested Areas dominated by shrubs.

Legend %
0
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100

N
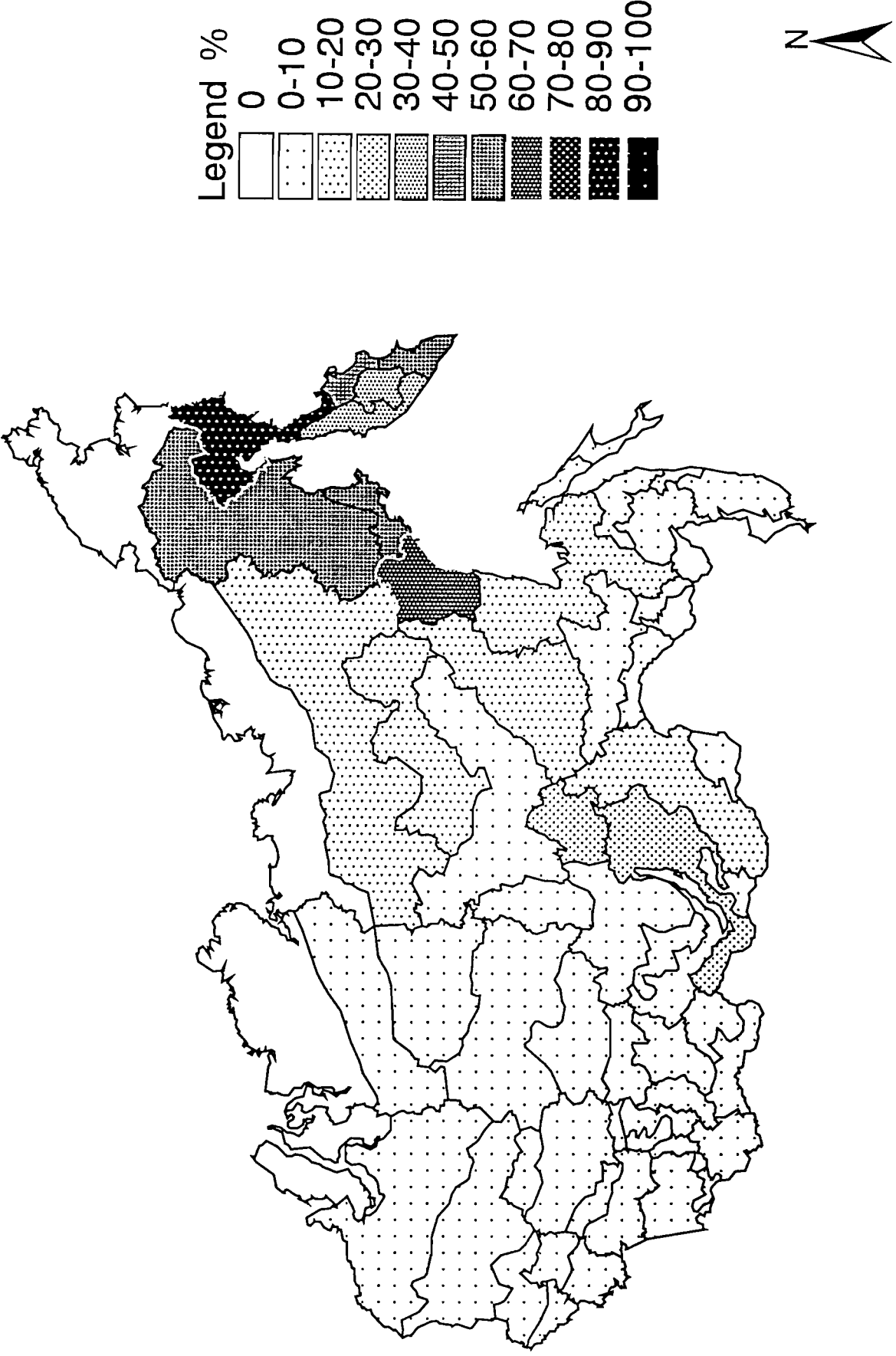
Map 7.12. Effective area of coniferous species as a proportion of the Forested Areas.

Legend %

	0 or no data
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N
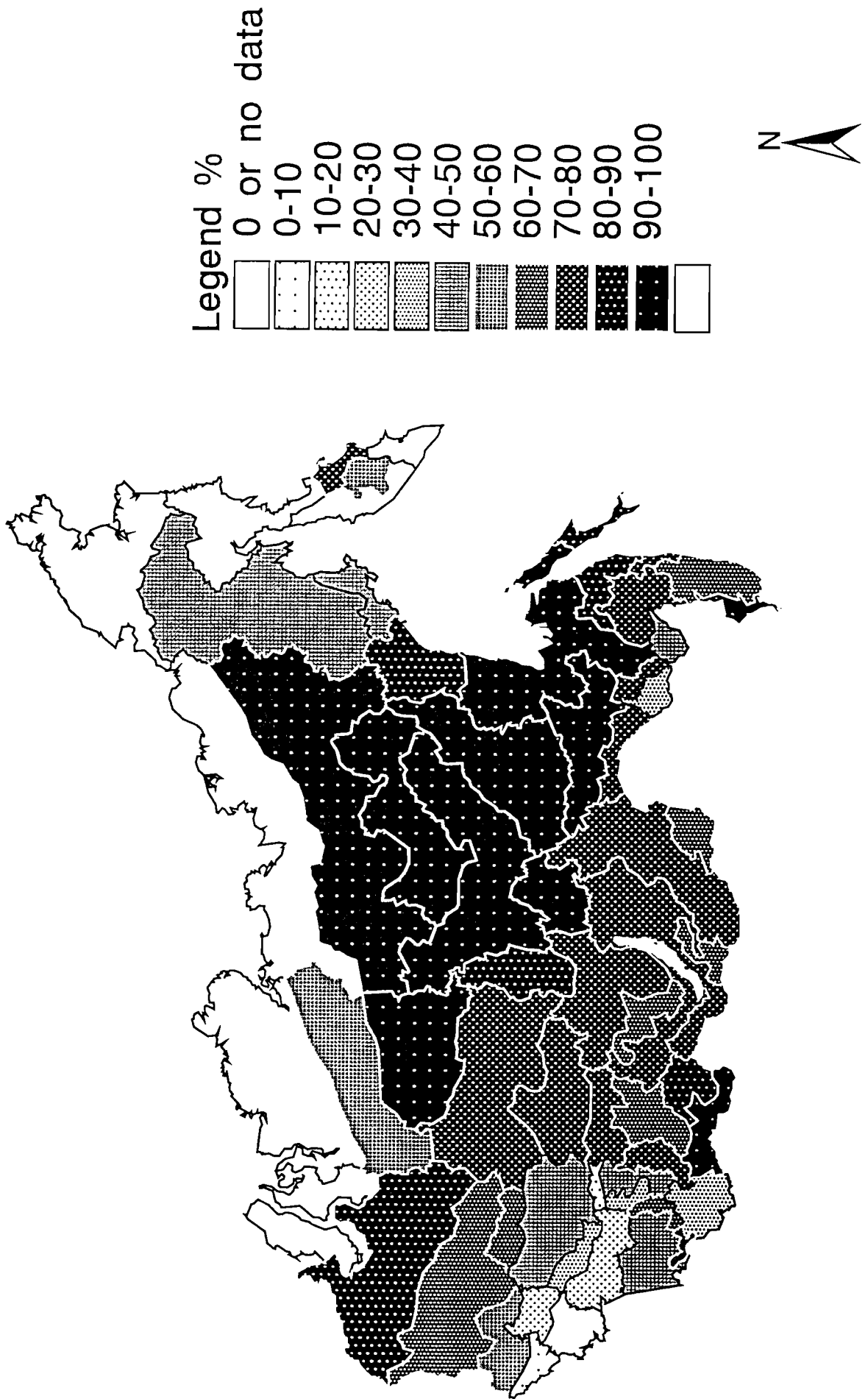
Map 7.13. Effective area of pine as a proportion of Forested Areas.

Legend %

☐	0 or no data
☐	0-5
☐	5-7.5
☐	7.5-10
☐	10-15
☐	15-20
☐	20-25
☐	25-30
☐	30-35
☐	35-41

N
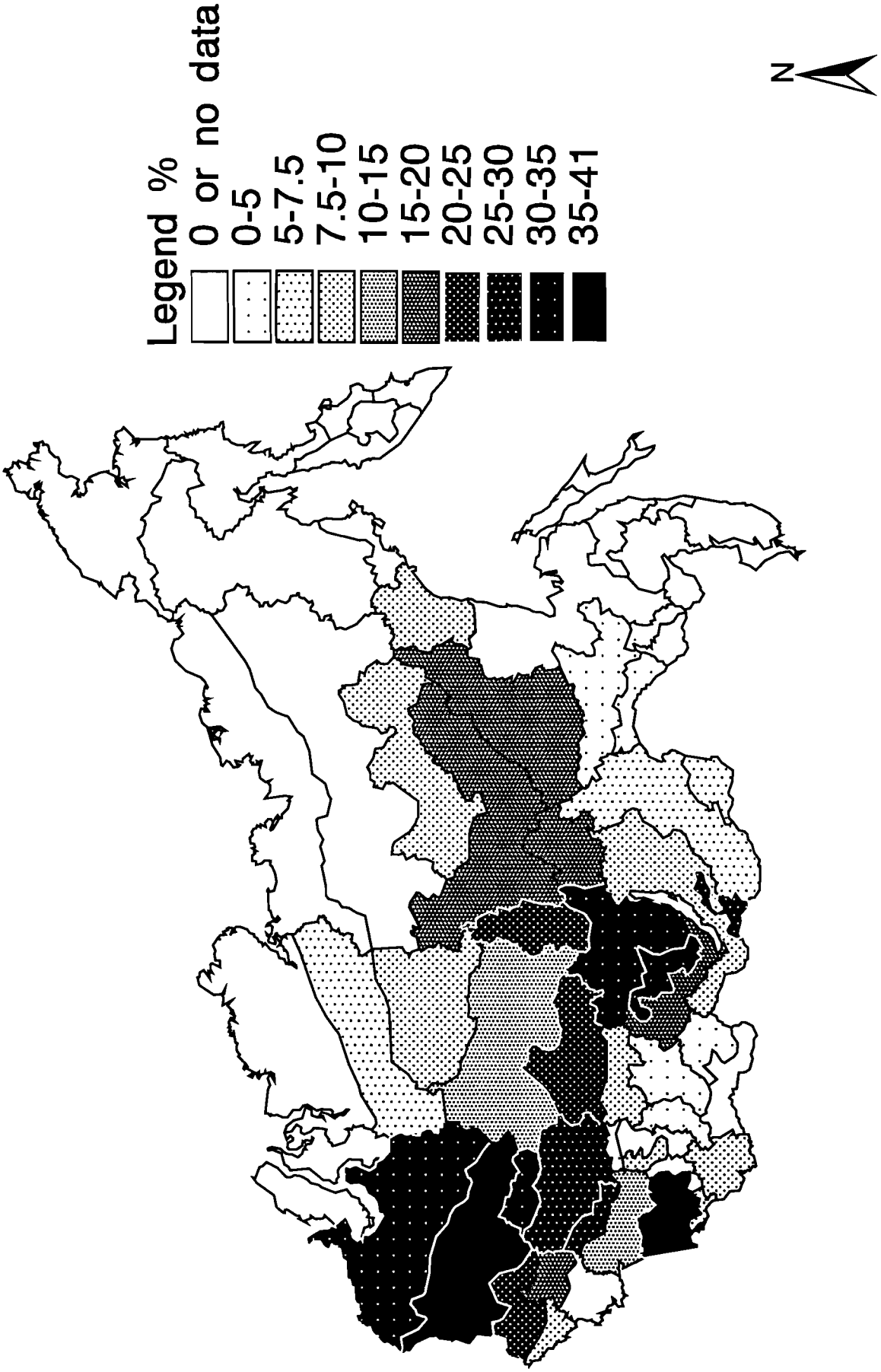
Map 7.14. Effective area of spruce as a proportion of Forested Areas.

Legend %

0	
0-2	
2-5	
5-10	
10-15	
15-20	
20-25	
25-30	
30-35	
no data	
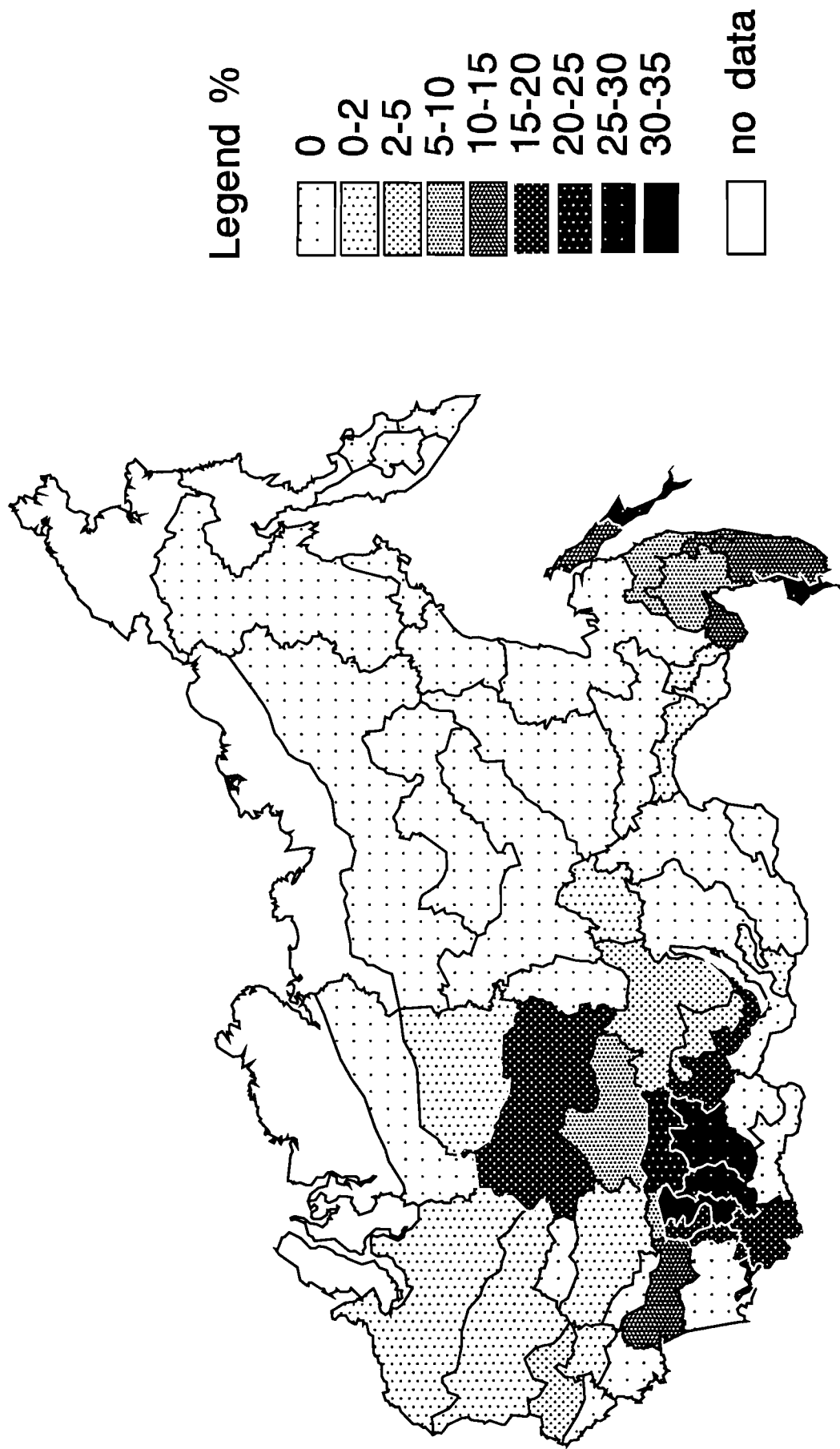
Map 7.15.   Effective area of larch as a proportion of the Forested Areas.

Legend %

0 or no data
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100

N

42
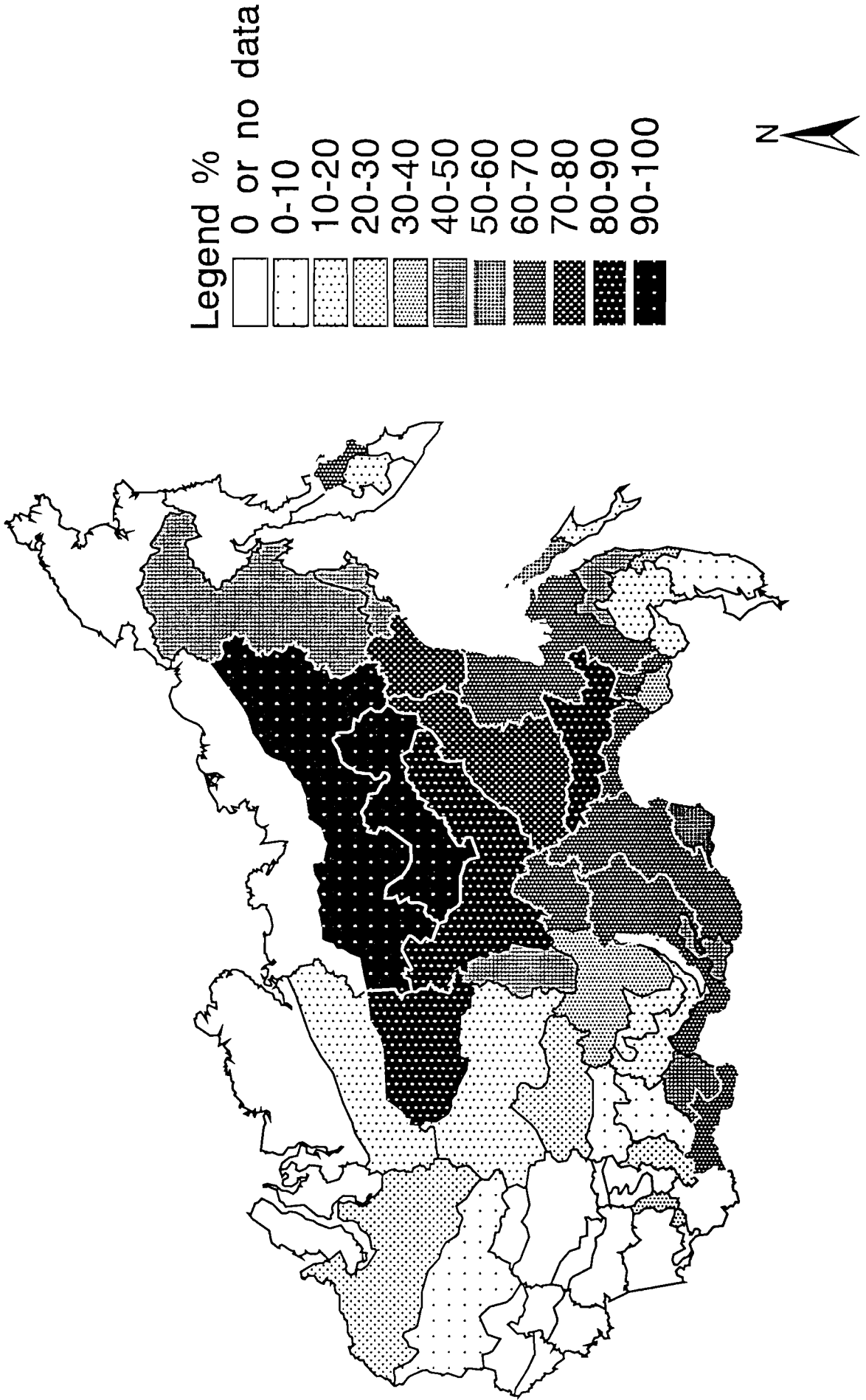
Map 7.16. Effective area of fir as a proportion of the Forested Areas.

Legend %

0 or no data
0-2.5
2.5-5
5-7.5
7.5-10
10-15
15-20
20-25
25-30
30-35
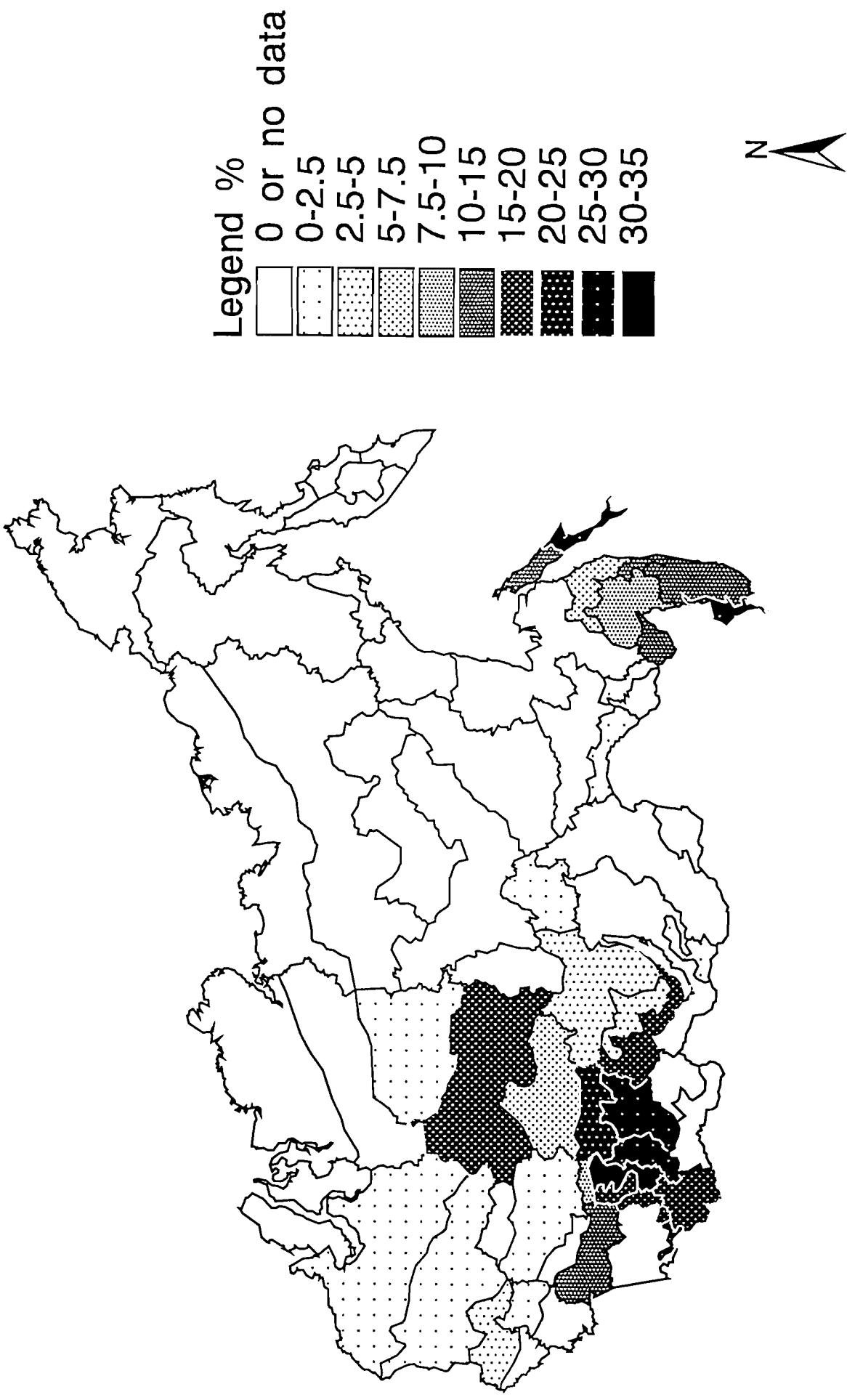
Map 7.17. Effective area of cedar as a proportion of the Forested Areas.

Legend %

	0 or no data
	0-5
	5-10
	10-15
	15-20
	20-25
	25-30
	30-40
	40-62

N
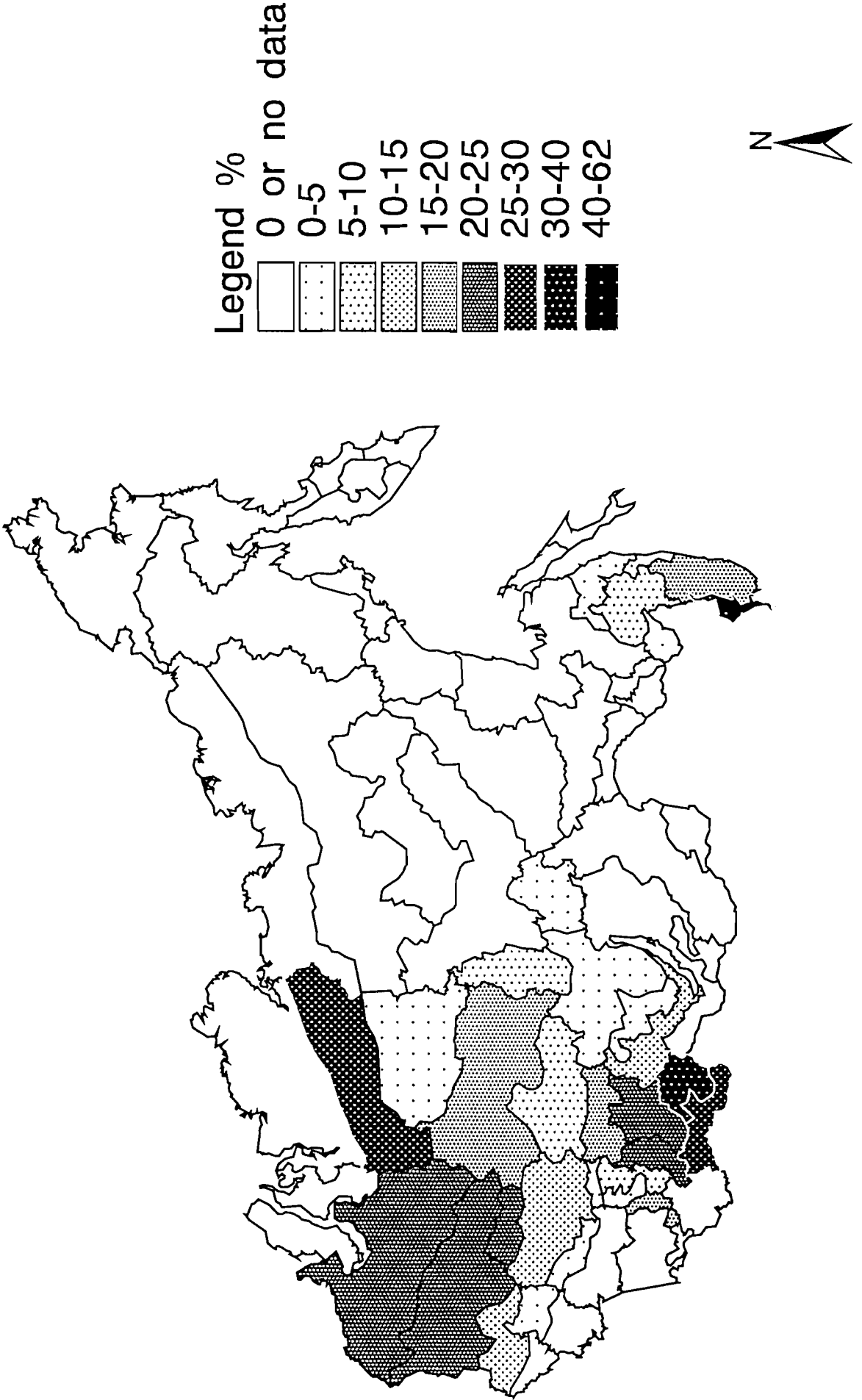
Map 7.18.   Effective area of soft deciduous species as a proportion of the Forested Areas.

Legend %

	0 or no data
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N
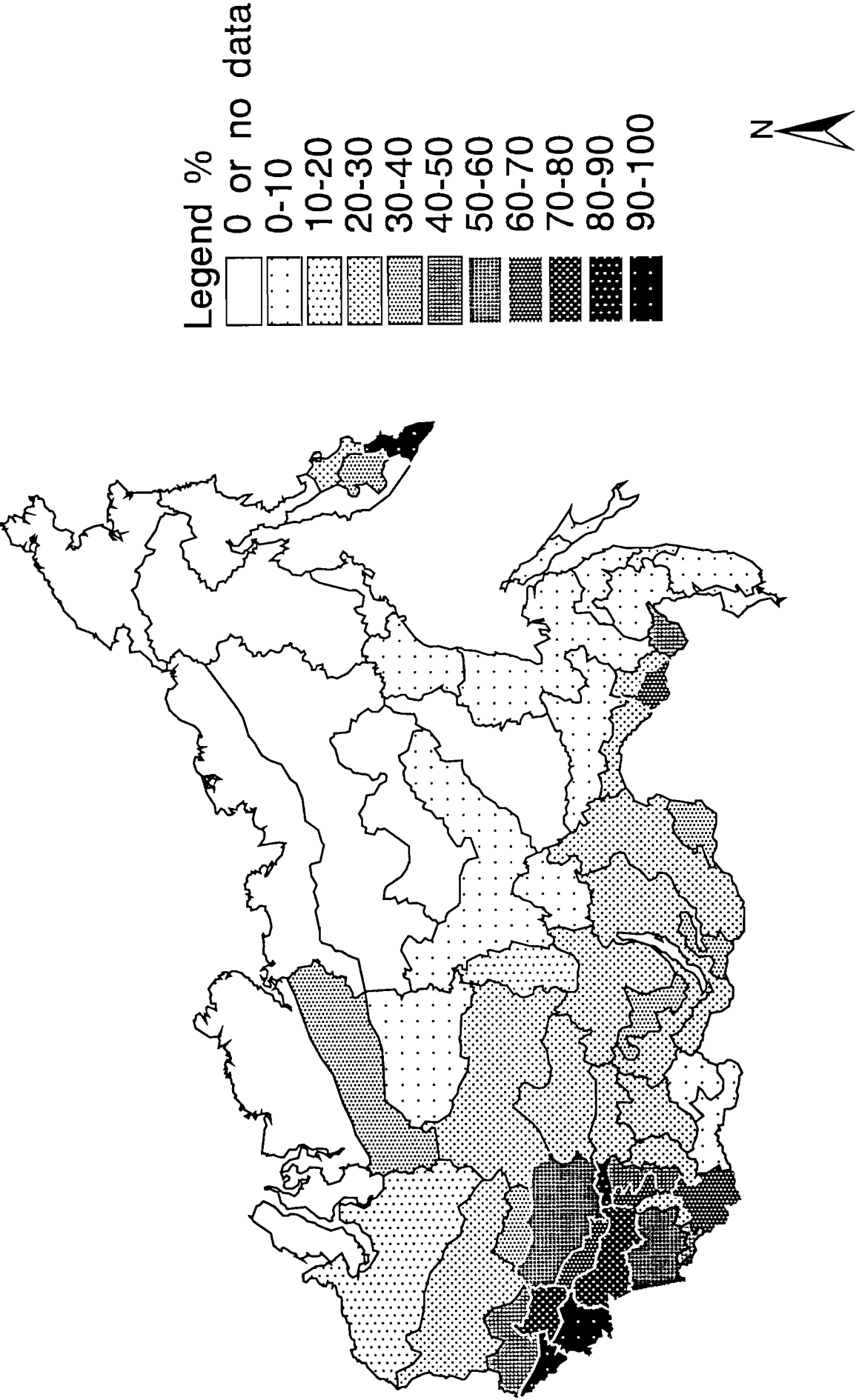
Map 7.19. Effective area of birch as a proportion of the Forested Areas.

Legend %

0 or no data
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100

N
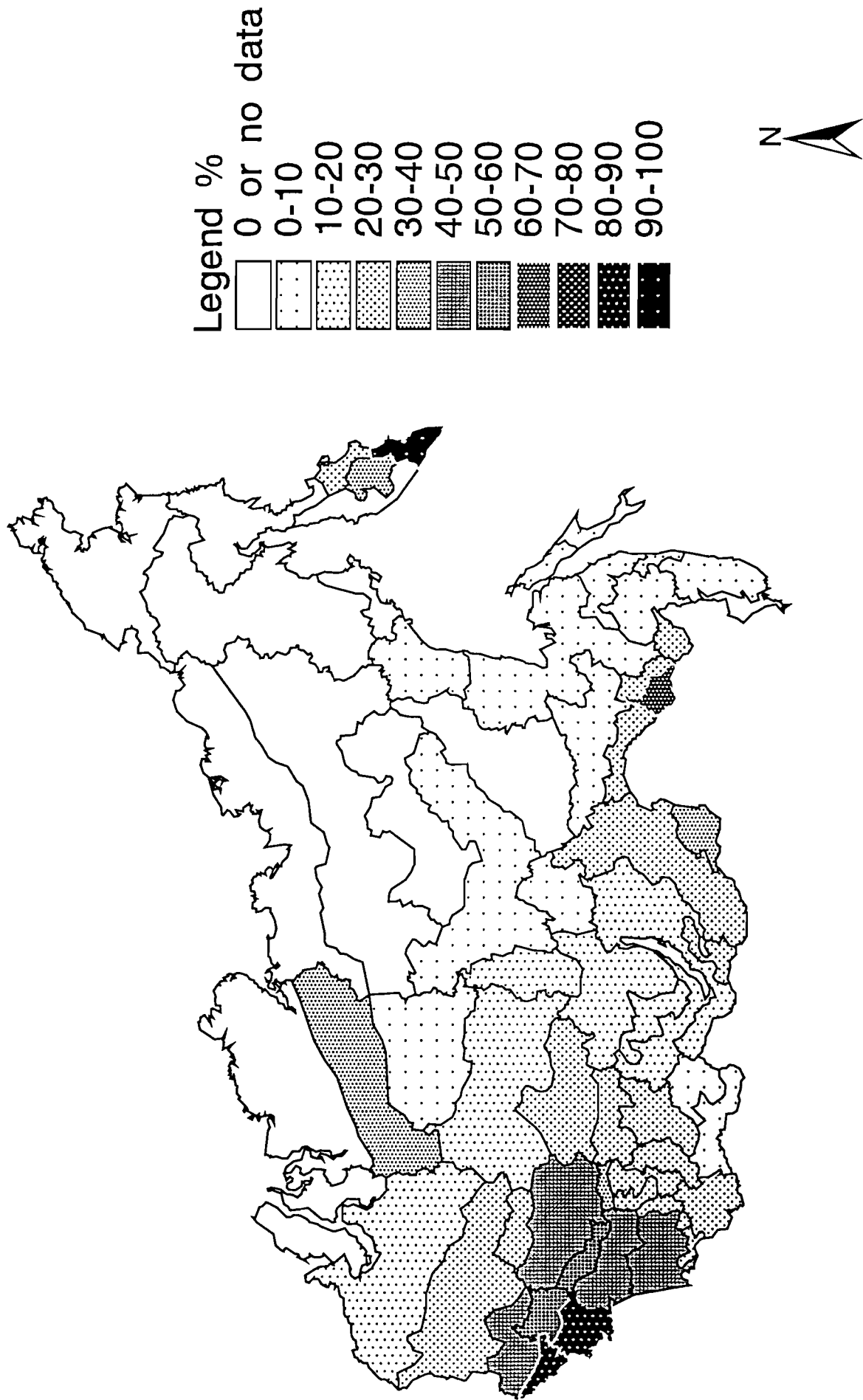
Map 7.20. Effective area of aspen as a proportion of the Forested Areas.

Legend %
0 or no data
0-2.5
2.5-5
5-7.5
7.5-10
10-15
15-20
20-25
25-30
30-43

N
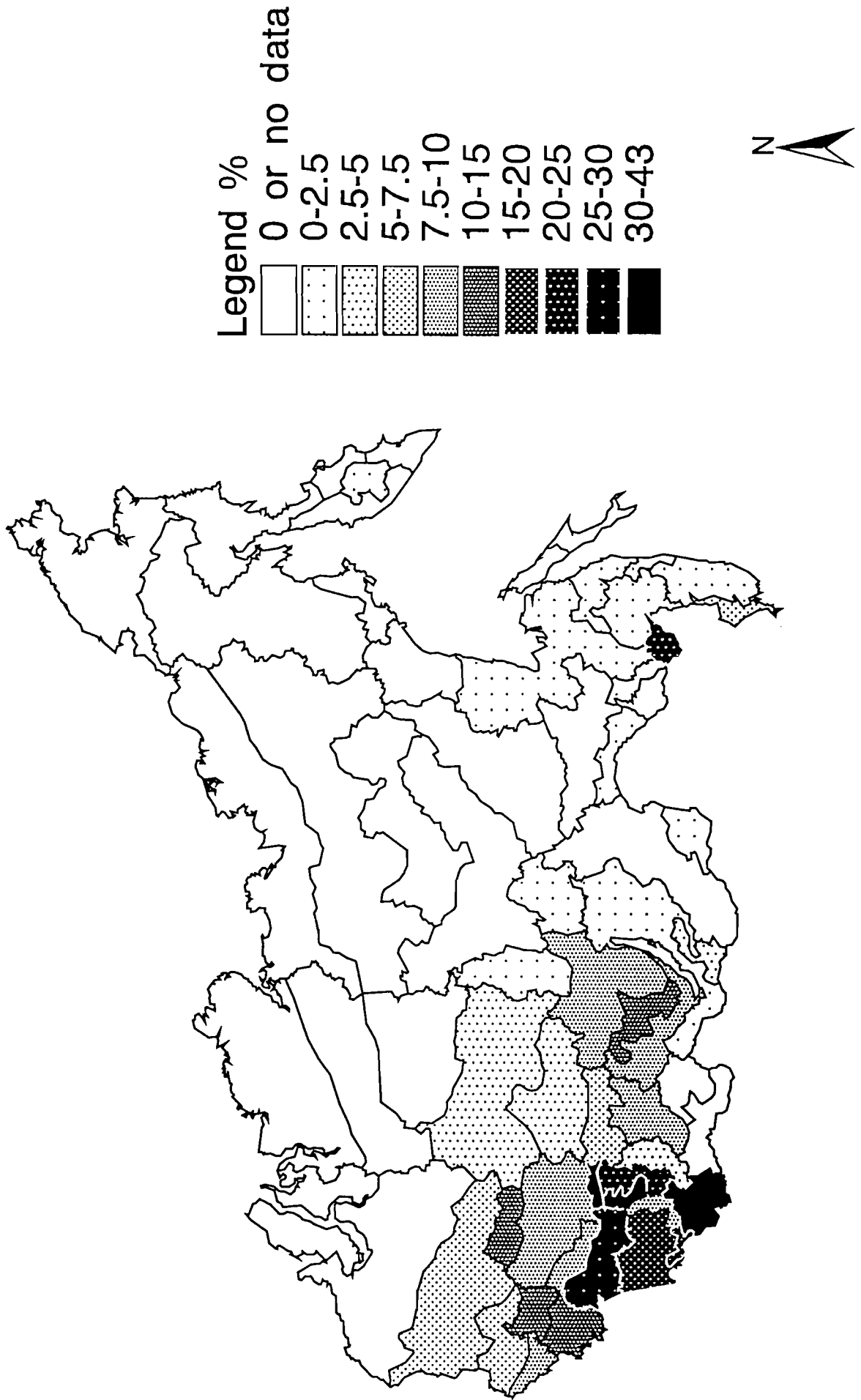
Map 7.21. Effective area of hard deciduous species as a proportion of the Forested Areas.

Legend %

☐ 0 or no data

|	
⋮	0-5
	5-10
	10-15
	15-20
	20-25
	25-30
	30-35
	35-40
	40-45
	45-50

N

48
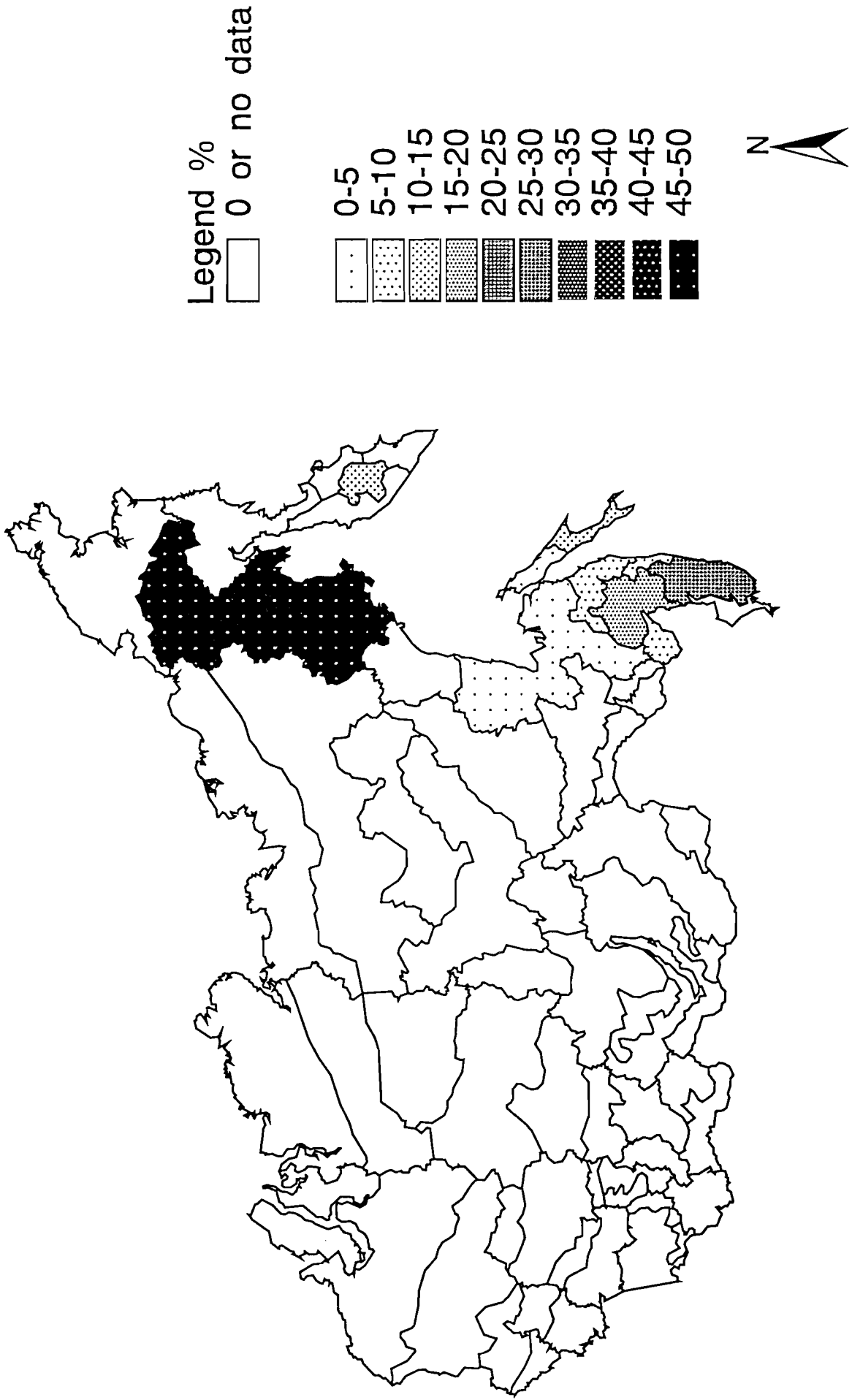
8. Development Stages of the Forests

The distribution of all species under 20 years of age of the total Forested Areas is presented in Map 8.1. Map 8.2 shows the distribution of all species of the Forested Areas, which are in the first development stage. The first development stage according to Russian classification is defined as middle-aged and immature stands. Map 8.3 shows the distribution of mature and over-mature forests for all species. In Maps 8.4 to 8.6 the development stages are shown in the form of proportion of effective areas.

49

Map 8.1. Percentage of all species under 20 years of age of the Forested Areas.

Legend %

☐	0
☐	0-2.5
☐	2.5-5
☐	5-7.5
☐	7.5-10
☐	10-15
☐	15-20
☐	20-25
☐	25-30
■	30-55

N
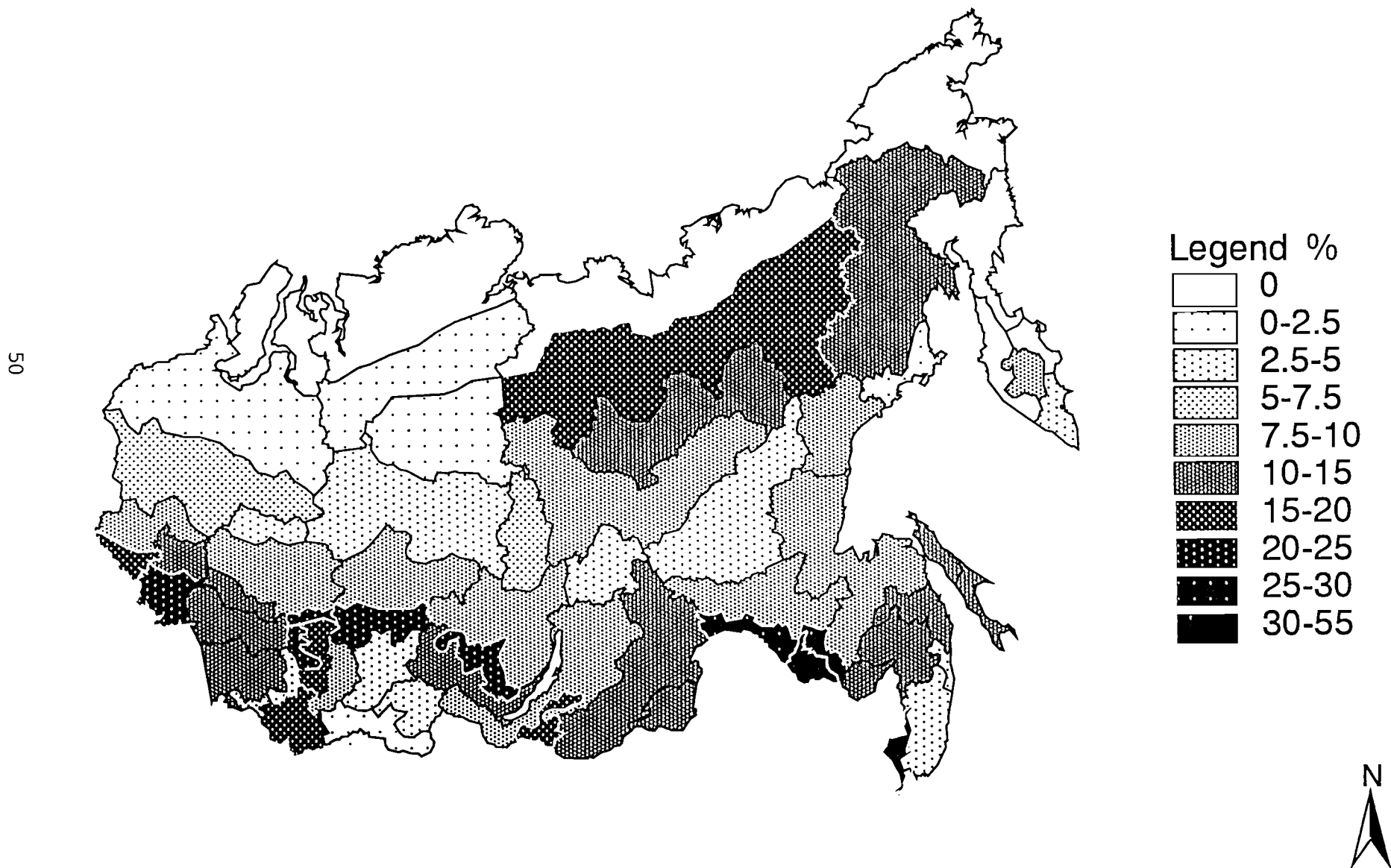
Map 8.2. Percentage of Forested Areas with all species in the first development stage.

Legend %
0
0-2.5
2.5-5
5-7.5
7.5-10
10-15
15-20
20-25
25-30
30-45

N
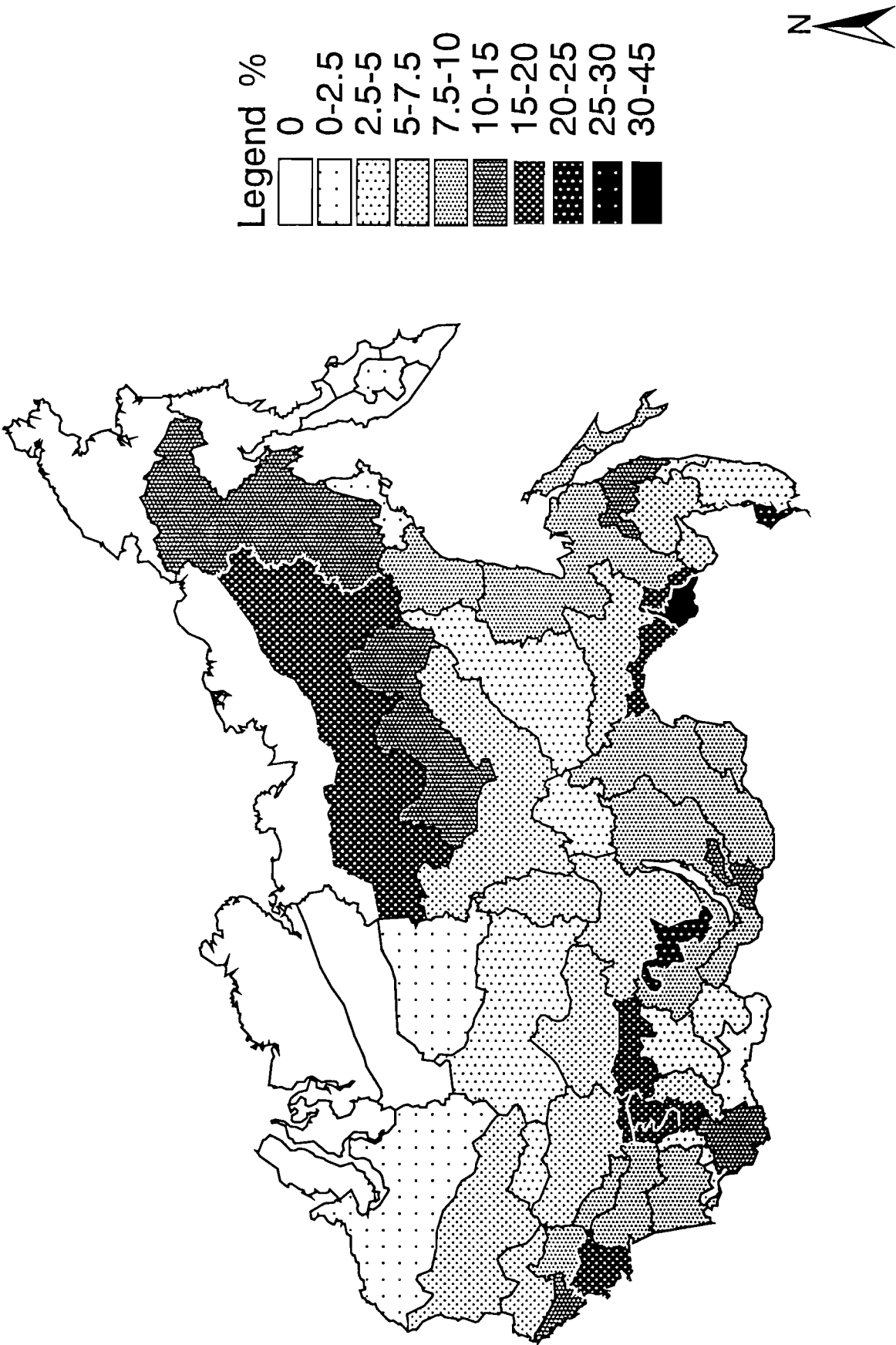
Map 8.3. Percentage of Forested Areas with all species in mature and over-mature development stages.

Legend %

☐	0
	0-10
	10-20
	20-30
	30-40
	40-50
	50-60
	60-70
	70-80
	80-90
	90-100

N
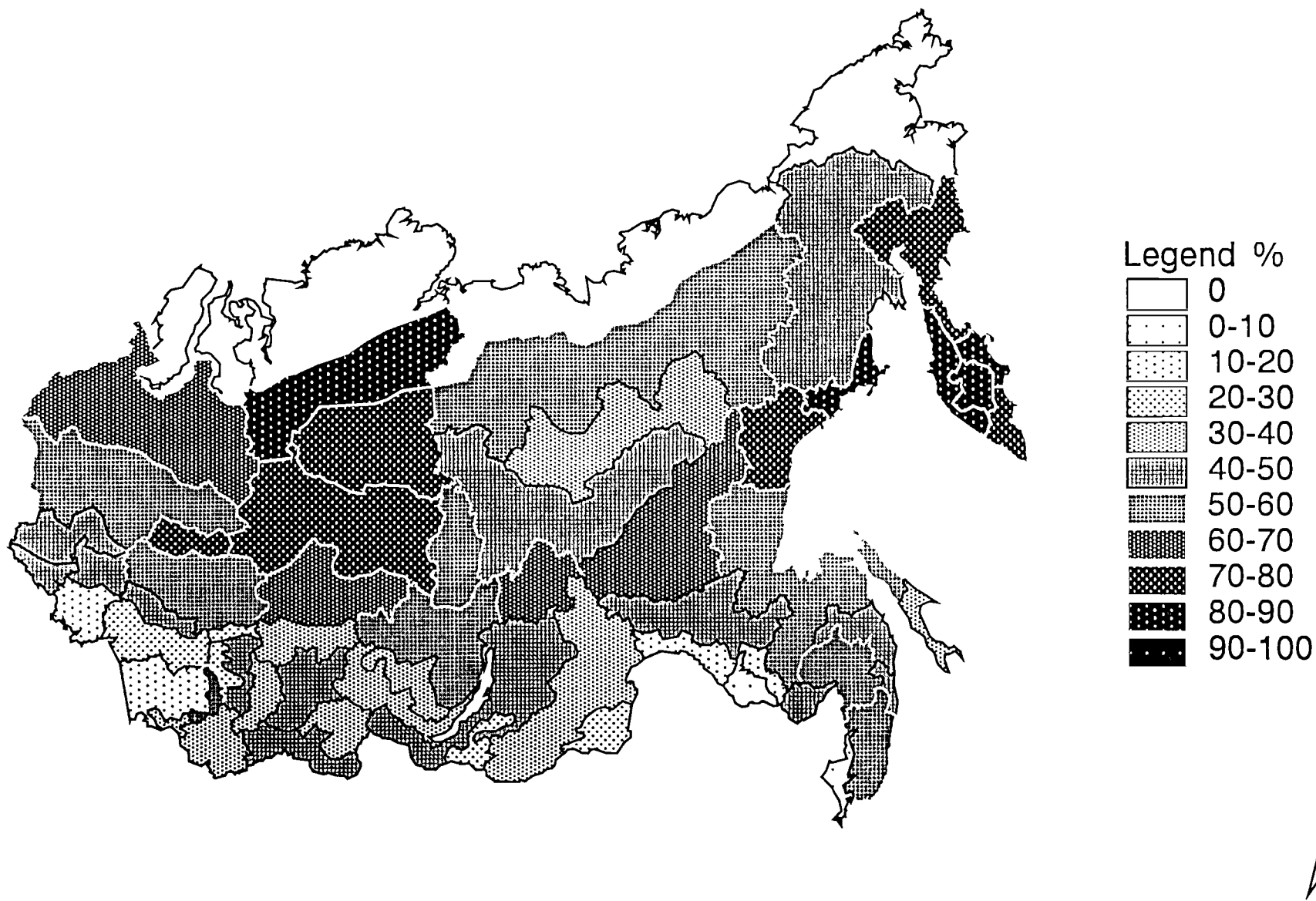
Map 8.4. Proportion of effective areas of the main species of Forested Areas under 20 years.

Legend %
0
0-1
1-2
2-3
3-5
5-7.5
7.5-10
10-15
15-20
20-25
25-30

no data
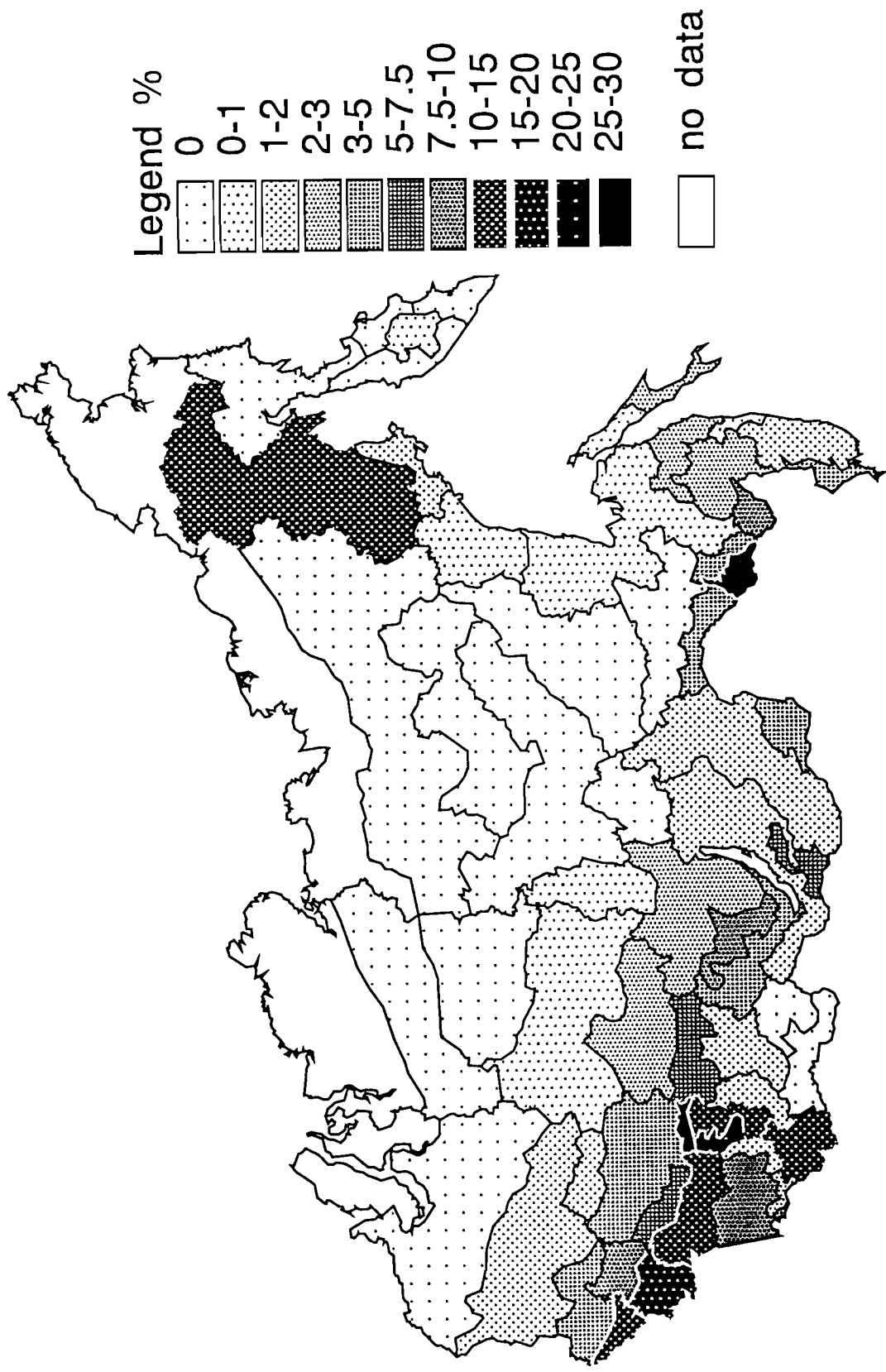
Map 8.5. Proportion of effective areas of all species of the Forested Areas in the first development stage.

Legend %

- 0
- 0-2.5
- 2.5-5
- 5-7.5
- 7.5-10
- 10-15
- 15-20
- 20-25
- 25-42

no data

N
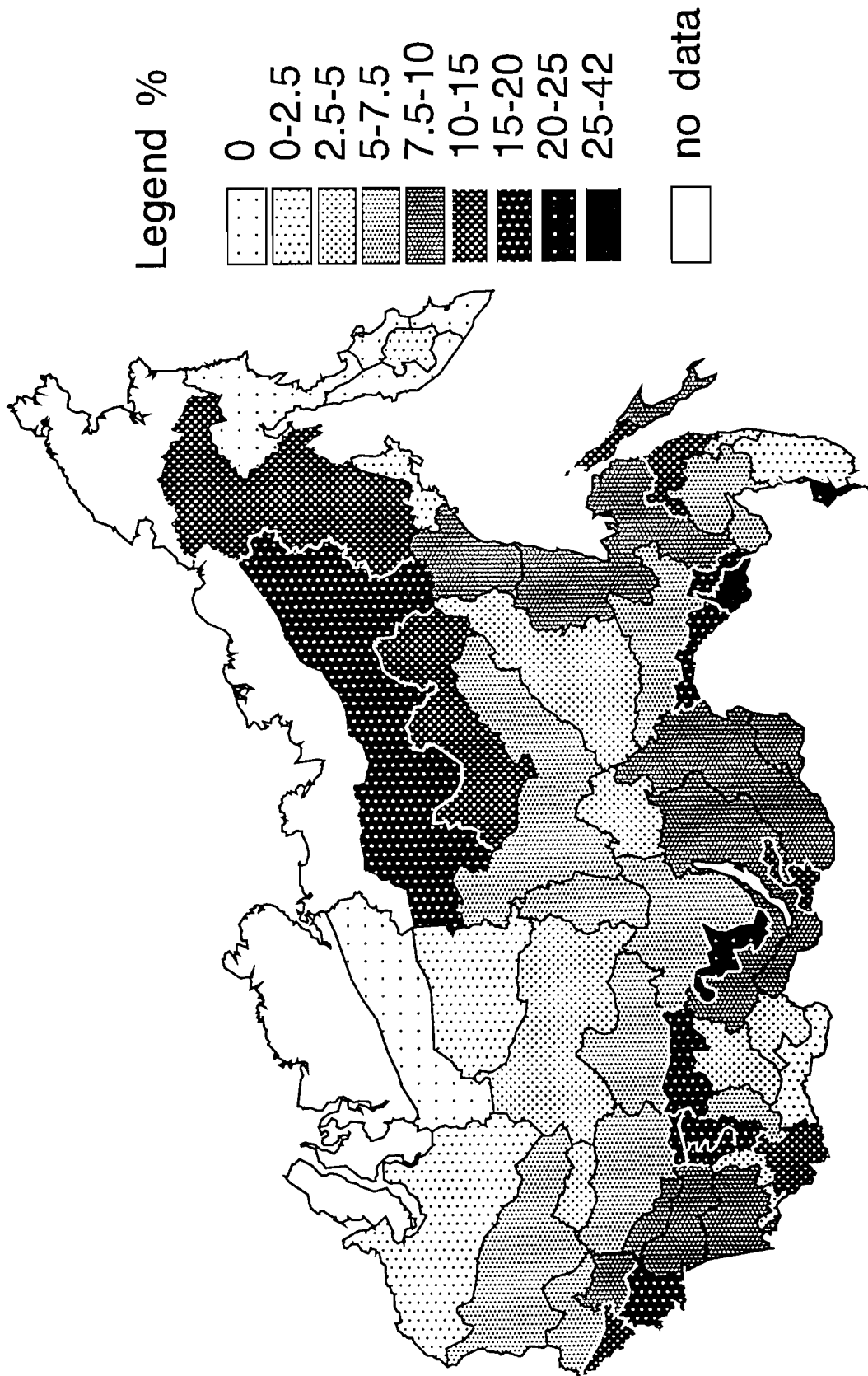
Map 8.6. Proportion of effective areas of all species of Forested Areas in the mature and over-mature development stage.

Legend %

- 1-10
- 10-20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90

no data

N
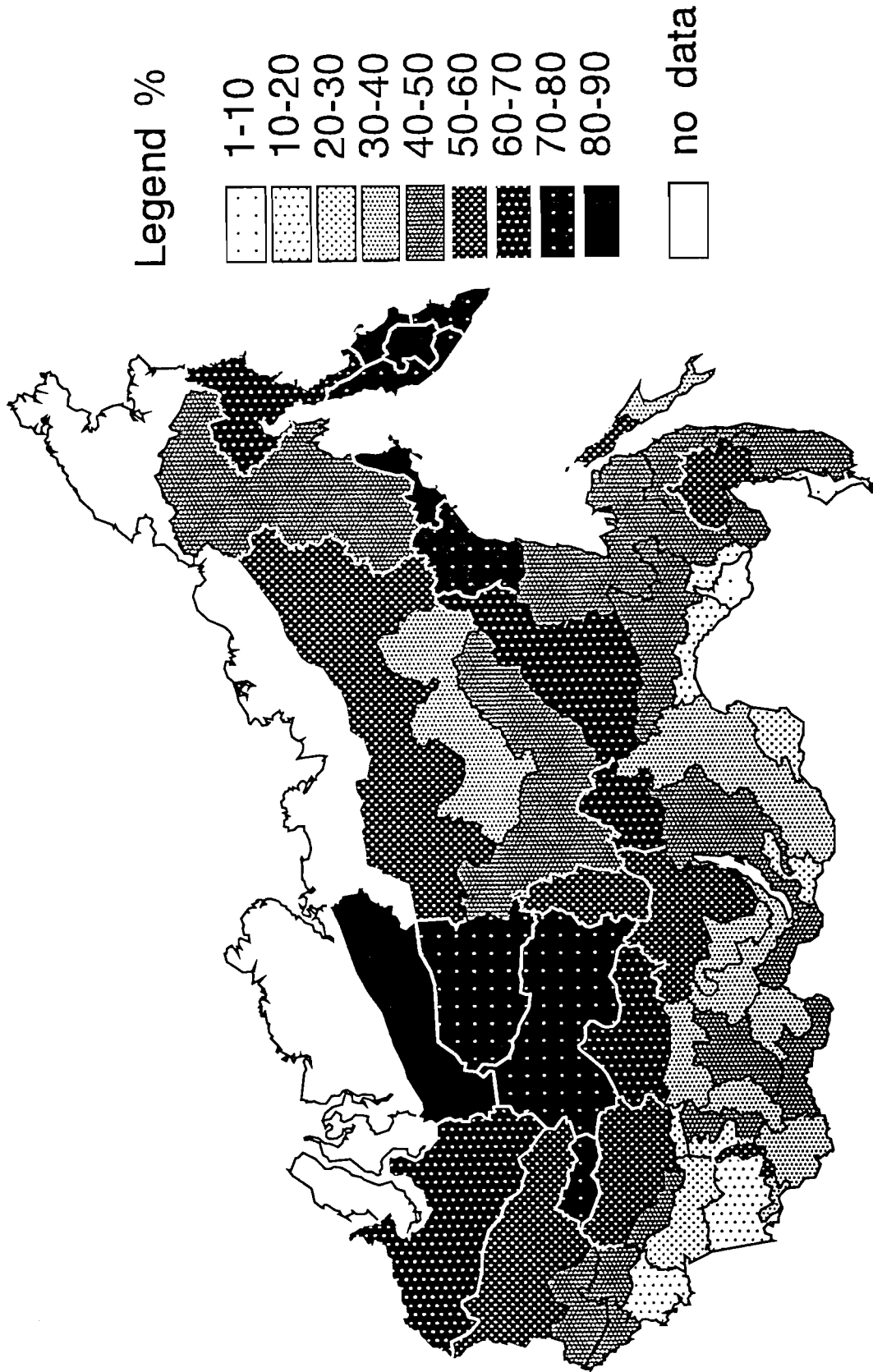
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