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AUTONOME PROVINZ BOZEN SÜDTIROL

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INTERNATIONAL COOPERATIVE PROGRAMME ON INTEGRATED MONITORING ON AIR POLLUTION EFFECTS ON ECOSYSTEMS

Dendroecological Investigations at the permanent plots IT01-IT02 in South Tyrol

(co-funded by EU-Reg. 3528/86, 2157/92, 1091/94)

Schort Report 1995

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DENDROECOLOGICAL INVESTIGATIONS
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The growth chronology of forest wood biomass, which has always been a vital cognitive element inforestry management, has lately become all the more important due to the capacity of forest ecosystems to fix carbon as a function of mainly environmental and climatic variables.

A dendroauxometric and dendroclimatogical investigation was carried out in 1995 in the two permanent observation plots of Ritten/Renon and Montiggl/Monticolo, respectively numbered ITO1 and ITO2 in the I.C.P. - I.M. (°) European grid.

The investigation, commissioned and co-funded by Reg. EU 1091/94 (Commission of the European Union), was carried out by DENDRODATA S.A.S. of Verona (°).

METHODOLOGY

The research was conducted in several phases.

- In the first phase, a classical dendrochronological investigation was carried out to construct the seasonal chronologies of the main tree species (ITO1: Norway spruce; ITO2: pubescent oak and Scots pine) on which to verify the correctness of the sequential dating.
  Only the cores taken from a height of 1.30 m were used for the construction of the individual sequences and the successive mean from each plot. The cores taken from near the base, which can present irregular growth patterns due to the proximity of the roots, were taken into consideration for determining the age of the tree.

  Measurement of the width of the tree-rings was conducted using the CCTRMD device (Computer Controlled Tree-ring Measuring Device) which is precise to one-hundreth of a milimetre (Aniol 1987).

- Through further core boring of accessory species, manna ash and hornbeam in the ITO2 area of Montiggl/Monticolo, the reconstruction of the history and evolution of the stand was carried out.

- Using the skeleton plot methodology, the events which happened to every single tree was determined, from the dating of the formation of the first tree-ring, to the identification of abrupt decreases or increases in growth due to silvicultural operations.

- Subsequently, using the dendroclimatological investigations, the climate-growth relationship for each main species was determined, identifying the climatic parameters which influenced their growth most, using the calculation of the function responses.

The results of the investigations which were carried out are set out below. For the main species of the sample areas of Ritten/Renon and Montiggl/Monticolo, table 1 shows the following parameters: length of the series, average tree-ring growth values (expressed in hundredths of mm), average sensitivity, standard deviations, self-correlation of 1st order.

Table 1 - Main parameters of the mean curves for each station for the dominant species.

SAMPLE AREA	SPECIES	PERIOD	AVERAGE VALUE	SD	SELF-COR	A.S.
Ritten/Renon	Norway spruce	1846 - 1995 AD	136.1	59.8	0.951	0.116
Montiggl/Monticolo	Scots pine	1892 - 1995 AD	204.4	65	0.561	0.212
Montiggl/Monticolo	Pubescent oak	1912 - 1995 AD	138.8	61	0.555	0.262

ITO1 RITTEN/RENON

Norway Spruce

Mean curve

The investigations showed that the Norway spruce population examined in the Ritten/Renon sample area were all of the same age.
A total of 12 Norway spruce specimens were examined, with an mean age of 144. The mean curve which was obtained covers the period from 1846 to 1995 AD (Fig. 1).
The curve presents a low sensitivity of 0.116, coupled with a strong self-correlation, above 0.9. Thelow sensitivity which, with few exceptions, characterises the single sequences, can explain the generally low values of the statistical parameters examined within the series analysed and the not very high number of characteristic years present.

In the graph of the mean curve of the plot two phases of recovery during this century can be made out, the first at the beginning of the first decade, the second towards the end of the 1950' s.

Skeleton plot

Among the characteristic years investigated, the minimum value of **1948** stands out, well-known in the specialist literature, for Norway spruce, silver fir, Scots pine, Cembran pine, larch, oak and beech (Siebenlist-Kerner 1984; Z' Graggen 1987), the minimum of **1968**, noted on Norway spruce, silver fir and Scots pine and also the year **1987**. No significant maximum values were recorded.

It must be pointed out that the characteristic years of 1904, 1948, 1969 and 1979 are also present in the chronology of the Veneto region; the 1948 minimum value was also recorded by Siebenlist-Kerner (1984) in the Austrian Tyrol.

Two phases of abrupt recovery were recorded, which were already present in the dendrochronological curve. Using the skeleton plot it was possible to ascertain the year of the beginning of each phase with greater precision. The first phase which involved almost all the trees, begins in the year 1913, the second, found on 8 sample-trees, begins in the years 1950-1955. These allow us to identify and chronologically arrange past silvicultural operations not otherwise documented.

Conclusions

The last decades have not witnessed any significant abrupt reductions in growth which might indicate possible distress of the tree-stand.

From what has emerged from the results of the calculations of the function responses, it seems that Norway spruce has found favourable climatic conditions for growth at the Ritten/Renon plot. In particular the rainfall-distribution for the area, with a summer maximum, seems to correspond to the ecological needs of Norway spruce.
The absence of a significant relationship between growth and rainfall may further indicate particularly favourable conditions for Norway spruce in rainfall distribution over the year. It has been observed that some of the characteristic minimum values formed in years characterised by low rainfall, noted in the literature not only for Norway spruce but also for silver fir and Scots pine - such as the minimum values of 1948 and 1968 already mentioned above - were duly recorded on the Norway spruce of Ritten/Renon. The well-known 1976 minimum value however, also a particularly dry year, is present only in five of the twelve sample trees under investigation.

It was possible to establish that the charactersitic minimum values for Norway spruce correspond to years with average maximum temperatures for May lower than in preceding or successive years, just as the maximum values generally coincide with average maximum temperatures for May higher than in preceding or successive years.
In particular, the lowest average maximum temperature for May of the whole century corresponds to the minimum value of 1984. The only exception is the 1984 minimum which was not accompanied by particular values of the temperatures for May, but corresponds to a particularly dry year, and noted on other tree species (Siebenlist-Kerner 1984; Z' Graggen 1987).

ITO2 - MONTIGGL/MONTICOLO

The two mean curves for Scots pine and oak at Montiggl/Monticolo are characterised by good sensitivity values of 0.212 and 0.262 respectively, with an auto-correlation of less than 0.6 for both species.
The mean curves for the two tree species are well-synchronised with each other, both optically and statically (t of Student equal to 4.62, CC = 69.9 with relative static reliability of 99.9) with the following characteristic years in common: 1975, 1976, 1985 and 1986.
In addition, it was noted that the curve for pubescent oak correlates with good values of the statistical parameters with the curve for oak recorded by Nola (1991) in the Po basin.

Scots Pine

Mean curve

Ten Scots pine specimens with an average age of 67 years were examined. The mean curve covers the period 1892-1995 (Fig. 2).
The results clearly demonstrate the progressive and inexorable reduction in growth starting from the 1940' s. This is a sign that this species, now that it has exhausted its pioneering or preparatory function, has given way, in the evolution of the tree-population, to climatic species.

Skeleton-plot

The characteristic years recorded were the following: 1942, 1955, 1964-1965, 1976, 1983, 1986, 1991 and 1993. The minimum values at the years 1976, 1983 and 1986 coincide with minimum values recorded on the mean curve of the plot.
No relevant abrupt variations in tree-growth were recorded.

Pubescent Oak

Mean curve

The mean age of the 10 specimens is 53, excluding 2 which were outside the area, whose first rings were dated 1906 and 1872 respectively.
The curve covers the period from 1912 to 1995 AD (Fig. 3).
Beyond abrupt variations due to repeated cutting in the past, a progressive reduction in growth over time was recorded.

Skeleton-plot

The characteristic years are mainly made up of those with minimum values, especially those of 1950, 1960, 1965, 1970, 1974 and 1976.
Only one maximum value, corresponding to the year 1987, is present in a significant number of samples.
The minimum values of 1965 and 1976 coincide with the characteristic years recorded for the mean curve of the plot. Corresponding to the year 1962, 5 samples began a short phase of abrupt reduction which lasted about 5-6 years. Only in the case of one sample did this continue until 1986.

Accessory Species

Also five specimens each of manna-ash and hornbeam dating from the 1940' s and 50' s were examined.
The dendrochronological examination conducted on the accessory species was essentially devoted to the identification of the age of the sample specimens to reconstruct the history of the forest ecosystem in question and was conducted by taking just one core-sample from each specimen selected
for a total of 5 samples for each species.

Manna Ash

Mean curve

Readings of the manna-ash samples were difficult due to the presence of a phase of reduced growth which affected the sample trees in the period from the late 1960' s to the early 1980' s (Fig. 4). In particular, some samples show tree-rings of extremely small width for those years, rings consisting of merely spring growth.
On the basis of individual dating, the manna-ash population is basically the same age, with an average age of 52. This is surprising, considering the width of the stems, the diameter of which is between 5.5 and 9 cm.

Skeleton plot

The characteristic years recorded were almost all with minimum values, in particular 1962, 1963, 1977, 1978, 1990 and 1994 and only one maximum of 1992.
All the samples showed abrupt reductions in growth between the late 1960' s and the late 1970' s/early 1980' s.

Hornbeam

Mean curve

The difficulties encountered when taking readings of Hornbeam samples whose tree-rings could often not be identified with certainty despite using different techniques meant that no reliable sequences could be obtained for this species.
The sequence obtained for specimen no. 107 however, seems to be correct (Fig. 5). Optically, it synchronises with the average plot curve for pubescent oak for the whole period prior to the 1970' s.Taking the dating of the first identifiable ring on the samples with the necessary caution, the data seem to indicate that the hornbeam specimens date from the 1940' s and 1950' s.

Conclusions

The rarity of specimens older than 60 years indicates that until the middle of this century the area was subject to frequent tree-cutting, especially of coppices.

Of note is the intense use of wood for burning during the last war which was followed by sudden increases in growth during the years immediately after, at the expense of the remaining specimens of pubescent oak (Fig. 3). **It seems, then, that only the last few decades have seen a new trend in silvi-cultural management, tending to restore the natural composition of the forest.** What is interesting from a dendrochronological point of view are the similar growth patterns of the two main species which are shown in the presence of some common characteristic years.
Even if no limiting effects attributable to periods of drought emerged from the analysis of climatic data, the results of the function responses worked out for Scots pine showed the determining role of summer rainfall (June-August) as against the negative influence of the maximum temperatures for August on the growth of this species. Of note in this regard is how the characteristic minimum values of the tree-ring series corresponding to 1983, 1984 and 1991 coincide with years of low summer rainfall. In particular, in 1983, a year corresponding to a minimum, low summer rainfall was accompanied by high maximum temperatures during August. In the case of the two minimums of 1986 and 1993, on the other hand, summer rainfall was not particularly low, except for the month of July 186.

Spring and early rainfall (April-June) have a positive influence on pubescent oak, analogous to what has already been observed for the genus *Quercus* both in continental and in Mediterranean Europe (Chalabi 1981, Tessier 1984, Nola 1991, Aloui 1987, Wazny and Eckstein 1991, Schirone e Romagnoli 1990).
In particular, the positive effect of the maximum temperatures during April seem to indicate that this is the month when pubescent oak restarts its vegetative phase at Montiggl/Monticolo.
This relationship was noticed by Tessier (1986) on the same species and, according to Serre-Bachet and Tessier the beginning of cambium activity in pubescent oak can generally be traced to the month of April.
Common to the two species is the positive role of maximum temperatures in November of the preceding year, as ascertained also for turkey oak (*Quercus cerris*) and pubescent oak in Sicily. This relationship has been attributed to the fact that, when the cambium has already almost finished its activity, the mild temperatures favour the storage of the reserve substances (Romagnoli, Martinelli and Pignatelli 1994).

The investigations which have been conducted have confirmed what was already known, namely that radial stem growth represents the synthesis of the innumerable environmental-stational factors whose individual effects are difficult to identify and interpret.

For this reason the dendroclimatic function responses obtain the necessary statistical reliability only in some cases, due to the fact that the climatic factor is clearly influenced by others (pedology, soil microbiology, decomposition of organic matter, mineralization, availability and mobility of nutrients, photosynthesis and assimilation, pathogens, etc.) which interact with it and influence the growth process.

Further developments in the investigations will have to take these aspects into account, especially the dynamics of the biogeochemical cycles of the main elements.

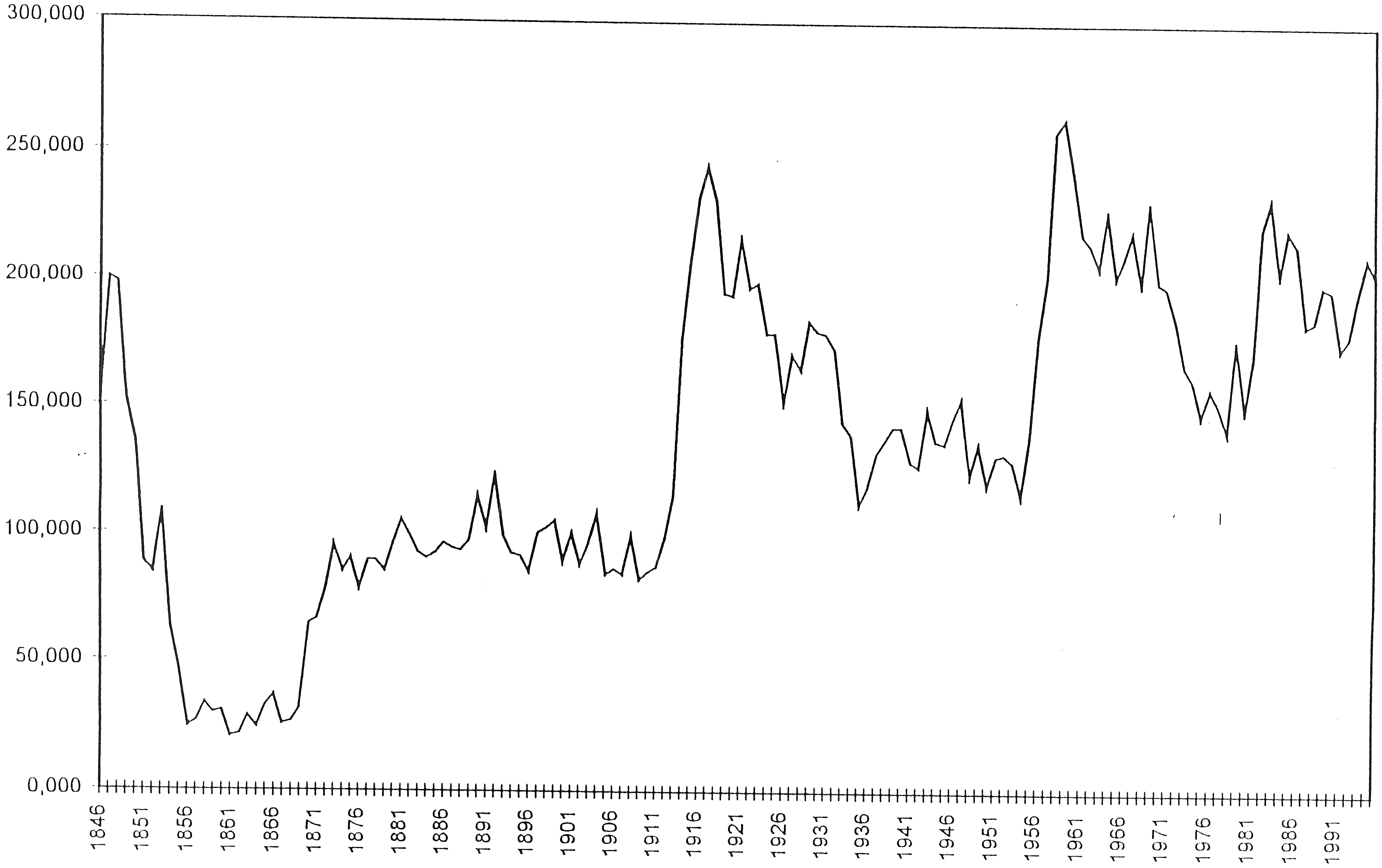
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fig. 1 - Renon

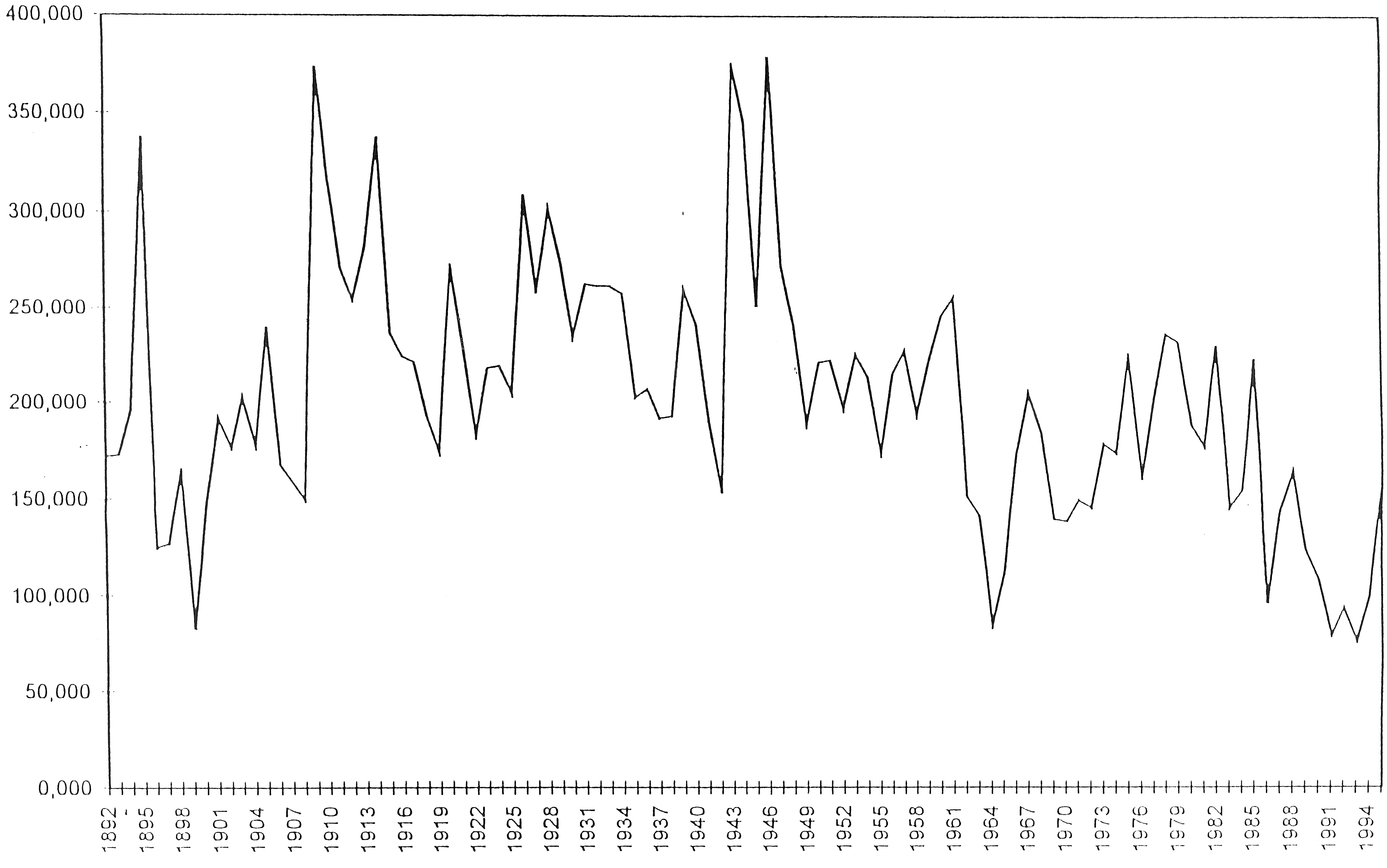
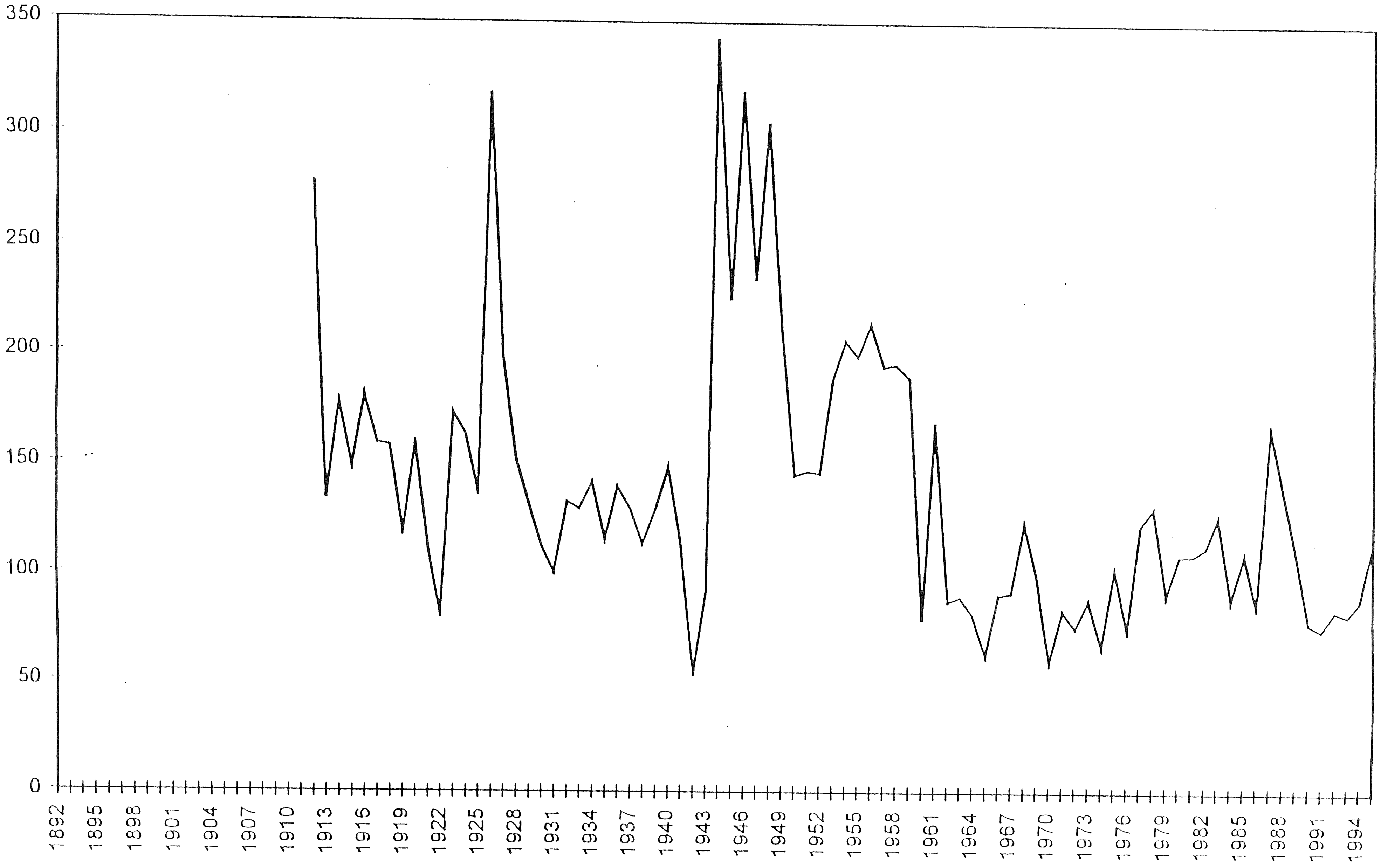


fig. 2 - Monticolo



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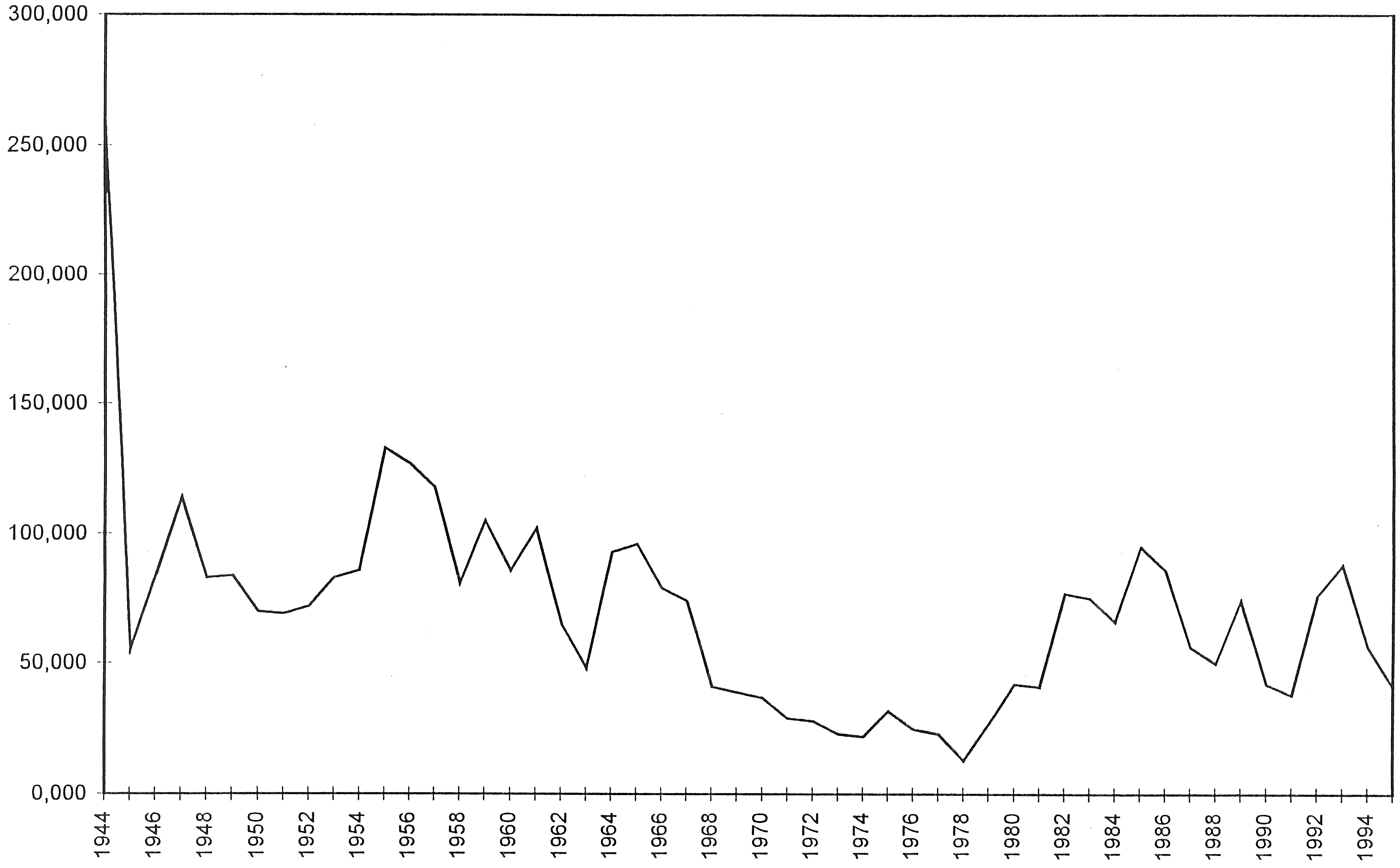

fig. 4 - Monticolo

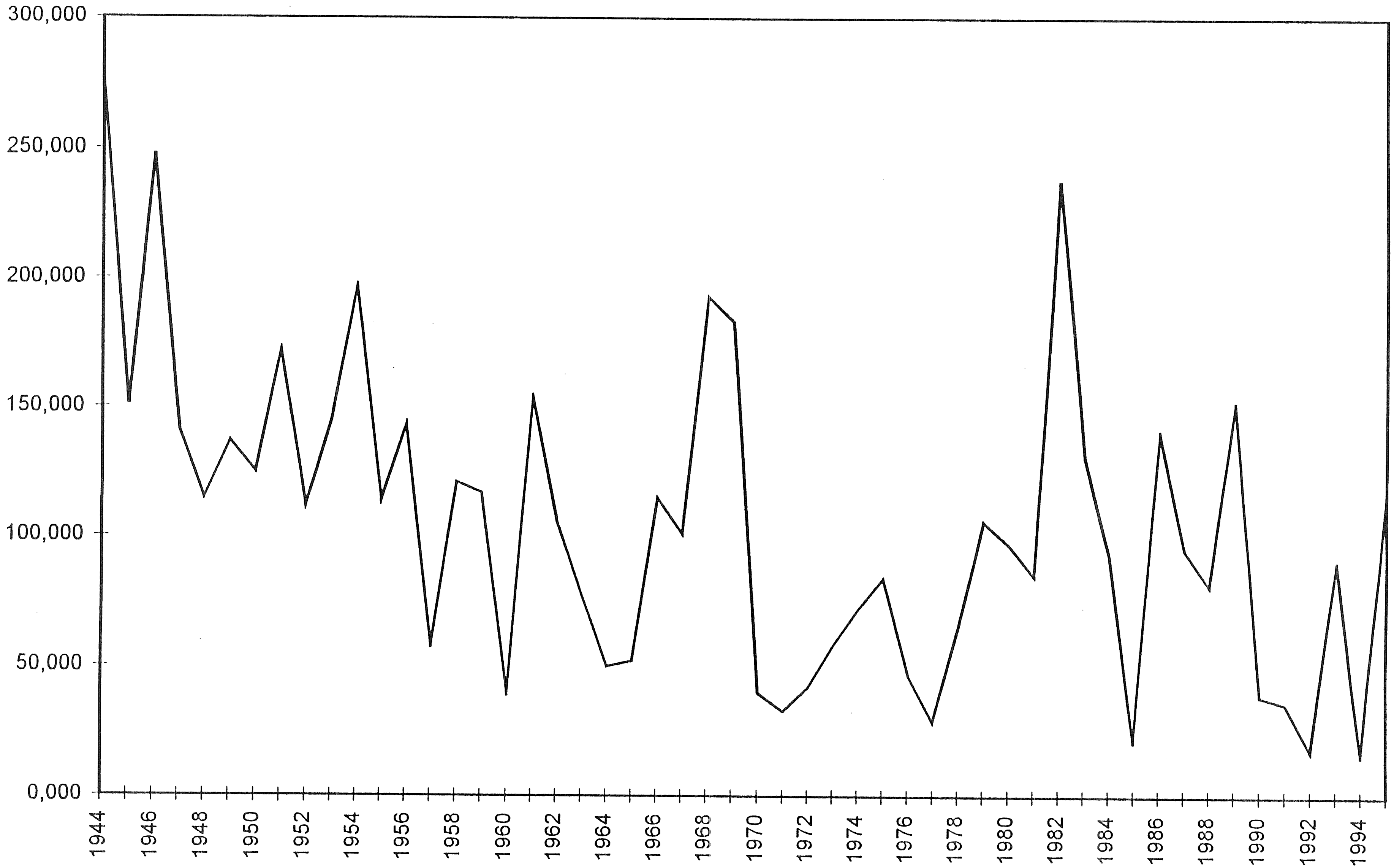

fig. 5 - Monticolo