

Europäisches Umweltjahr
European Year of the Environment
1987

**XVth INTERNATIONAL
FORESTRY STUDENTS
SYMPOSIUM**

PROCEEDINGS

"FORESTS IN DANGER - HUMAN IMPACT"

21st - 25th April 1987

Munich
Federal Republic of Germany

CONFLICTS BETWEEN PRODUCTIVE AND SOCIAL USES OF FORESTS:
A STUDY OF THE EFFECTS OF RECREATION ON TIMBER PRODUCTION
IN A RECREATIONAL AREA OF SPAIN

by Elena Gómez Chico,
Andrés Orive, Martínez Falero, J. Solana
Department of Project and Planning, E.T.S.I. Montes,
Politechnical University of Madrid, Spain

Introduction:

In recent decades there has been a universal tendency, towards growth in the demand for outdoor areas of leisure and relaxation. Thus the countryside, and especially forested areas, play an important role in the satisfaction of this demand. This is true for Spain as well.

Therefore, in view of the growing demand on the social functions of the forest, as compared to the role it plays for exploitation, it becomes necessary to make these two different types of use more compatible: on the one hand there are the traditional uses of the forest - the production of timber, grazing, protection of watershed, while on the other hand there are the social uses - recreation, landscape, the conservation of certain values

Integration of these two types of uses, poses certain practical problems, among which we might mention the following problems for the particular case of recreation:

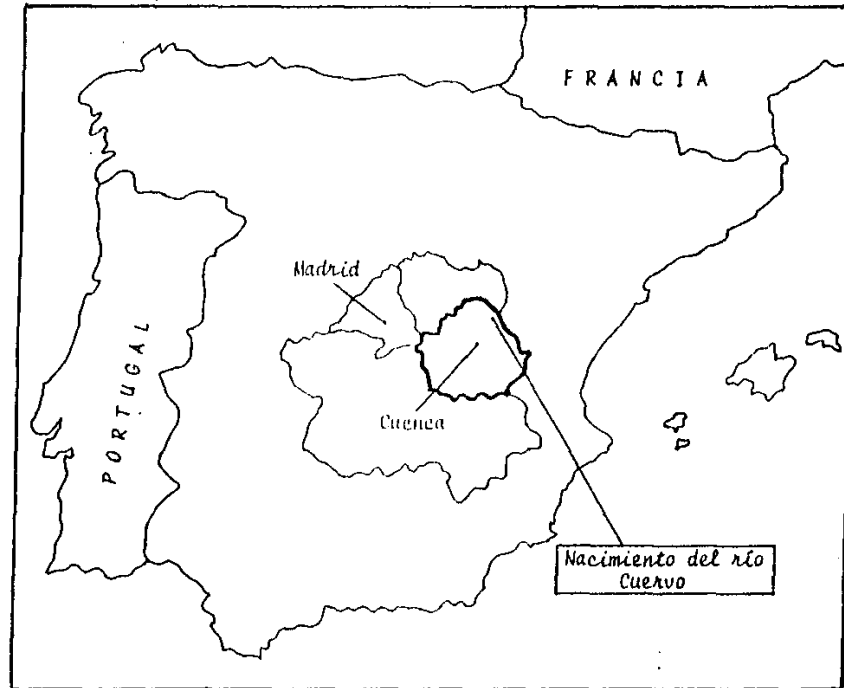
a) Striking a balance between, on the one hand, forestry and harvesting methods (felling, regeneration, thinning, etc.) and on the other, maintenance of the tree stand in proper condition for recreational activities (aesthetic quality, canopy closure, density of understory, etc.).

b) Impacts or adverse effects of one of the uses on the others, in particular, impact of recreational use on the productive potential of the forest.

This last aspect has not yet been dealt with very much, and is not often documented in specialised literature. Moreover, results (Lapage, 1962; Legg, 1973; Butler and Knudson, 1977; James T.D.W. et al., 1979) are difficult to extrapolate from conditions which are different from those of the study.

Not very much is known about the effects of different types and intensities of recreational use, on growth, nor about the fragility of different arboreal species and formations. We think it is quite important to go somewhat deeply into this topic, which is fundamental when it comes to developing policies for the control and planning of recreational activities in forests which have multiple uses. In this paper we describe the methodology, and analyse the results obtained in a study about the effects of recreational use on the growth of *Pinus sylvestris* in an expanse of multiple use forest.

FIGURE 1. Geographic location of the study area



Description of the area studied:

The area in which the investigation was carried out is situated in the "Serrania de Cuenca", a mountainous area located in the centre of Spain. The "Nacimiento del Rio Cuervo" (Source of the River Cuervo), is the name given to a natural area which includes the source of the river itself as well as the upper stretch of the drainage basin of the River Cuervo and comprises an approximate surface area of 1300 ha. It is a valley which was opened up by the erosive action of river water, it is surrounded by very steep slopes, and is set in a countryside which is decidedly wooded. Outstanding visual features are waterfalls, cliffs and rocks. The average altitude of the area under study is 1500 m. The climate may be described as temperate-cool mountainous continental. Rainfall is abundant (850 mm per annum on the average) though there is a period of drought in the summer. Soils are of the "calcimorphic brown" type. However, in those places where there are, or recently have been, erosive phenomena, or sedimentation of a certain intensity, immature soils having a lower degree of development, of the type "rendzina dolomitica", are found. The pH of these soils is neutral or slightly alkaline.

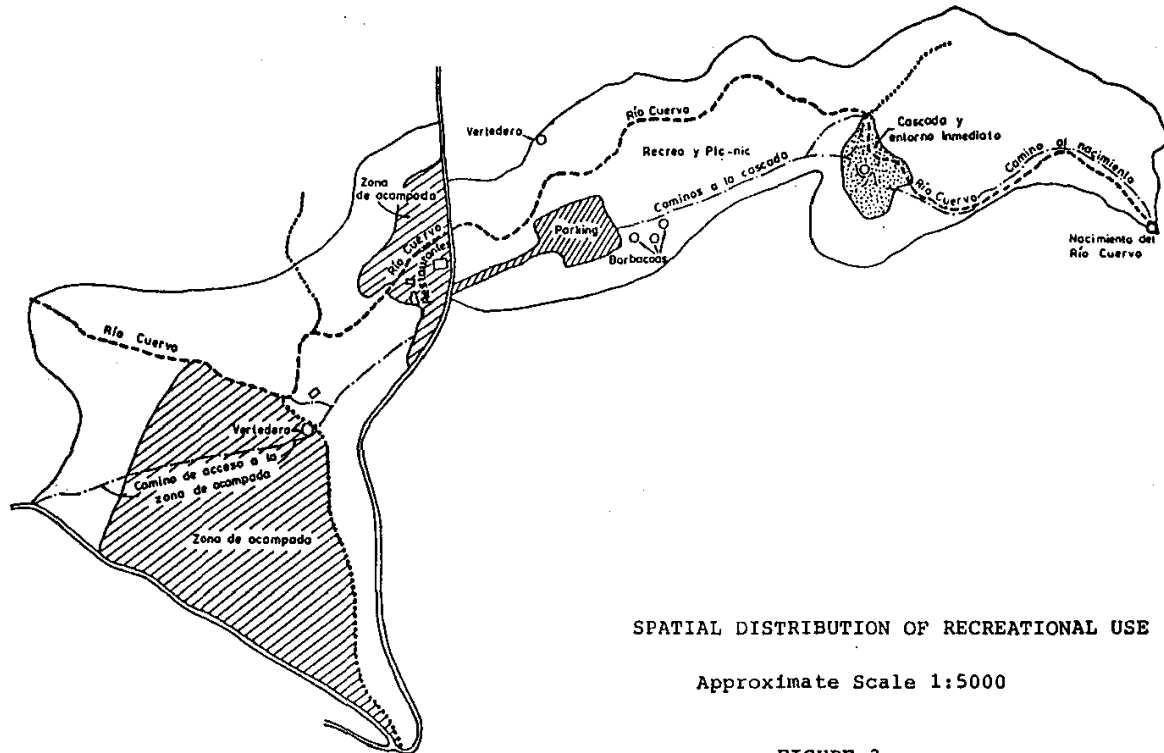
Pine trees, *Pinus sylvestris* mixed with a few scattered individuals of *Pinus nigra*, form the predominant vegetation. Nonetheless, the potential vegetation would consist of groves of *Quercus faginea* which at present have vanished from the area under study. The reasons for their disappearance are felling, forest harvesting, and the advance of natural pine, indigenous to the area.

The region is being exploited in three ways: timber harvest, grazing and recreation.

The exploitation of timber is the main factor; an annual production figure of 1.6 million m³ may be stated. What is more, this timber is one of the better quality coniferous timbers in Spain. Grazing is seasonal; the land is only used during the warmer months. Now, while timber and grazing are traditional activities which have been going on for centuries, recreational use is only recent, going back no more than 15 years.

The volume of recreational use to which this area is subjected is very high indeed; the annual number of visitors is estimated at 30,000. The high number of visitors occurs almost exclusively concentrated during the summer months, a period during which on the other hand the vegetation is already subjected to greater stress on account of the lack of water. The recreational activities which go on are of different types: camping, picnics, walks, etc..

In figure 2, the surface area affected by recreational use is shown, as well as a spatial distribution of uses. Recreational use does not have a uniform spatial distribution; the geomorphical characteristics of the area and the existing infrastructure (road network, car parks, restaurants) are concentrated in certain areas and according to road access.



SPATIAL DISTRIBUTION OF RECREATIONAL USE

Approximate Scale 1:5000

FIGURE 2

General methodology of the study:

The study of the possible effects of recreational activities on arboreal growth has been carried out in accordance with the conventional methodology of studies aimed at detecting environmental changes, by comparing and contrasting healthy and damaged samples.

The sample plots were, on the one hand, distributed randomly over the territory, and on the other hand, they were systematically fixed along linear axes. To the data extracted from these sample plots, the data taken from samples of isolated trees located in the most frequented areas was added.

The data taken for each tree were: diameter, height, mechanical damage and depth of root exposure. We also used Presser drills (increment core borers) to measure total, average and annual radial growth.

"Damaged" samples were those considered to be made up of trees which had exposed roots, caused by being trampled on. We discarded from this group those trees which had naturally exposed roots due to steeply sloping ground; in the same way we also did not include in the damaged section trees with mechanical damage, as these were not exclusively found in the area affected by recreational use. The scarcity of *Pinus nigra* in the area justifies the fact that the study concentrated exclusively on *Pinus sylvestris*.

Given that the influx of visitors to the Source of the River Cuervo region, began only fifteen years ago, and the real rush only about 5-10 years ago, then hypothetically, diminished growth, if any, should appear in the annual rings corresponding to recent years.

Effects on growth:

Radial growth

Initial data

The study of radial increment was carried out using a sample of sixty trees, of which twenty-one were damaged. Table 1 shows the characteristic data for each of the trees in the sample.

Method

The annual growth of the damaged and undamaged trees, by age classes, were at first contrasted directly; however, a lack of any clearly defined results indicated that we should make a study of the trend. The procedure adopted for the study of the trend was that of the moving average. The growth of each year is given by the average growth for the three previous years and the three subsequent years. For the damaged trees, and with the aim of not losing accuracy in those cases where the differences in growth were small, we chose, for the last 10 years, the two years before

and after; and for the last 5 years, the year before and after the corresponding point.

The seasonal effect was eliminated by introducing the value of the quotient between trends; the changes in the gradient of this quotient could well be indicative of the existence of impact.

Results

In the following figures we show the results obtained by age-class (Figures 3-7) and by homogeneous classes of growth rings (Figs. 8-12).

At first we carried out an analysis with age-classes, but negative results made it advisable to use groups of trees with a similar number of growth rings. The reason for this was to eliminate the effects of trampling, on the growth of young trees which were used in order to estimate how many years pass before the tree reaches the standard height of 1.3 metres. By observing the second group of graphs it can be seen that there are no differences between the growth of healthy and damaged trees, which might be ascribable to recreational use.

Growth in height

Initial data

The sample of trees used is shown in Figure 13.

Method and results

We studied the trend of the height/diameter ratio both in healthy and in damaged trees, using the same method of the moving average, but on both axes. At each point we looked at the average of the five previous and subsequent diameters and heights (Figs. 13 and 14). The comparison of the trend-curves does not show any evidence of change in height in the damaged trees, as both curves are cut off at two points (Fig. 14).

TABLE 1

SAMPLE OF TREES USED FOR THE STUDY OF RADIAL GROWTH

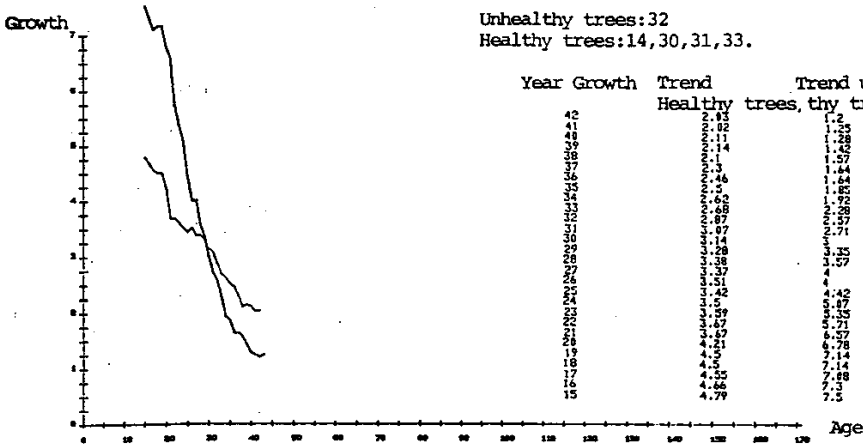
Tree	Year: Growth	Diameter	Total Growth	Average Growth	Root exposure	Stem scars	Height
1.	38	34	92	2.42	9.5	1	16
2.	43	15	53	1.23	13	1	10
3.	66	27	100.5	1.52	0	0	16
4.	31	25.5	114	3.67	9	0	14
5.	58	47	174	3	0	0	11
6.	56	33	136.5	2.43	17	1	22
7.	35	13	49.5	1.41	0	2	15
8.	140	37	135.99	1.97	0	0	19
9.	119	37	141.99	1.19	60	0	18.5
10.	28	23	97	3.46	30	3	12
11.	67	32	116.99	1.74	8	0	13
12.	117	62	226.49	1.93	20	0	16.5
13.	55	19	66.99	1.21	2	1	8.5
14.	17	13	53.5	3.14	0	0	8
15.	39	21	93	2.38	0	1	19
16.	33	23.5	110	3.33	0	1	19
17.	42	17	82.49	1.96	0	0	16
18.	38	29	124.5	3.27	6	0	13
19.	107	34	142.99	1.33	15	0	17
20.	45	35.5	77.5	1.172	9	0	15
21.	36	33	130	3.61	10	4	14.5
22.	49	33	131	2.67	5	0	17.5
23.	37	15	65.5	1.77	7	0	8
24.	133	42	150.99	1.21	15	0	15.5
25.	145	46	155.99	1.14	22	0	17
26.	142	35	121.49	1.94	6	4	17
27.	143	48	153.66	1.07	0	0	22
28.	143	36	133.99	1.11	6	6	15.5
29.	123	16	68	7.333	0	0	8
30.	22	22	32	2.222	6	1	11
31.	21	22	79.5	3.78	6	1	12
32.	22	22	16.5	0.75	3	1	16
33.	27	22	68	2.518	0	3	9.5
34.	47	43	67.5	1.57	5	7	7.5
35.	35	33	111	3.36	5	1	13
36.	35	33	111	3.36	5	1	13
37.	43	41	161	3.7	2	0	17
38.	41	41	157	3.83	2	0	18
39.	46	46	163	3.54	2	0	17.5
40.	46	46	163	3.54	2	0	17.5
41.	41	41	157	3.83	2	0	18
42.	43	43	163	3.79	2	0	17.5
43.	41	41	157	3.83	2	0	18
44.	41	41	157	3.83	2	0	18
45.	41	41	157	3.83	2	0	18
46.	41	41	157	3.83	2	0	18
47.	41	41	157	3.83	2	0	18
48.	62	34	127.99	3.76	28	4	15.5
49.	36	36	69	1.91	28	1	14.5
50.	36	36	92.5	2.56	22	4	14.5
51.	36	36	92.5	2.56	22	4	14.5
52.	15	15	46.5	3.1	0	3	14
53.	15	15	46.5	3.1	0	3	14
54.	74	62	121	1.63	6	1	7.5
55.	62	43	91	2.11	6	3	12
56.	59	43	110	2.67	6	0	17
57.	66	46	99.5	1.65	6	0	19
58.	104	99	103.5	1.99	0	2	15
59.	85	31	122.5	1.44	15	3	14
60.	54	32	109	2.01	0	0	13
60	44	32	130	2.95	0	0	13

. Trees with roots exposure caused by trampling

Depth of root exposure in cm.

AGE CLASS 1 (TREES FROM 39 TO 44 YEARS)

— Radial growth trend of affected trees
 — Radial growth trend of healthy trees



AGE CLASS 2 (TREES FROM 45 TO 49 YEARS)

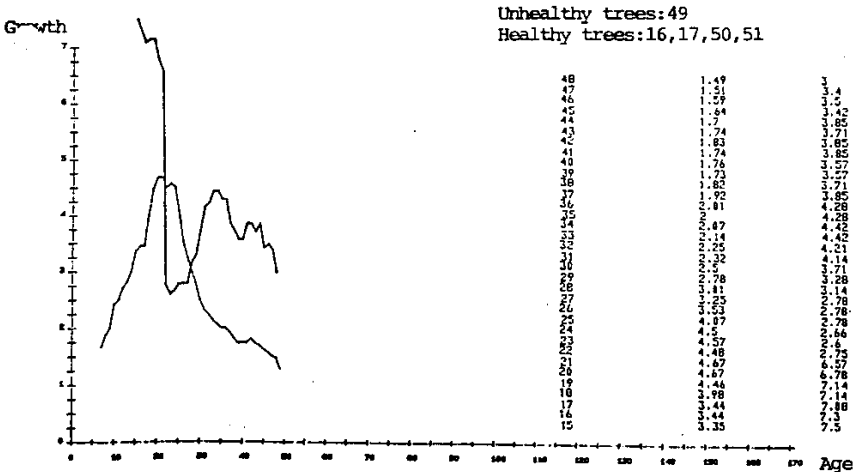
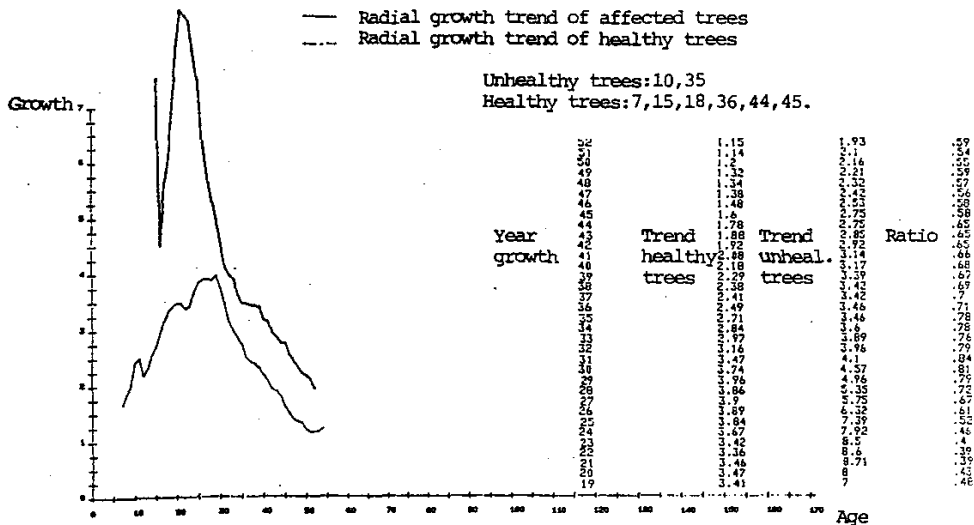


FIGURE 3

AGE CLASS 3 (TREES FROM 50 TO 54 YEARS)



AGE CLASS 5 (TREES FROM 60 TO 64 YEARS)

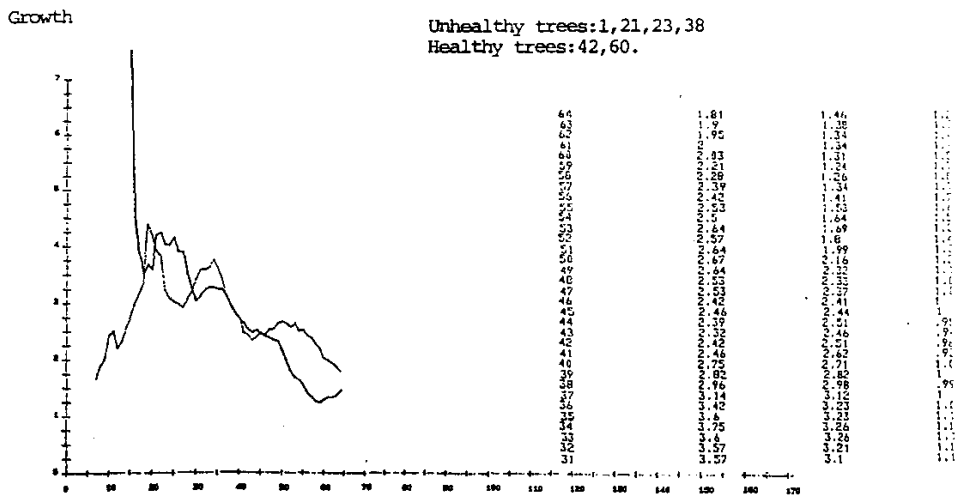


FIGURE 4

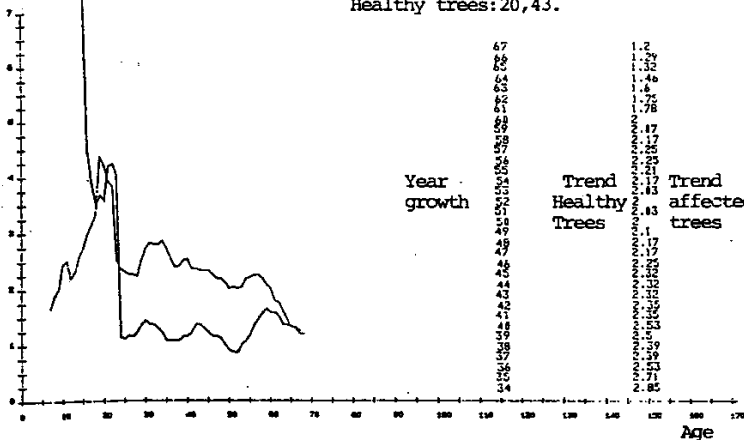
Age

AGE CLASS 6 (TREES FROM 65 TO 69 YEARS)

— Radial growth trend of affected trees
 --- Radial growth trend of healthy trees

Growth

Unhealthy trees:2
 Healthy trees:20,43.



AGE CLASS 7 (TREES FROM 70 TO 74 YEARS)

Unhealthy trees :22,37.
 Healthy trees :40,59.

Growth

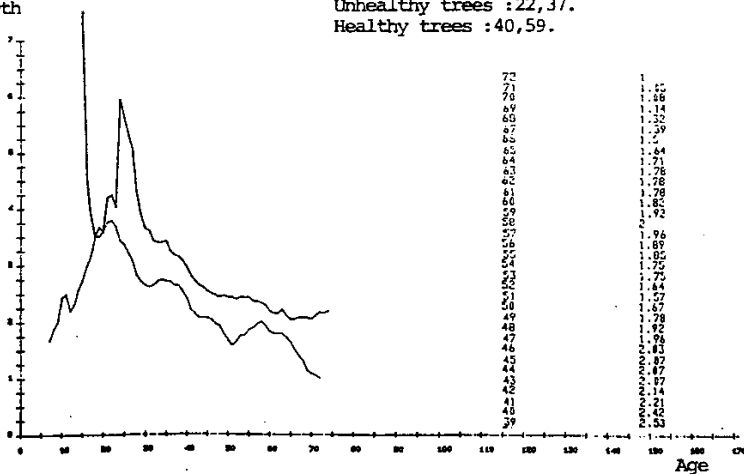
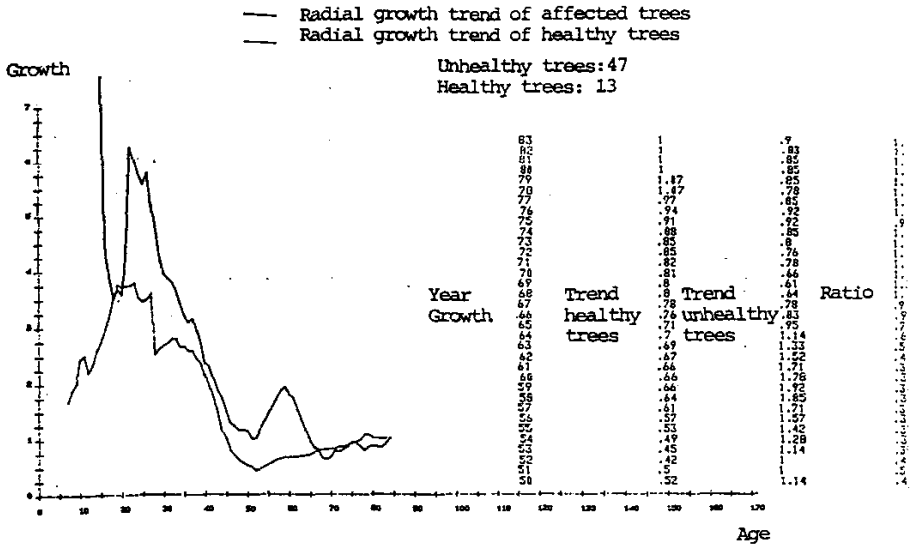


FIGURE 5

AGE CLASS 9 (TREES FROM 80 TO 84 YEARS)



AGE CLASS 11 (TREES FROM 90 TO 94 YEARS)

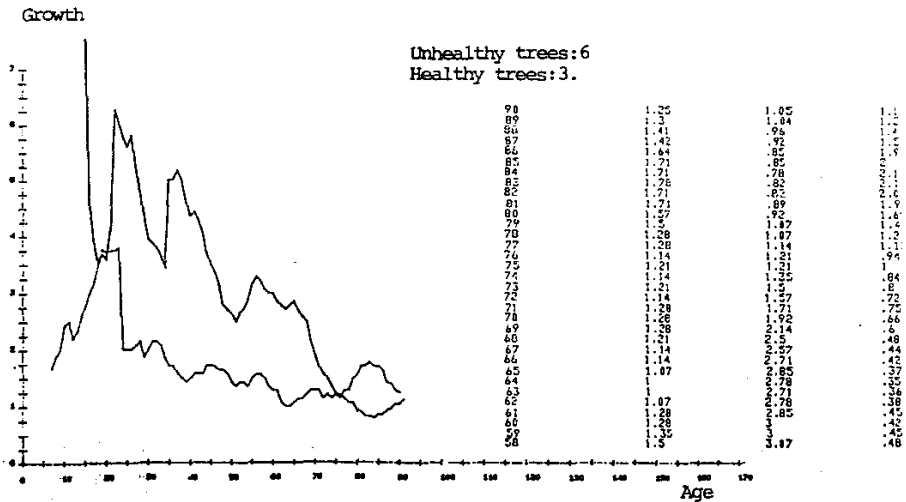
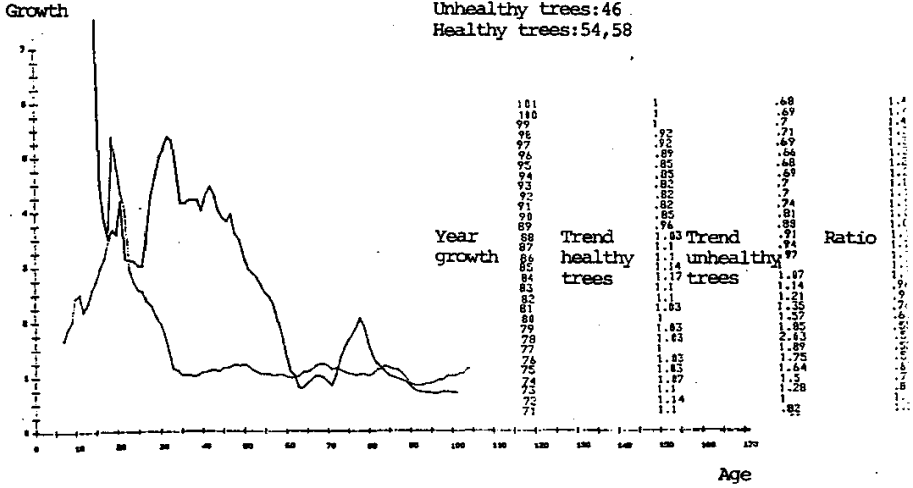


FIGURE 6

AGE CLASS 13 (TREES FROM 100 TO 104 YEARS)

— Radial growth trend of affected trees
 - - - Radial growth trend of healthy trees.

Unhealthy trees:46
 Healthy trees:54,58



AGE CLASS 18 (TREES FROM 140 TO 200 YEARS)

Unhealthy trees:9,19,41
 Healthy trees:8,12,24,25,26,27,28.

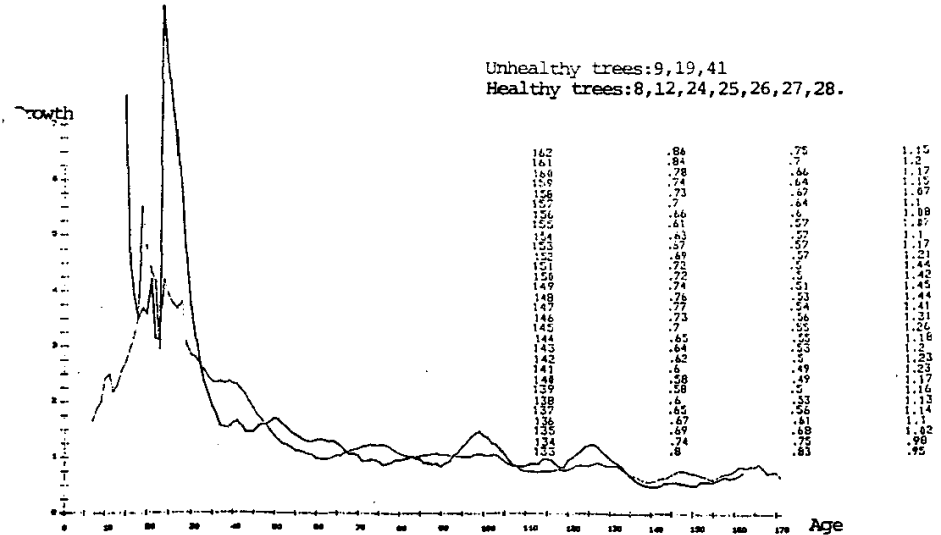


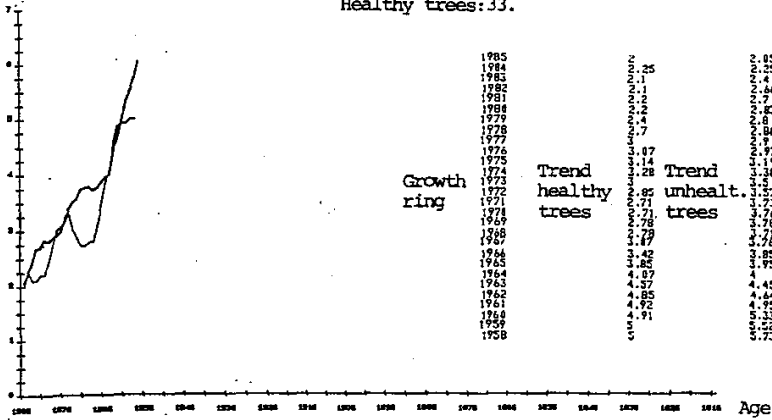
FIGURE 7

CLASS 1 (FROM 25 TO 29 GROWTH RINGS)

— Annual radial growth of affected trees
 — Annual radial growth of healthy trees

Growth

Unhealthy trees: 10,32,49
 Healthy trees:33.



CLASS 2 (FROM 30 TO 34 GROWTH RINGS)

Unhealthy trees : 4
 Healthy trees : 16,44,45,50,51.

Growth

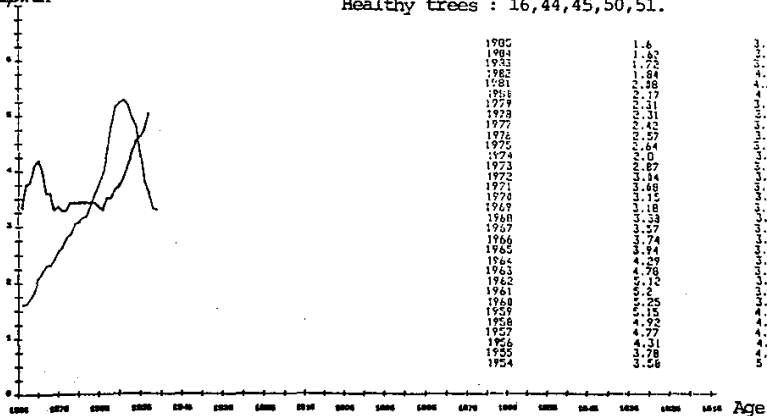
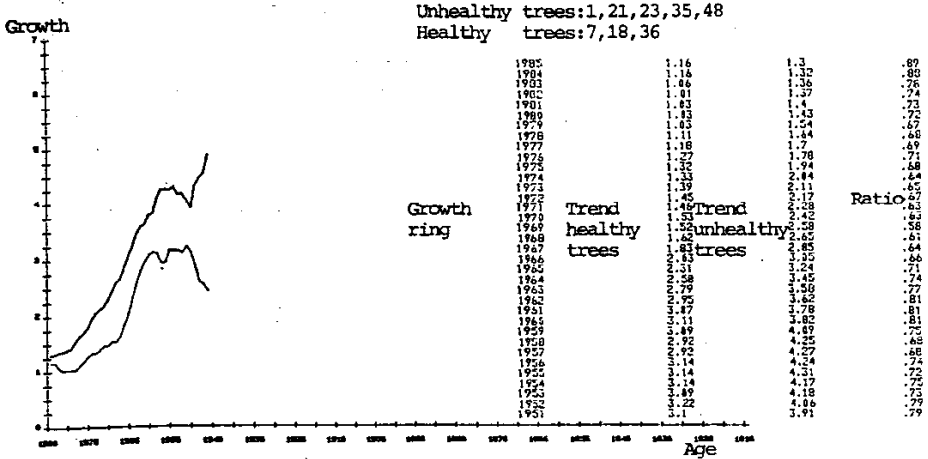


FIGURE 8

CLASS 3 (FROM 35 TO 39 GROWTH RINGS)

— Annual radial growth trend of affected trees
 --- Annual radial growth trend of healthy trees



CLASS 4 (FROM 40 TO 44 GROWTH RINGS)

Unhealthy trees: 2, 38, 39
 Healthy trees: 15, 17, 42, 43

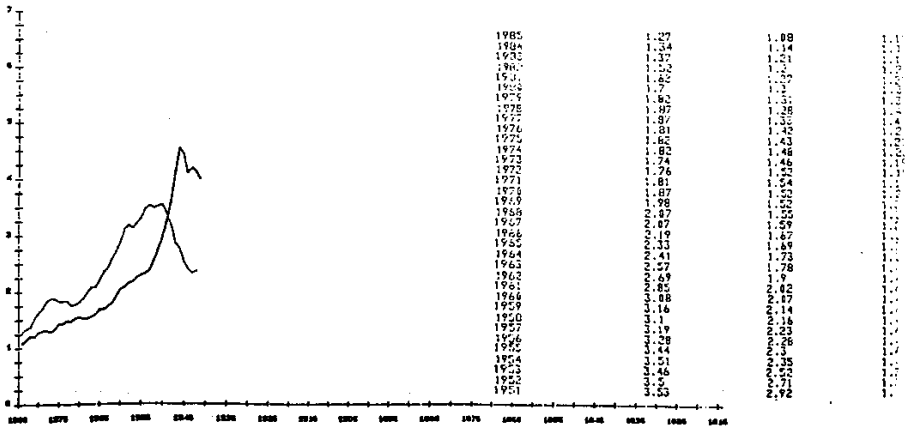
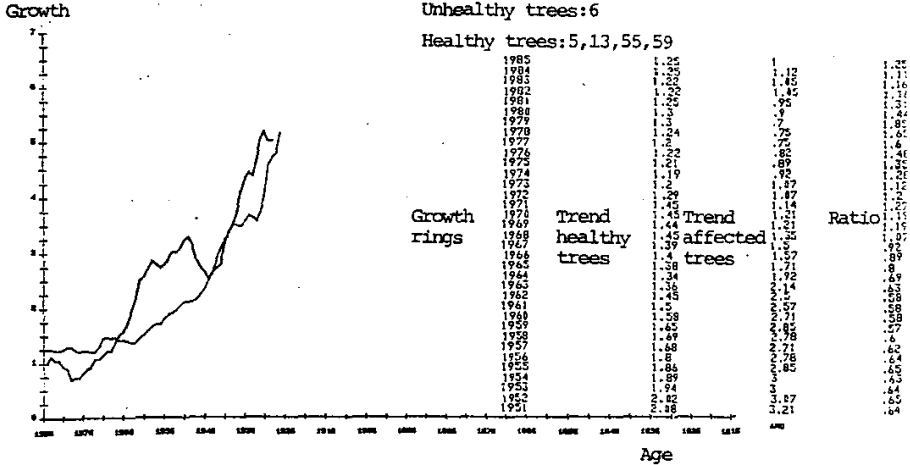


FIGURE 9

CLASS 7 (FROM 55 TO 59 GROWTH RINGS)

— Annual radial growth trend of affected trees
 — Annual radial growth trend of healthy trees



CLASS 8 (TREES FROM 60 TO 64 GROWTH RINGS)

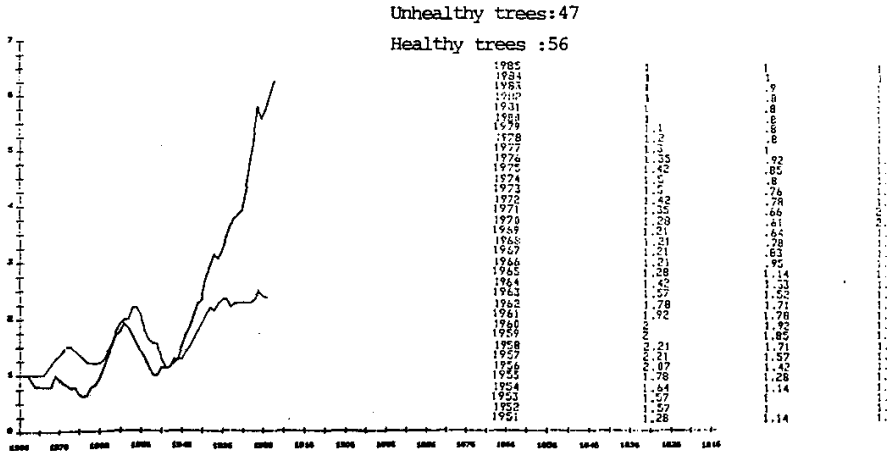
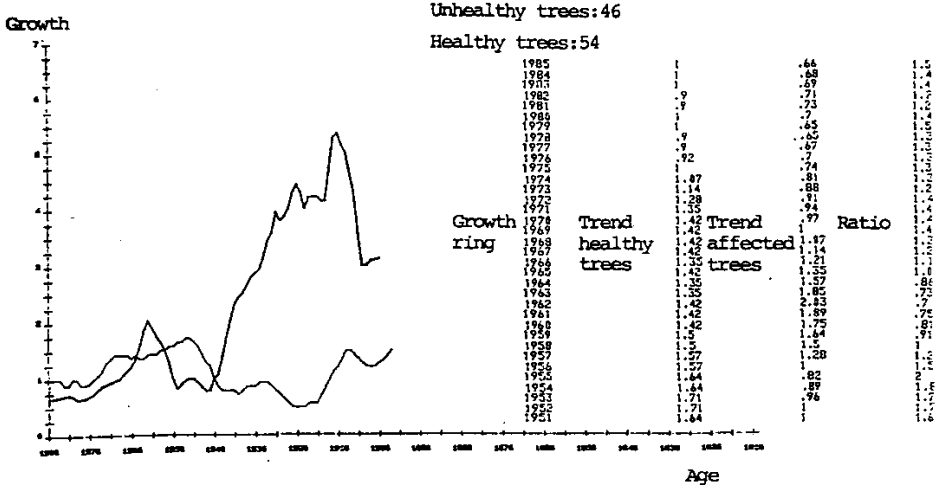


FIGURE 10

CLASS 12 (TREES FROM 80 TO 84 GROWTH RINGS)

— Annual radial growth trend of affected trees
 - - - Annual radial growth trend of healthy trees



CLASS 16 (TREES FROM 100 TO 109 GROWTH RINGS)

Unhealthy trees:19
 Healthy trees:57

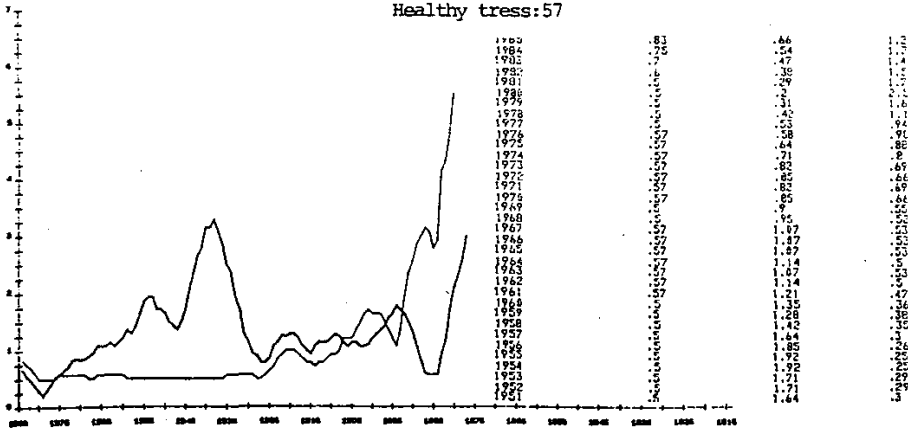
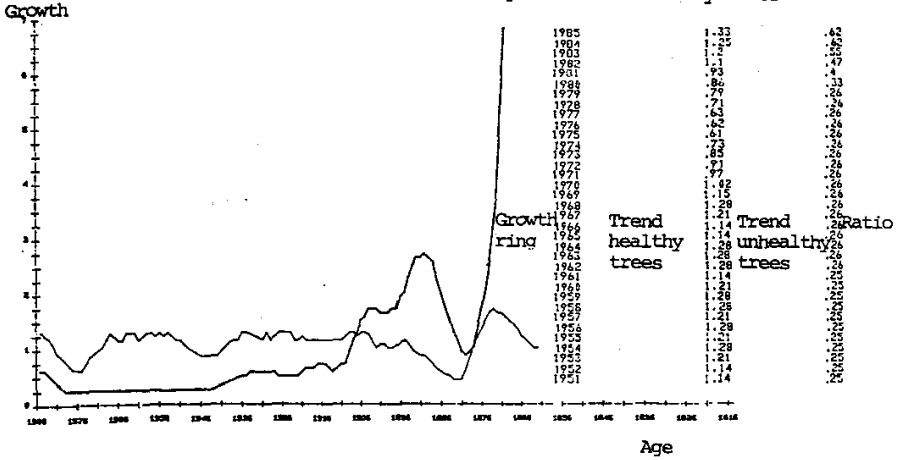


FIGURE 11

CLASS 18 (TREES FROM 120 TO 129 GROWTH RINGS)

— Annual radial growth trend of affected trees
 — Annual radial growth trend of healthy trees

Unhealthy trees:9 Healthy trees:28



CLASS 19 (TREES FROM 130 TO 139 GROWTH RINGS)

Unhealthy trees:41

Healthy trees: 24,26

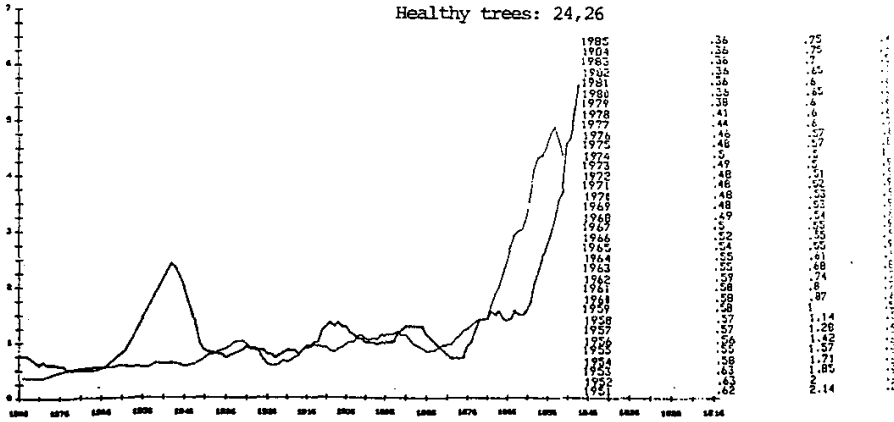


FIGURE 12

CURVE OF HEIGHT-DIAMETER IN THE TOTAL STAND

+ Real value

— Trend of curve (moving average on both axes)

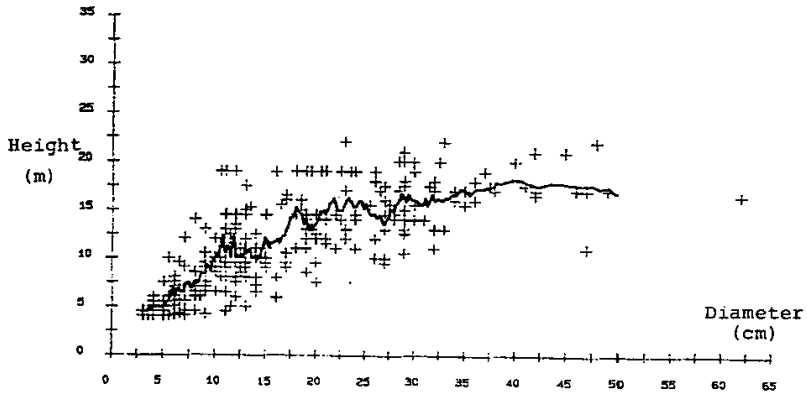
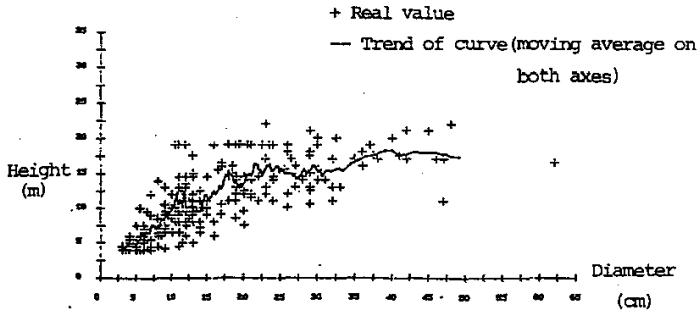


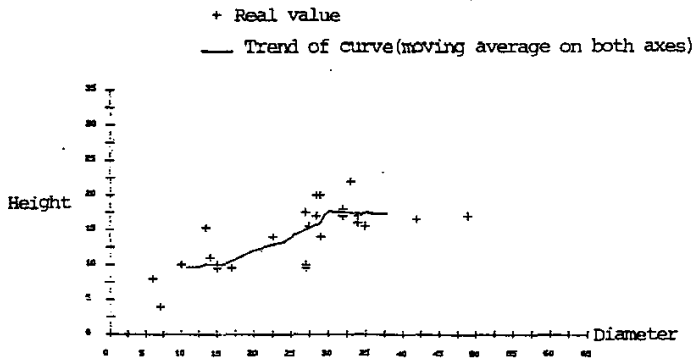
FIGURE 13

FIGURE 14

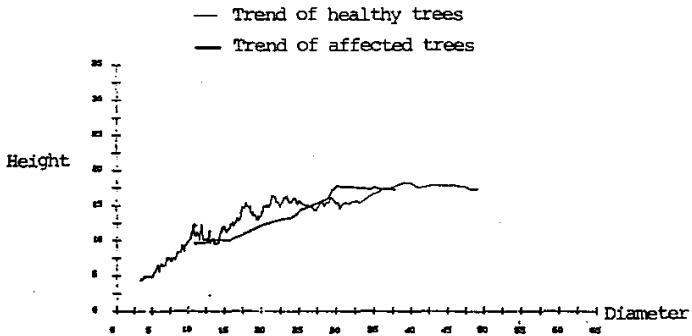
CURVE OF HEIGHT-DIAMETER IN THE HEALTHY TREES



CURVE OF HEIGHT-DIAMETER IN THE AFFECTED TREES



CURVE OF COMPARISON BETWEEN BOTH SETS OF TREES



Conclusions of the Study:

Recreational activity in the area of the Source of the River Cuervo does not, up to now, appear to have had any negative effects, either on the radial growth or on the growth in height of *Pinus sylvestris*.

Assuming that the value of the form factor is invariable, we may conclude that forestry production, measured as the volume of timber per surface unit per annum, has not been reduced by the recreational uses to which the land has been submitted.

From our point of view, the "adaption of the environment" to the already long established presence of cattle in this area, might be of importance here. The effects of cattle on the biophysical environment (compacting by trampling, for example) are similar in many ways to those of the recreational influx.

The present state of affairs where there is no impact, may nevertheless change in the future, if the pressure of recreational use keeps increasing or even if it stays at the same level, and if the critical thresholds of impact are exceeded. Further investigation in the future will clarify this.

References:

COLE, D.N., 1978
Estimating the susceptibility of wildland vegetation to trailside alteration. *Journal of Applied Ecology* 19; 281-286

COLIN BANCROFT, B.S.C., 1978
Forestry for the quality of life: evaluation and analysis of the impact of forestry on recreation. Paper presented to Eight World Forestry Congress.

COUNTRYMAN, D.W. and SOFRANKO, D.M., 1982
Guiding land use decision: planning and management for forest and recreation. The Johns Hopkins University Press. Baltimore.

FOIN, T.C. et al., 1977
Quantitative studies of visitors impacts on environments of Yosemite National Park, California, and their implications for Park Management Policy. *Journal of Environmental Management* 5: 1-22

GOMEZ CHICO, E., 1986
Efectos ecológicos del uso recreativo. Estudio del área en torno al Nacimiento del Rio Cuervo. E.T.S.I. Montes. Tesis Doctoral (No publicada).

JAMES, T.D.W. et al. 1979
Effects of camping recreation on soil, Jack Pine and understory vegetation in a Northwestern Ontario Park. *Forest Science* 25,2,338-349.

McEWEN, D. and TOCHER, S.R., 1976
Zone management: Key to controlling recreational impact in developed campsites. *Journal of Forestry* 74: 90-93.

SATCHELL, J.E., 1976
Les effets de la récréation sur l'écologie des paysages naturels. Conseil de L'Europe.

Joint Paper

Madrid

Spain

Conflicts between Productive and Social Uses of Forests: A Study on the Effects of Recreation on Timber Production in a Recreational Area in Spain

Summary

The paper refers to the importance of obtaining information about the impact recreational use has on the forestry potential. This is necessary for the formulation of management objectives in multiple-use forests.

The effects of recreational use on growth in terms of height and diameter of a *Pinus sylvestris* stand are described.

The study from which these results were obtained is discussed.

Résumé

Dans cet exposé on analyse l'importance de la connaissance des effets de l'utilisation récréative de la forêt sur le potentiel productif forestier ainsi que l'information nécessaire pour établir des règles d'aménagement dans les forêts multi-objectifs. On décrit à la suite les résultats obtenus dans une étude de l'effet de la fréquentation récréative sur la croissance diamétrique et l'hauteur d'un forêt constitué par *Pinus sylvestris*.

Zusammenfassung

Der Vortrag referiert die Bedeutung, die eine fundierte Kenntnis der Wirkung der Erholungsnutzung des Waldes auf das forstliche Wachstum hat. Diese dient der Unterstützung der Zielfindung für die Bewirtschaftung von Wäldern, die mehrere Funktionen zu erfüllen haben.

Die Ergebnisse einer Studie über die Auswirkung der Erholungsnutzung auf das Höhen- und Durchmesserwachstum eines Kiefernbestandes werden diskutiert.