1. INTRODUCTION

This study, carried out in 2003, constitutes one of the areas of examination dealt with in the EFOMI (Ecological Valuation in Alpine Forest Ecosystems by Integrated Monitoring) project, a three-year scientific project co-ordinated by the Istituto Agrario di S. Michele all’Adige. EFOMI aims to evaluate the health of woods in Trentino using an interdisciplinary approach (surveys on climate, air, water and soil chemistry, flora, vegetation, fauna, etc.). It also intends to identify and describe the most suitable biological indicators for defining the health of forest ecosystems (Bonavita et al. 1993; Minerbi et al. 1996). The small mammals were studied in relation to the relevance of their “ecological weight” in forest environments (see for example Locatelli & Paolucci 1998a).

The aim of the survey was the definition of the characteristics of the community of small mammals in the study area and the verification of whether these can be used as suitable biological indicators, contributing towards determining the health of the forest ecosystem.
2. STUDY AREA

The study area was chosen on the basis of results from a previous survey carried out in 2000 in two forest sites in the province of Trento: Lavazè, in Val di Fiemme, and Pomarolo, in Vallagarina. Of these, only the first was shown to be potentially suitable for achieving the objectives, as the Pomarolo area was shown to lack variety in terms of species and above all the necessary number of individuals. The Lavazè site is situated at the pass of the same name (eastern Trentino), at an altitude of 1780 m a.s.l. It covers a surface area of 2 hectares within subalpine spruce woods.

3. MATERIALS AND METHODS

3.1. Data collection

The capture programme, which provided for the suppression of the small mammals captured, was carried out using pitfall traps without bait, partially filled with water.

The 99 traps were laid out over a rectangular grid of 9x11 traps, around 10 metres apart from one another. Each trap was numbered in order to define the exact point of capture for each small mammal.

The traps were active from 4 July to 4 October 2003, thus for 92 consecutive nights, and they were checked weekly to recover the samples.

The capture programme (sensu Jones et al. 1996) was thus particularly extensive, involving 9108 trap-nights.

3.2. Indices adopted

- Index of relative density (Cagnin et al. 1998):

\[ T = \frac{N \times 100}{(t \times n)} \]

where: \( N \) = number of animals captured; \( t \) = number of active traps; \( n \) = number of trapping nights (as the animals are mainly active at night we prefer to talk about trap/nights).

- Relationship between insectivores and rodents:

\[ I/R = \frac{n^i}{n^r} \]

- Index of dominance of the different species:

\[ C = \sum (Ni/N)^2 \]

where: \( Ni \) = number of individuals of each species; \( N \) = total number of individuals (the classes are: \( C > 0.05 \) = dominant species; \( 0.05 > C > 0.02 \) = sub-dominant species; \( C < 0.01 \) = minor species).

4. RESULTS AND DISCUSSION

A synoptic outline of the mammals captured is presented in the table 1.

186 individuals belonging to 12 different species were captured. In the table the capture of 3 Microtus sp. is recorded, although these are not counted among the species present as it was not possible to classify the samples accurately.

The course of the growth curve for the number of species captured probably indicates that the number of individuals captured corresponds very closely to that of the species actually present (Fig. 1).

The captures did not show a significant tendency to decrease, as often occurs in the event of the progressive impoverishment of the community as a result of capture. The sequence would not appear to be significantly influenced by the substitution of the individuals captured with others coming from outside the area of study. Indeed, application of the chi-square test to compare the frequency of capture at the 64 traps situated on the two most external concentric rectangles and those of the 35 “internal” traps did not highlight significant differences. The most likely explanation for the lack of a progressive decrease in captures should thus be sought for in the abundance of the mammal population rather than in the entrance of new individuals to the sample area.

Lastly, the very clear concurrence of minimum capture levels with the full moon is worth noting (nights with full moon: 13/07, 12/08, 10/09). To a certain extent this is surprising, as the reduction of activities such as elusive behaviour with regard to predators is known to occur for species living in open areas but has not been unambiguously demonstrated for those living in a forest habitat (Kaufman & Kaufman 1982; Price et al. 1984; Bowers 1988; Wolfe & Summerlin 1989; Jensen & Honess 1995).

At 2.065 the T index of relative density is particularly high in relation to the high number of individuals captured.

The most important result of the study is the species variety, representing the highest level of theriological biodiversity ever noted in stations in the province of
This should be considered particularly high if we bear in mind the limited extent of the studied area and the presence of a single macro-environment, but also the relatively high altitude at which the area is situated. This level of biodiversity indicates the high overall quality of the forest ecosystem, as it demonstrates the existence of a wide richness of ecological niches and of particularly complex trophic networks.

As regards the species captured, in terms of ecological significance certain species of small mammals stand out: the two water shrews, the field vole and the forest dormouse. The water shrew is an insectivore typically linked to wetland sites (banks of streams, marshes). It appears to be relatively widespread in Trentino but is never common, whereas the Miller’s water shrew, which usually lives in marshes and peat bogs on the valley floor, is much less widespread. Distribution of both the field vole and the forest dormouse, whose ecology is closely linked to humid conifer forests, glades and peat bogs, is limited to a geographical area to the east of the Adige and there are also few known stations in the rest of Italy (Lapini et al. 1993; Locatelli & Paolucci 1998a).

The relationship between insectivores and rodents, another indication of the community structure, is heavily weighted in favour of the first, corresponding to 1.818. Given that insectivores are predators and occupy a high trophic level, this result demonstrates the existence of an abundant and diversified coenosis of soil invertebrates, and thus of high productivity, which is also an indication of the high overall quality of the forest ecosystem.

As regards the “weight” of the various species in the context of the community, there are three dominant species, two insectivores and one rodent: the common shrew (C = 0.097), the pygmy shrew (C = 0.094) and the bank vole (C = 0.072). All the other nine species are minor. As far as the dominant species are concerned, the picture is only partly comparable with the data obtained from similar mountain habitats in Trentino, although with different capture methods, both in the Adamello Brenta Nature Park (Locatelli & Paolucci 1998a) and in the Cadino Forest (Locatelli & Paolucci 1998b), where the pygmy shrew appeared as a minor species.

\[\text{Tab. 1 - Captures made at the site (the explanation of the indices is in the text).}\]

<table>
<thead>
<tr>
<th>Species</th>
<th>No. individuals</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common shrew <em>Sorex araneus</em></td>
<td>58</td>
<td>0.644</td>
</tr>
<tr>
<td>Pygmy shrew <em>Sorex minutus</em></td>
<td>57</td>
<td>0.633</td>
</tr>
<tr>
<td>Miller’s water shrew <em>Neomys anomalus</em></td>
<td>1</td>
<td>0.011</td>
</tr>
<tr>
<td>Water shrew <em>Neomys fodiens</em></td>
<td>4</td>
<td>0.044</td>
</tr>
<tr>
<td>Snow vole <em>Chionomys nivalis</em></td>
<td>1</td>
<td>0.011</td>
</tr>
<tr>
<td>Bank vole <em>Clethrionomys glareolus</em></td>
<td>50</td>
<td>0.555</td>
</tr>
<tr>
<td>Field vole <em>Microtus (M.) agrestis</em></td>
<td>4</td>
<td>0.044</td>
</tr>
<tr>
<td>Common vole <em>Microtus arvalis</em></td>
<td>3</td>
<td>0.033</td>
</tr>
<tr>
<td>Common pine vole <em>Microtus (T.) subterraneus</em></td>
<td>1</td>
<td>0.011</td>
</tr>
<tr>
<td>Vole sp. <em>Microtus sp.</em></td>
<td>3</td>
<td>0.033</td>
</tr>
<tr>
<td>Yellow necked mouse <em>Apodemus (S.) flavicollis</em></td>
<td>1</td>
<td>0.011</td>
</tr>
<tr>
<td>Wood mouse <em>Apodemus sylvaticus</em></td>
<td>1</td>
<td>0.011</td>
</tr>
<tr>
<td>Forest dormouse <em>Dryomys nitedula</em></td>
<td>2</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Number of collected individuals: 186
Number of species: 12
Total T: 2.065
I/R: 1.818
H': 1.566

Fig. 1 - Growth curve in the number of species captured in the course of thirteen weeks trapping.

In the sampling test carried out in 2000 an alpine shrew (*Sorex alpinus*) was also captured at the same site; thus in total there were 13 species identified in the census at the site.
Biotic diversity, calculated using the Shannon-Wiener function which takes into consideration both the number of species and the relative abundance of each, is an important parameter in estimating the value of the forest ecosystem, also because it represents a measure of the stability of the communities (Begon et al. 1989). At the Lavazè site it is 1.566, thus relatively high (Washington 1984), once again indicating the very good health of the ecosystem.

5. CONCLUSIONS

The results which emerge from examination of the community of small mammals in the study area demonstrate the existence of a forest ecosystem of very high overall quality, meaning that it is very “healthy”.

In general, as regards the possibility of using small mammals within the context of the ecological evaluation of forest coenosis, the following considerations can be made:

- the most effective descriptive factors have been identified as follows: species present in the study area, with relative naturalistic importance; species richness; insectivores/rodents relationship; relative density; dominance; biotic diversity;
- a considerable amount of data on populations is necessary in order to carry out statistical correlations with the environmental variables;
- the demographic fluctuations typical of many species of small mammals may complicate the identification of correlation between community parameters and environmental variables;
- certain community parameters which it is straightforward to obtain (species richness and diversity first of all) undoubtedly supply trustworthy indications as regards the overall quality of the forest ecosystem studied;
- the methods adopted allow the comparison of data for different years and different stations; with a relatively limited effort they are capable of contributing to the determination of the health of the forest ecosystem.

AKNOWLEDGEMENTS

The present work was carried out in the framework of the project EFOMI (Ecological Valuation in Alpine Forest Ecosystems by Integrated Monitoring) funded by the Autonomous Province of Trento.

Our thanks go to Lucia Corrà for her assistance in the field work, Eva Ladurner and Luca Lapini for their help in defining the material gathered and Paolo Paolucci for his advice.

REFERENCES

Cagnin M., Moreno S., Aloise G., Garofalo G., Villafuerte R. & Cristaldi M., 1998 - A comparative study of Spanish and Italian terrestrial small mammal coenoses of diffe-


