Conservation and management

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■ Historical changes and current state

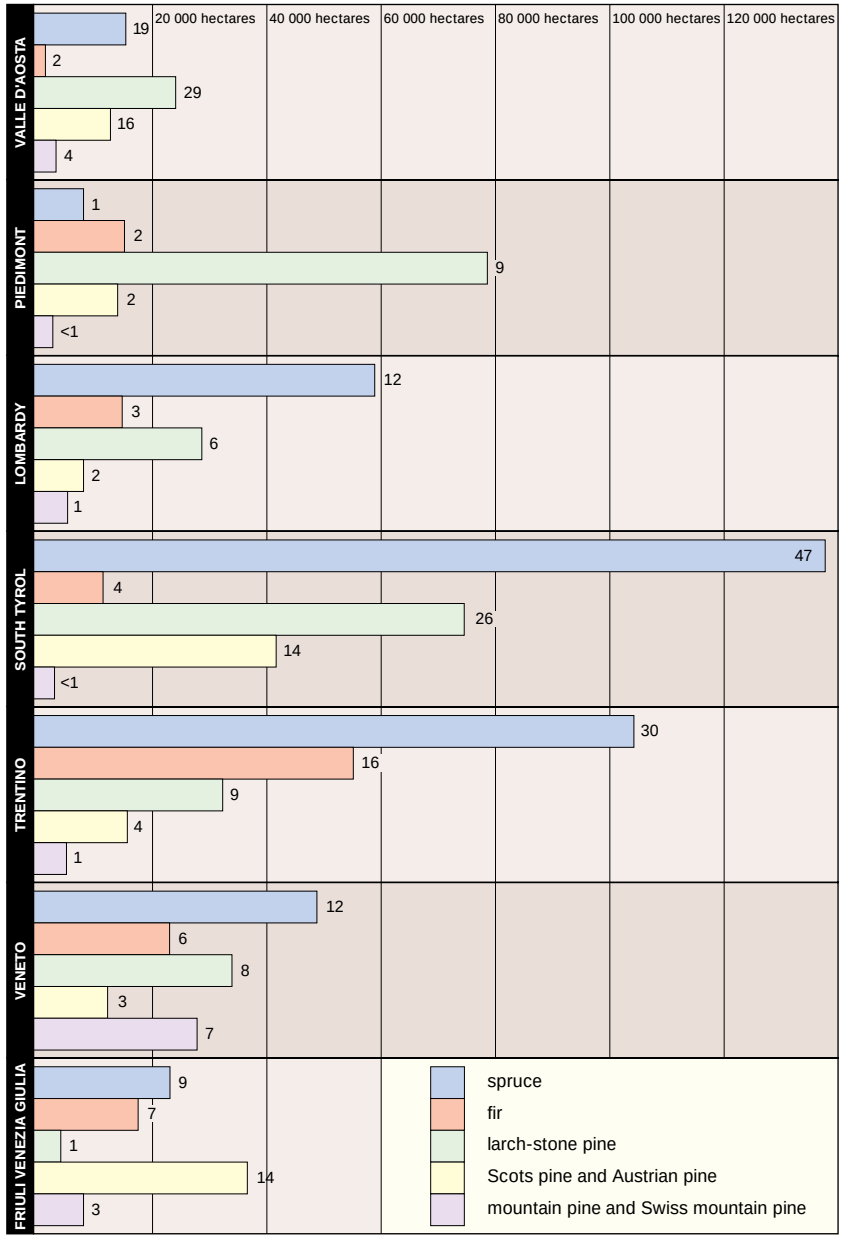
Edge of a Norway spruce woodland

Relatively widespread and apparently stable, mountain coniferous woodlands are commonly perceived as the natural and primitive epitome of high-lying areas. However, this is frequently a stereotyped point of view, and far removed from reality. In Italy, as over the entire Mediterranean area and, more in general, central-southern Europe, the forest vegetation of mountain areas has been subjected for centuries to various kinds of intervention, exploitation and treatment, which have largely modified the original structure, guiding its evolution.

On steep or rugged terrain that is unsuitable for human settlements, crops or grazing, the forests of Norway spruce, silver fir, larch and pine covering them have historically been maintained, but they have been extensively and continually exploited for timber. Their wood has long been important, both for building and as firewood, removed by locally different methods and at an intensity that has fluctuated over the centuries. In Italy, the use of mountain conifer forests for timber is still undoubtedly an important item in the national economy, although imports far exceed exports. As an example of orders of magnitude, the total annual timber production in the province of Trento is estimated to be 450,000 cubic metres, of which half is Norway spruce.

In some places, however, the original mountain forests which grew spontaneously after the last Ice Age have been eliminated, particularly from less steep slopes, but even more so from valley bottoms, plateaux and the typical basins and terraces which have taken the name “alps”. These lands have been

Planted pinewood of Douglas fir (*Pseudotsuga menziesii*)



Extent of conifer woodlands in some Italian Alpine regions; figures indicate the percentage of each type

converted to pasture for sheep, cattle, goats and horses, growing food or forage crops, and building stable or seasonal human dwellings, with their attached infrastructure.

Cattle grazing at the edge of a conifer wood

The forests were eliminated by direct felling or gradually degraded over time, until they reverted to open or scattered vegetation. Two of the more obvious effects of these selective eliminations have been the general lowering, in some sectors of the Alps, of the upper limit of the spruce, larch, stone pine and beech woodlands, and the marked discontinuity of their transition towards pastures or meadows. Instead, during the 19th century, particularly after the promulgation of Italian Forestry Law 3267 in 1923, there was extensive and widespread reafforestation, mainly of conifers, as part of a land management policy almost exclusively aimed at forestry production and geomorphological stabilisation of mountainsides, but scant attention was paid to ecological processes and natural and aesthetic values. Stands of mainly spruce and pine were planted on slopes which had been deforested for some time. This policy also followed the widespread abandon of traditional sylvo-pastoral practices, which had been significant in the previous century over most of the Italian mountain areas, with consequent re-colonisation of fields no longer grazed or mown. In many cases, however, similar reafforestation has involved areas less suitable for this type of vegetation, such as low-lying hills or the soils along riverbeds, in which very different plant communities grow. Conversely, during the two World Wars, some areas suffered from very intense exploitation.

Even where the tree cover has been maintained or has expanded, centuries-old human management and more recent interventions have markedly altered these conifer-dominated biological communities. Their distribution and extent have been modified, with cases of local contraction or expansion, a shift in altitude, and fragmentation and isolation of relict forests, particularly along the Apennines. The specific tree composition has also been altered: in some places in the Alps, almost single-species stands of Norway spruce have substituted other types of woodland, whereas on the Apennines, beech has often been favoured over silver fir. Species of pine that are exotic or just not locally spontaneous have also been planted, e.g., the original diffusion of Austrian pine has expanded in this way. The structure and demographic dynamics of forest populations have also changed, leading to situations of anomalous densities,

imbalances in age class composition, increased susceptibility to parasites and disease, difficulties in regeneration, and a reduction in the availability of old trees, undergrowth and dead wood (necromass). As a consequence, the composition of the entire biological community associated with coniferous forests has also changed, with the disappearance of species of herbaceous plants, shrubs and animals, and the spread of others. Particularly sensitive to the structural characteristics of forest vegetation are, for example, heliophilous (sun-loving) or sciaphilous (shade-loving) herbaceous plants, fungal communities dependent on particular plant species and soil chemistry, saprophage and xylophage insects, and birds which nest in tree holes. There have also been voluntary introductions of *Formica rufa*, which have had a strong impact on forest ecology - for instance, on the Apennines between Tuscany and Emilia Romagna.

One of the menaces which may create local damage to forestry formations, in addition to direct destruction for urbanisation and its related infrastructure, always to be avoided, is on a smaller scale: trampling by too many people. In the tourist season, searching for mushrooms and forest fruits (including berries) is a very popular pastime, and it is not by chance that many laws have been passed aimed at limiting these harvests. In relation to the very marginal economic gain, the damage they can cause to the ecosystem can, over time, become very significant.

Protecting an ant-hill in the Casentinesi Forest (Emilia Romagna and Tuscany)

■ Functions and values

Fir split by an avalanche

The value of mountain forests, including coniferous ones, as precious and renewable sources of timber, is historically consolidated in the economy and culture of the Alpine and Apennine populations.

Production chains for the timber of Norway spruce, larch and silver fir still thrive in places. But these woodlands are still exploited for hunting birds and mammals as game and for their natural products, such as edible mushrooms and woodland soft fruit.

These activities sometimes persist as an integration of the local economy or purely for recreation. The role played by woodlands in the natural consolidation of mountainsides has been clearly recognised for some time now, also at normative level. In mountain climatic conditions, where the erosive effects of rainfall, surface runoff and cryoclasticism are intense, the conifer tree cover plays a significant role, especially those species with a higher pioneer capacity such as mountain pine and larch, or ones which are more resistant to variations in temperature and available water. Their root apparatus consolidates rocky substrates and soils, whereas above-ground vegetation slows down runoff and thus reduces the force of water flow. In recent forestry policies, therefore, the importance of “protective woodlands” is acknowledged, and they have been maintained or newly planted to protect human settlements and other constructions at lower altitudes.

Appreciation of these environments for their landscape value and their potential as places for holidaying and recreational activities is also widespread. Especially in some sectors of the Alps, the maintenance of spruce and larch forests is therefore linked to the tourist economy. Within the ambit of a strategy of tourist promotion compatible with environmental protection, the relict sites of Heldreich pine in the Calabrian Apennines are of especial importance from the aesthetic and conservational viewpoints.

The traditional perception of mountain conifer woodlands as a resource of mainly economic, protective or landscape interest, still today often relegates

Holed trunk riddled with parasites

recognition of their basic natural and ecological value to second place. Compared with other environments, it is true that they contain a lower proportion of rare species or those that are a conservation priority, at either local or Italian level. For example, in the Red List of plants of the province of Belluno, compiled by Argenti and Lasen in 2004, none of the 102 species classified as gravely endangered is characteristic of sub-alpine conifer forests, and only three of the 123 species identified as endangered are typical of, although not exclusive to, pinewoods. Similarly, in the Red List of plants of the province of Trento, compiled by Prosser in 2001, none of the 64 species considered gravely endangered are typical of mountain conifer forests, and only one of the 97 endangered species is associated with these types of habitat. Again, in the Red List of animals of the South Tyrol, published in 1994, invertebrates living in coniferous forests are all rated at a lower level of endangered species.

Ceruchus chrysomelinus

In truth, more primitive situations and ones less affected by the centuries of human sylvicultural management, such as those of some pinewoods on steep mountainsides and ravines, or rocky substrates and crests, may host rare and endangered plant species - at least locally, two examples being the stemless milk-vetch (*Astragalus excapus*) and finger-leaved violet (*Viola pinnata*). In the same way, ancient forests with large quantities of necromass sustain particularly rich animal communities, made especially precious by the presence of saproxylophagous organisms, i.e., those associated with decaying wood and, because of this, especially vulnerable to the traditional practices of removing dead tree branches and clearing the undergrowth. Many of the rarest forest species belong to this ecological group, mainly being insects which live in this environment at the larval stage. In some cases, the records of these species are so dated or sporadic as to throw doubt on the current survival of the known populations. For example, this is the case for some of the previously-mentioned syrphids, or the rare *Ceruchus chrysomelinus*, a small lucanid beetle to be found in a few sites in the Alps and in the Casentinesi district of the Apennines. The age of the trees also influences soil structure and the vertical distribution of its fauna. In ancient forests, soil-dwelling invertebrates reach greater depths than in young forests. This is because, with

Sicilian pine (*Abies nebrodensis*)

the passage of time, the fine organic particles produced on the surface tend to accumulate in the deeper layers, creating a disparity between several centuries-old forests and those of only a few decades.

This shows, amongst other things, the extraordinary importance of forest cover in the formation of soils, in the knowledge that the degradation of soil and its consequent aridity is a serious problem at global level. To evaluate the biodiversity of a forestry formation correctly, it is necessary to consider not only the tree layer and vascular plants, but also the other groups, such as bryophytes, lichens and, most importantly, decomposing fungi.

Within the wide panorama of biodiversity in Italy, coniferous woodlands are relatively poorer than others in terms of endemic species or those with a restricted distribution area. Given the extension of these forests, especially in the Alps, and their climatic affinity with other vast territories to the north and east, their biological communities are mainly composed of species with ample distribution. One exception is the forests of Austrian pine in the eastern extremity of the Alps, which host various species at the western edge of their distribution areas, of Illyrian chorotype. The woodlands of the Maritime and southern Cottian Alps, a sector notoriously rich in endemic species which are affected by the influence of the Mediterranean, are also more diversified, and may harbour species of appreciable phytogeographical interest. The presence is also often undervalued, especially along the Apennine chain, of limited populations, often fragmentary and in regression, which are however representative of genotypes and evolutionary lines differentiated from their northern forms. This is the case, in particular, of the Sicilian pine (*Abies nebrodensis*), listed in the Habitats Directive as a priority species among those of European interest. The black pine (*Pinus laricio*) and Heldreich pine (*Pinus leucodermis*) are also of particular value because of their genetic differentiation. In addition, the Apennine populations of Norway spruce, silver fir and Austrian pine present higher genetic diversity or partial differentiation with respect to their more northerly populations.

■ Management practices and aims

Harmonising sylvicultural policies, with protection of biodiversity and ecosystem maintenance, must certainly be the primary objective. In Italy, efforts to re-orientate forestry management practices along lines that are as compatible as possible with the functioning of the ecosystem have become widespread, while centuries-long local traditions and cultural differences are still respected. Purely market solutions, luckily, almost no longer exist. The solidity of forestry planning, at least for state properties and especially in the regions of north-east Italy, is therefore one of the pillars of land management.

In terms of conservation of biodiversity, it should be recognised that it may be more efficient to maintain different systems of exploitation for forests, even in limited areas. The theoretical models which aim at rigid uniformity of structures undoubtedly ensure an equilibrium between removal and renewal, but in reality they leave little margin for that differentiation of ecological situations which is so necessary for enriching biological communities. In other words, extensive areas of monoculture, especially of Norway spruce, may be highly functional and guarantee prospects of natural regeneration but, at the same time, they are monotonous and reduce the level of biodiversity.

The publication of a series of regional volumes on the subject of forestry types has given impetus to more attentive consideration of flora, fauna, vegetation

Sporadic Heldreich pines along the ridge of Monte Alpi (Basilicata)

and aesthetic landscape values. The many recommendations inserted in the management notes provide useful guidelines, for each type, for maintaining or improving ecosystem functioning. Some general principles, such as leaving more large trees and dead wood, should contribute towards a system of structures closer to a natural state, greater diversification of microhabitats, and sustenance for populations of saprophagous and xylophagous invertebrates and birds, which require old trees for feeding and nesting. Greater diversification would also favour the predators or parasites of xylophagous species, which may cause damage following demographic explosions. A complex biological community can lead to higher self-regulatory capacity on the part of forest populations, and better resistance against adverse weather events such as high winds, heavy rainfall and late snowfalls.

In all probability, an optimal solution would be to plan, for the various forest types and biogeographical ambits, reserved areas in which all human activities were suspended. Rather than just small plots, which are useful for experimental or teaching purposes, it would be necessary to have areas of at least 100-200 hectares available, to be left to evolve naturally without any type of human intervention, except that of checking the main ecological parameters. The lower competitiveness of the timber production chain in the least accessible areas, or where the local market is depressed, would encourage the setting up of such conservation programmes.

Tree stumps and dead wood are fundamental for woodland ecological equilibrium

The Italian Ministry of the Environment has very recently funded a project to identify ancient woodlands (even only covering a few hectares) in the national parks. Hopefully this project will later be extended on a regional basis and contribute towards the definition of IPA (Important Plant Areas). Both in the Alps and Apennines, recently regenerated woodlands, as well as those artificially replanted, occupy appreciable areas which could be re-converted towards floral structures and compositions more in harmony with the true potential vegetation.

The Habitats Directive, currently the fundamental normative document for the management of natural environments at European level, identifies some types of mountain conifer woodland growing in Italy among the habitats of European interest whose preservation requires the designation of special conservation areas. These include the mountain acidophile and alpine forests of *Picea* (*Vaccinio-Piceetea*), alpine forests of *Larix decidua* and *Pinus cembra*, mountain and sub-alpine forests of *Pinus uncinata* (with priority for those on chalky or limestone substrates), southern Apennine forests of *Abies alba* and sub-Mediterranean woodlands of Austrian pine and the mountain pine formations on calcareous-dolomitic substrates with hairy alpenrose: the latter two are indicated as priority habitats. Surprisingly, the woodlands of Scots pine, many of which are of high natural value and play a very significant ecological and landscape role, have not been inserted. The Alpine fir woods, which certainly represent very

Planted forest of Austrian pine in the northern Apennines (Emilia Romagna)

Lady's slipper orchid (*Cypripedium calceolus*)

Hazel grouse (*Bonasa bonasia*)

natural woodlands, also have no explicit acknowledgement in the systems of codes included in the Nature 2000 network. However, they may be associated with beech or spruce woodlands where the formations are mixed. Of the species of plants and animals present in the Italian mountain coniferous woodlands, those listed in Annex II, as species of European interest for which it is necessary to set up areas of protection, are: *Abies nebrodensis* and *Cypripedium calceolus* among plants, and the brown bear (*Ursus arctos*) among vertebrates. Directive 79/409/EEC also lists some birds associated with the conifer formations in Annex I, including the hazel grouse (*Bonasa bonasia*) and capercaillie (*Tetrao urogallus*), Tengmalm's owl (*Aegolius funereus*) and little owl (*Glaucidium passerinum*), the three-toed woodpecker (*Picoides tridactylus*), black woodpecker (*Dryocopus martius*) and grey-headed woodpecker (*Picus canus*). Recognition of the value of invertebrates as fundamental components of ecosystems, and the need to develop adequate management strategies which take them into account, has only been emerging fairly recently. In Italy, the attempts that are being made are still modest, the majority being limited to the protection of a few species of ecological importance or notable aesthetic impact. As regards mountain conifer woodlands, laws and regulations at various administrative levels have recognised for some time the necessity to protect *Formica rufa*, on the basis of the traditional emphasis on the ecological effects of its colonies on Alpine forestry soils. Two xylophagous beetles have also been inserted in Annex II of the Habitats Directive: *Stephanopachys substriatus*, a small bostrychid known in some sites in Valle d'Aosta and Trentino, and *Buprestis splendens*, a jewel beetle associated with cool climes of Mediterranean environments and only found in Italy on Monte Pollino, where it lives on Heldreich pine.

■ In search of enchanted forests

A non-quantifiable value is also recognised for the oldest woodlands, due to their millenary and recent history, which has given them their current structure and composition and renders each one slightly different, even to an untrained eye. No virgin forests exist on the Alps, as they have all been exploited in the past, but there are plenty of examples of highly natural situations, or those where

traditional forms of use have left their mark on the landscape and which today can be considered worth preserving. A concise survey of localities is proposed here, divided by region. These localities are considered representative of a complex set of values and are certainly worth discovering and visiting. The list does not presume to be exhaustive, also because the perception of a woodland's fascination may be very subjective. The hope is that first-hand experience of these gems of nature can contribute more towards understanding and respect for nature than can a thousand words, images and affirmations of noble principles, by entering into people's hearts and minds. It should be noted that not all the locations cited are included in protected natural areas, although obviously more favourable conditions would exist in these, for an investment in the recovery of naturalness for the benefit of future generations.

In Piedmont, the Gran Bosco di Salbertrand at Alevé (from the fir woods up to the larch-stone pinewoods) and the woodland of stone pine, one of the highest in Italy, are widely recognised, even in the scientific literature. Other natural gems are the silver fir woods of Val Chisone and, more especially, those of Val Pesio and the mixed woodlands of silver fir and Norway spruce in Val Segnara and Val Quarazza (Valle Anzasca district). The woodland of silver fir of Bosco della Bandita di Foens, at Savoulx, is unusual. The woodland of Inverso di Laval (Pragelato) is exceptional for Swiss mountain pine, as is one which is the property of the town of Bardonecchia in Val Stretta, in French administrative territory.

Pinewood surrounding Lake Tovel (Trentino)

In Valle d'Aosta, the forest of Swiss mountain pine on serpentine rocks in the Mont Avic Natural Park stands out - it is also known as the "seeded woodland".

This is an extraordinary example of regeneration and re-naturalisation after excessive exploitation, due to the need to supply charcoal for the once thriving mining industry in the area.

Woodland of stone pine in Val di Fassa (South Tyrol)

In Lombardy, a region where, although the most interesting woodlands are probably the broadleaved ones on the plain, fir woods worth noting are those in Val Gerola, as well as the very unusual ones in the Lake Garda district near Tremosine. The silicaceous (on mesic soils, and thus fertile) spruce woodlands of the Valle delle Bratte (Savoire dell'Adamello) and the sub-Alpine ones near the pass of Croce Domini are all very distinctive. It should also be recalled that the Valtellina flanks of the Orobie mountains are rather inaccessible in parts and it is therefore likely that examples of ancient woodlands may be found there. The woodland of stone pine in Valfurva is also unusual.

In the South Tyrol, where the tradition of forestry management is among the oldest and the practice of pasturing very deep-rooted, the centuries-old contorted larches, covered in lichens, of the mid and upper Val Senales are very well worth seeing. Some very interesting xeric larch woods with savin (*Juniperus sabina*) are also to be found there. There are also lovely larch woodlands growing in the upper Valle Aurina. The most attractive forest of Norway spruce is probably that of Latemar, with the famous Lago di Carezza. The Puez-Odle Natural Park contains the stone pine woodland of Rodelwald, close to the Rodella pass, between Eores and Passo delle Erbe, in which there are some extremely interesting peaty sites. A stone pine woodland, still young, but very promising because of its structure, is growing on the Senes plateau, and there are some extraordinary scattered trees situated up towards the treeline, between the Alpe delle Pecore and the lake of the same name in the Natural Park of the Sesto Dolomites. The well-known formations of the Stelvio National Park (also on the Trentino and Lombardy slopes) should not be forgotten.

In Trentino, the forestry situation has also benefited from good sylvicultural traditions. The forest of Paneveggio (with a net prevalence of Norway spruce) is certainly among the most famous and productive, but only some sites are worth mentioning for their beauty and naturalness - for example, the stone pinewood that grows to the west of the Travignolo, towards Cima Bocche. The most

romantic forest (there is a risk of becoming lost in it!) is that around the Lago di Tovel, on enormous detritus blocks which have generated a series of pot-holes. As well as the predominant Norway spruce, silver fir, larch and Scots pine also grow here. Other localities of the Adamello-Brenta Natural Park offer suggestive views with areas of forest hosting ancient plants. Among the most exceptional woodlands are those of Val Noana (Primiero), with prevalent silver fir and a few notable beeches. For the Veneto, the whole area of the Dolomites is interesting for its woodlands of Norway spruce and silver fir. It would be very difficult to point out the singularities without running the risk of forgetting other similar ones. The wood of larch and stone pine that can be seen ascending towards Cinque Torri, in the Dolomiti d'Ampezzo, certainly deserves an admiring pause, as does the one known as Vescovo di Bressanone, near the town of Livinallongo, Col di Lana, although orographically it is really in the high Val Badia. In general, the valleys which conserve the most significant specimens are those of the Ladin or Romansh-speaking peoples, because of their cultural tradition and the climate. The endo-Alpine pinewoods (Gotres, Rufiedo) reveal a variegated tree composition and an unusual structure, enhanced by the low fertility of the substrate. The forestry cover of Comelico is probably at its most panoramic in the beautiful Val Visdende (Norway spruce and fir woods). Along the Valle del Piave, at Caralte, the pinewoods of Austrian pine and those mixed with Scots pine stand like sentinels on steep, rugged slopes. Those in the wilderness area of Val

Upper Val Pesarina (Friuli Venezia Giulia)

Montina are certainly among the most impressive. The attractive woodlands of Digola and Val Talagona, and some areas of the nature reserve at Somadida, offer more than one reason for interest (woods of fir, Norway spruce, pine and larch). Lastly, in the Dolomiti Bellunesi National Park, there are numerous sites of excellence (Caiada, Prampèr, Val del Grìsol), and some areas in the northern part of the Monti del Sole have now become well naturalised and include trees of notable size and appreciable amounts of dead wood. On the border between the Veneto and Friuli, the famed Bosco del Cansiglio is in reality mainly beech and mixed fir-beech, although there are also belts of fir and Norway spruce.

Swiss mountain pine in the Emilia-Romagna Apennines

In Friuli Venezia Giulia, a region with marked forestry traditions, the most famous forest is probably the Tarvisio state forest. The woodlands of Fusine (Tarvisio), Lotti (Tarviso, Malborghetto Valbruna, Pontebba) and Pramosio (Paluzza) have similar characteristics, where silver fir, partly because of the high precipitation in the region, plays an often pre-eminent role. Notable mixed spruce and fir woods are to be found at Paularo and the Bosco Bernone (Ampezzo, here also with beech, a very frequent situation in this region). The surroundings of Passo Pura (Ampezzo) have been used for some time as experimental and teaching areas and are popular with botanists. Towards the border with Belluno (Sauris-Lavardet), the Norway spruce woods with sphagnum moss are notable. Lastly, the pinewoods of Val Resia are extremely interesting and highly unusual.

There are not very many well-known and aesthetically noteworthy natural woodlands of conifers in the Apennines, due to the reasons given in the relative chapter. However, to draw up a brief list, we can first mention the woodland of Norway spruce of the Campolino Nature Reserve, in the Tuscan Apennines, a short distance from Passo dell'Abetone, which is celebrated for its stands of silver fir. In the central Apennines, a good example is the Abetino di Rosello Nature Reserve, situated in the province of Chieti, where there are some well-preserved mixed communities of beech and silver fir. As regards the formations of Mediterranean mountain pine in the southern Apennines, the classic reference for Heldreich pine is in the Pollino National Park. Splendid examples of Calabrian pine are to be found in the Sila National Park. An effort, more cultural than economic, is required to preserve and improve this heritage, which well deserves, with everything that it represents, to be better known, enhanced and promoted.

Suggestions for teaching

MARGHERITA SOLARI

■ Conifers

Secular specimen of Norway spruce

- Aims: to develop the capacity for observation and comparison; to learn to identify plant species; to increase knowledge of landscape changes in relation to climate and the impact of man.
- Level: primary-school pupils between 8 and 10 years of age; secondary-school pupils 11 to 13 years of age
- Equipment: literature; materials for drawing up cards and panels; proper clothing for the field trip; camera.
- Possible collaborators: nature guide, forest ranger or expert botanist.

PRELIMINARY STAGE (FOR TEACHERS)

1. Choose an area for an excursion in an easily accessible conifer woodland. Study the species present and obtain information on how the woodland is managed.

2. Prepare materials for introducing systematic botany (twigs bearing cones gathered in the countryside or purchased), set up iconographic material. Concentrate attention on the most common species (silver fir, Norway spruce, larch, mountain pine, Scots pine, Austrian pine) and perhaps those widespread in the local area (stone pine, Swiss mountain pine) or rare, but growing locally (Sicilian fir, Heldreich pine, black pine).

CLASSWORK

3. Make a general introduction and involve the pupils in a discussion. Describe the specific characteristics of conifers: needle-shaped, generally persistent leaves, which guarantee the plant the basic elements of photosynthesis

Winter landscape with conifers (Parco Naturale delle Dolomiti Friulane)

Silver fir (*Abies alba*)

Norway spruce (*Picea abies*)

Mountain pine (*Pinus mugo*)

Austrian pine (*Pinus nigra*)

Scots pine (*Pinus sylvestris*)

Swiss pine (*Pinus uncinata*)

throughout the year; production of resin in the wood as a defence against parasites; equilibration against excessive transpiration and very low temperatures; cone production, etc.

4. Divide the class into five or six groups and provide cards summarising the characteristics of each species, to be used for their identification (one species per group): height of the trunk in metres; colour and conformation of the bark; position, shape and length of the female cones; shape, colour, length, type of insertion of the needles; shape of the crown.

5. Prepare a card summarising all the analysed species and distribute photocopies to pupils.

Frozen pine needles

6. Organise the excursion: prepare cards to be used for observations in the field; date and place, appearance of the woodland, prevalent colours of the trees, any smells, presence of vertebrates or invertebrates, cones on the ground, presence of identified conifers.

FIELD EXCURSION

7. Guided observation, with the help of a nature guide, forest ranger or expert botanist, of the typical conifer species present: cones, colour and form of bark and needles, shape of the crown, estimation of the height of isolated specimens; observation of the environment: soil, light, presence or absence of undergrowth, presence of mushrooms or toadstools and plants, presence of any other tree species and animals (or signs of them: chewed cones, holes in trunks, etc.). Provide information on tree felling in the woodland, timber uses, sylvicultural practices of both planting and harvesting (also in the past).

8. The groups of pupils should compile cards on their field observations. Take photographs of the environment and details observed.

ONGOING CLASSWORK

9. Summarise the species observed in the field, during a class discussion; compile a panel of photographs with comments.

10. Give information, with the help of an expert, on the distribution of species in

Pine processionary moth
Traumatocampa pityocampa

This moth lays from 100 to 400 eggs on a clump of pine needles. The larvae hatching from these eggs are densely covered in hairs and, over five stages, reach 3-4 cm in length. They move along the ground following a thread secreted by the leading caterpillar in the group: this is the origin of the name *processionary moth*. The caterpillars then transform into chrysalids protected by a large white cocoon, positioned at the tips of the pine branches, which tends to darken with the passage of time. The chrysalids spend from two to four months in this condition, although in some cases this may be prolonged to one or even two or three years. A grey moth emerges, from 30 to 40 mm long with crepuscular habits. The damage caused by the processionary moth is due to the fact that the larvae feed voraciously on pine needles, causing defoliation of occasionally devastating proportions. The natural enemies of the pine processionary moth are birds and some hymenoptera. Their control by humans may be mechanical, biological, or through the use of pheromone traps.

Austrian pine (Abruzzo)

Italy; mention the environmental characteristics of woodlands of spruce, fir, larch, mountain pine, and woods composed of Scots pine and Austrian pine.
11. Hold a final discussion on the proficiency acquired in species identification, aimed at increasing pupils' sensitivity towards the studied environment.

FURTHER STUDIES ON ECOLOGY APPLIED TO CONIFER WOODLANDS

The work described so far has the aim, as mentioned above, of providing pupils with the ability to identify tree species. For secondary school, this may be further extended by an overview of woodland ecology, as follows:
1. Introduce the concepts of population ecology and communities, giving details on the relationships among competition, predation, symbiosis, parasitism, commensalism and mutualism.
2. Divide the class into three groups for further study of one of the following aspects of conifer woodlands, which are particularly fascinating from the ecology point of view: presence of symbiont or saprophytic fungi; role of wood ants in the biological control of invertebrates and their relationship with myrmecophilous (ant-loving) species; life-cycle of the pine processionary moth and its role in the community. Write texts and draw up panels. Each group should explain their special subject to the rest of the class.
3. Hold a concluding debate in the class on the complexity of the woodland ecosystem.

■ Woodpeckers

- Aims: to increase skills in identifying birds typical of conifer woodlands; to develop the capacity for analysis and comparison of the ecological specialisations of some animals; to develop a passion for bird-watching and, more generally, the local fauna.
- Level: primary and secondary school pupils between 9 and 12 years old.
- Equipment: literature; bird identification guide; recordings of bird song.
- Possible collaborators: nature guide or ornithologist.

PRELIMINARY STAGE (FOR TEACHERS)

1. Prepare literature which is simple for pupils to consult: guide to bird identification; iconographic and audiovisual teaching aids.

Black woodpecker
(*Dryocopus martius*)

Almost entirely black, this is the largest of the woodpeckers, reaching a length of 46 cm. The male has a red crown and crest, which is reduced to a mark on the nape in the female.
It lives in both coniferous and broadleaved forests, feeding mainly on ants and beetles, but also fruit.
Its excavated nest has an oval-shaped entrance, 30 to 50 cm in height, and may be up to a metre in depth.

Three-toed woodpecker
(*Picoides tridactylus*)

This small (21 cm) bird has a striking black-and-white livery, with longitudinal stripes on the head and transversal bands on the wings. The pileum is yellow in males and black in adult females.
It lives in old coniferous or mixed woodlands, preferably trees close to watercourses or clearings, and feeds mainly on larvae or insects living in wood, but it also integrates this diet with the sap of conifers.

Grey-headed woodpecker
(*Picus canus*)

A medium-sized woodpecker (25-30 cm), with whitish plumage on the breast and green back and wings, edged in brown.
The male has a red stripe along the forehead and black streaks like a moustache, from close to the beak towards the neck.
It feeds mainly on ants and other insects, digging holes up to 75 cm deep in anthills to gather its food.

CLASSWORK

2. Introduce the specific characteristics of the class of birds; arrange a small glossary summarising the terminology useful for study and identification of the various species (refer to the terms commonly used in the bird guides: plumage, crest, throat, breast, rump, nape, primary feathers, clutch, flight pattern, etc.).
3. Analyse, with a discussion in class, coniferous woodland characteristics and limiting factors.
4. Make a literature search in class on the characteristics that distinguish the Picidae family (strong feet, external toe facing backwards; robust pointed bill, ideal for making holes in tree trunks; very long protractile tongue, suitable for capturing invertebrates in cracks on the bark; short tail with stiff feathers, to act as a support on vertical trunks; habit of excavating nests in holes in trees, etc.).

Fir trunk holed by a black woodpecker

5. Divide the class into three groups for further study on the species living in Italian conifer woodlands (black woodpecker, three-toed woodpecker, grey-headed woodpecker); compile cards summarising each species, illustrating the geographical distribution and main characteristics (morphological characteristics or habits) useful for identification: colour of plumage, bill and feet; size; type of flight; feeding habits; territoriality: number of eggs per clutch; nesting period; habitat.
6. Listen to the calls of woodpeckers (audiovisual aids can be purchased). Pupils may also record their typical calls.
7. Ask a nature guide or ornithologist to come to class and present the other bird species common in the woodland environment (tits, thrushes, warblers, crossbill, bullfinch, nutcracker, diurnal and nocturnal raptors, etc.); wherever possible, accompany each description by listening to the bird calls and, if possible, recording them.

Hold a discussion in class on what pupils have learnt, concluding by mentioning the satisfaction that may be gained from the ability to identify birds and their songs in natural environments.

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Glossary

> Acidophile: refers to a plant community that prefers acid substrates, with pH of less than 7.
> Chorotype: type of geographical distribution of an organism, recurrent in more than one species; e.g., Boreoalpine, Mediterranean, Atlantic chorotype.
> Cryoclasticism: phenomenon of disaggregation of rocks caused by successive freeze-thaw phases.
> Fossorial: refers to an organism which lives mainly burrowing in the soil.
> Heliophile: preferring sun-lit environments.
> Mesophile: organism that avoids extreme possible ecological factors, preferring "average" conditions.
> Necromass: organic matter in phase of decomposition (fallen or dry trees, etc.); also termed "dead wood".
> Phytogeographical: related to phytogeography (or geobotany), which is the discipline that studies the distribution (chorology), ecology and relations between plants (phytosociology, vegetation science).
> Saprophage: organism which feeds on decomposing organic matter.
> Saproxylophage: organism which feeds on decomposing wood.
> Sciaphile: a shade-loving organism or plant community; the opposite of heliophile.
> Sclerophyllous vegetation: plants with leathery evergreen leaves, e.g., typical of the Mediterranean maquis.
> Synecology: study of ecosystems considered as single structures, their dynamics, and interactions among their components.
> Thermophile: an organism which grows best at relatively high temperatures.
> Thermoregulation: activity by means of which an organism regulates its body temperature by heat exchange with the environment.

List of species

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