Biodivers Conserv (2012) 21:131–144
DOI 10.1007/s10531-011-0170-5

ORIGINAL PAPER

Communicating old-growth forest through an educational trail

Emanuele Ziaco · Alfredo Alessandrini · Silvia Blasi · Alfredo Di Filippo · Steve Dennis · Gianluca Piovesan

Received: 16 December 2010 / Accepted: 6 October 2011 / Published online: 20 October 2011

Abstract This paper describes the experience of developing an educational trail inside an old-growth beech forest in central Italy. In the last 150 years local people exploited this stand almost exclusively for recreational purposes and now the beechwood has acquired new ecological value after having reached old-growth status. Despite the cultural-historical importance of the site, there is a substantial lack of knowledge about this magnificent stand among members of the public, who have no tools to understand its dynamics nor to accept those structural changes related to its natural evolution. Tourist facilities were restored at the site, according to non-restricting criteria, and an educational program was developed in order to promote a shared comprehension of old-growth forests, their ecological processes and value, the services they provide, and to increase tourist awareness toward this fragile ecosystem. We discuss the educational role ecotourism might potentially hold in western developed countries to link the public with the scientific world, educating people about nature, while preventing negative impacts on natural environments. Even if the importance of local communities in conservation of natural resources has been widely recognized by a number of conservationists, public involvement, particularly in forest conservation and management, still represents a difficult challenge, since it requires the implementation of a common understanding about forest ecosystems, forest goods and forest services. The educational trail inside the beech forest of Monte Cimino may represent a low impact strategy for preserving forest aesthetic functionality, limiting potential damages to the forest while increasing its importance for nature conservation.

Keywords Old-growth forest · Environmental awareness · Forest conservation · Ecotourism · Scientific communication

E. Ziaco (✉) · A. Alessandrini · S. Blasi · A. Di Filippo · G. Piovesan
DendrologyLab, Department of Agriculture, Forests, Nature and Energy (DAFNE),
University of Tuscia, Via S. Camillo de Lellis, 01100 Viterbo, Italy
e-mail: ziaco@unitus.it

S. Dennis
Department of Recreation and Parks Management, California State University,
400 West First Street, Chico, CA 95929, USA

Abbreviations
UN United nations
DP Description panel
IP Indicator panel
AP Admonishing panel

Introduction

Environmental awareness, ecotourism and forest conservation

Forest ecosystems provide habitats, goods and services, which are vital for a number of species and mankind as well (Bengtsson et al. 2000). Thousands of years of indiscriminate exploitation have altered the features of most forest ecosystems and decreased forest naturalness (e.g. reduced biodiversity related to natural forest conditions) (Liira et al. 2007). Conservation of forests has been one of the most important driving forces for the foundation of the early "environmentalist thought" in Western Colonialist Societies (Grove 1995). For a long time forest protection has been based on coercive restrictive programs, which entangled rural communities related to parks and forested protected areas between the conservation programs and their need for resources (e.g. wood, pasture and agricultural lands), creating severe social contrasts, strong aversion against the presence of protected areas (Marvier et al. 2006) and definitely leading in different cases to the failure of early conservation attempts. The most recent strategies for nature conservation have abandoned the coercive approach, but instead deal with the role of humans as fundamental actors of resources management and conservation programs (Ericson 2006). Given increasing attention toward the social context in natural resources management in recent years, new strategies have been developed in order to define conservation policies that better recognize the place of man in nature and the functioning of natural resources within society (Grumbine 1994).

Involving the general public in forest management requires the implementation of a common understanding about the way to sustainably utilize forest goods and preserve forest services and biodiversity. For this purpose a prior action is the development of a program of social learning to increase environmental awareness as a component of public opinion (Jensen and Middleton 1990). The need for educating people about environmental issues has been recognized in the agenda of the UN Conference on Human Environment held in Stockholm (Sweden) in 1972 and emerged again in the Agenda 21 adopted by the UN Conference on Environment and Development in Rio de Janeiro (1992) (United Nations (UN) 1993). Training for the environment is a fundamental aspect of environmental education, otherwise how can we expect to publicly discuss biodiversity, ecosystem services, sustainability, or forest conservation, if people have "negligible understanding of the services that nature provides or if they never experience nature?" (Kareiva 2008). Some authors recently argued that worrying evidence shows how at the beginning of the 21st century people in the western industrialized societies are becoming seriously disconnected from nature: Pergams and Zaradic (2008) found in fact a declining trend in visits to protected areas in the US and Japan since the late 1980s, which they interpreted as the sign of a remarkable detachment of modern man from nature. Although at global scale nature-based tourism, or "ecotourism", is rapidly increasing, especially in developing

countries where visits to protected areas are growing at rates that in many cases exceed 4% year^{-1} (Balmford et al. 2009), there seems actually to exist a worldwide negative relationship between visits to national parks and natural reserves and gross domestic production (GDP) (Balmford et al. 2009). The distance between us and the natural environment may be caused by the increasing disconnection between daily life and nature-based activities, but also by the absence of outdoor experiences at all levels of education, from primary school up through university level (Kareiva 2008).

Ecotourism has been largely accepted as a strategy for attaining both economical subsistence of rural communities and preservation of ecosystem functions and biological diversity in most developing countries (Bookbinder et al. 1998). But in the western developed countries this kind of tourism should be adapted to different landscapes, which have experienced a long history of human exploitation and transformations (Che 2006). There is strong concern about potential negative impacts of ecotourism and nature-based recreation on biodiversity and ecosystems all around the world (Kimmel 1999): the idea of ecotourism has been promoted and supported as a major means of dealing with the damaging effects of tourism, but ecotourism itself may cause substantial changes to the environment if developed without a careful planning process (Gordon 1994).

In Western societies ecotourism may represent an important weapon in the hands of conservationists for training people toward environmental awareness, providing them with the necessary skills to understand the surrounding environment and its transformations (Kassas 2002). Focusing on the strongly urbanized Mediterranean region, an alternative dimension is hoped to be drawn for small scale nature-based tourism, and the educational one seems to be the most promising as a long term strategy for biodiversity conservation and forest protection. Italy, for instance, and particularly the Etrurian landscape (i.e. Central Italy), is rich in natural amenities that if enclosed in a network of small scattered sites would probably generate a source of income for local communities through an environmentally-aware ecotourism.

Communicating old-growth forests through an educational trail

Old-growth forests represent the most complex ecosystem in the European landscapes, (Peterken 1996). They show the maximum degree of naturalness, with features that are lacking in managed forests: large trees, including senescent or dying individuals (Nilsson et al. 2003), abundant deadwood (Christensen et al. 2005) and a multi-aged structure, characterized by a fine-grained forest mosaic with patches belonging to different phases of stand structural development (Emborg et al. 2000). Old-growth structures usually occur in forests that escaped logging because of site inaccessibility (Piovesan et al. 2005), forests formerly included in aristocratic hunting reserves (Pontailler et al. 1997), forests with recreational/hydrogeological functions and forests of historical-cultural importance (Lo Monaco 1983).

Thanks to their uniqueness, old-growth forests represent a challenging case of study for silviculturists and conservationists, advantaged from having a flawless sample for developing nature-based silvicultural methods (Peterken 1996; Schnitzler and Borlea 1998; Emborg et al. 2000; Frelich and Reich 2003), to promote naturalness assessments in forest inventories for biodiversity monitoring (Winter and Möller 2008), to obtain reference conditions for interventions of ecological restoration (Bauhus et al. 2009) and to preserve "natural archives" of tree-rings series for dendroclimatic studies (Piovesan et al. 2008). But old-growth forests also hold the potential to accommodate ecotourism and nature-based activities. Particularly in old-growth forests, ecotourism may be difficult to manage

if tourists are not provided with a previous knowledge of the site they are going to visit (Che 2006).

Despite their enormous importance in nature conservation, old-growth forests actually represent one of the most threatened ecosystems on Earth due to forest fragmentation, illegal logging, infrastructure, unchecked tourism and social contrasts (Gilg 2004). In the last two decades the area of forest where conservation of biological diversity is designated as the primary function has increased on a global scale, presently representing about 12% of total forest area, as more and more countries are setting aside parts of their natural forests (Agricultural Food Organization of the United Nations (FAO) 2010). From a European perspective, the efforts for protecting old-growth remnants have led to the inclusion of "*Primeval Beech Forests of the Carpathians*" in the list of UNESCO World Heritage Sites in 2007 (United Nations Educational, Scientific and Cultural Organization (UNESCO) 2007). In 2011 the old-growth forest network was extended to include also "The Ancient Beech Forests of Germany" (http://whc.unesco.org/en/list/1133) and the scientific community is working toward a complete transnational nomination of primeval and ancient Beech Forests of Europe to the World Heritage List (see Knapp and Fichtner 2011).

We report a case study of a learning program focused on old-growth forests, to illustrate how ecotourism can represent a tool for linking the general public with the scientific world and broaden people's knowledge of forest ecosystems through a process of "ecolearning" (Kimmel 1999), intended to educate people about biodiversity, ecosystem processes and their services, reducing the negative impacts of unbridled tourism, and creating the foundations for a more active public participation in forest management. Numerous examples of public contestations against forest logging to preserve natural and cultural integrity are present in the literature (Takeda and Røpke 2010). But few studies have dealt with the role of ecotourism and interpretive trails inside forest ecosystems as a tool for environmental education (Báez 2002), and for public involvement in forest management (Hough 1984). In the following paragraphs we describe the experience of developing an educational trail inside an old-growth beech forest in central Italy aimed at linking the public with the scientific world around old-growth forests (Jensen and Middleton 1990).

Materials and methods

The secondary old-growth forest of Monte Cimino

The Nature Trail named "The old-growth forest" is located inside the beech forest of Monte Cimino (Viterbo province, Latium, about 70 km north of Rome) (Fig. 1). The study site is an historical forest, the highest part of *Silva Cimina* (Tito Livio, *Ab Urbe Condita*, Liber IX, 36–39) and probably it was a sacred wood since the bronze age. The beech forest has been exploited by local people in the last 150 years almost exclusively for recreational purposes, and through time has acquired new ecological and aesthetic value after having reached old-growth status.

The beech forest of Monte Cimino (also called by local people "La Faggeta", which means "beech forest" in Italian) is a secondary old-growth forest (Frelich and Reich, 2003) extended over 62 ha between 950 and 1050 m a.s.l. on the top of the mountain. The forest has been managed for a long time as a low-density grazing forest, but during the 19th century the aesthetic and recreational potential of the Faggeta dramatically increased under the demands of the local community, which made a strong opposition to every kind of

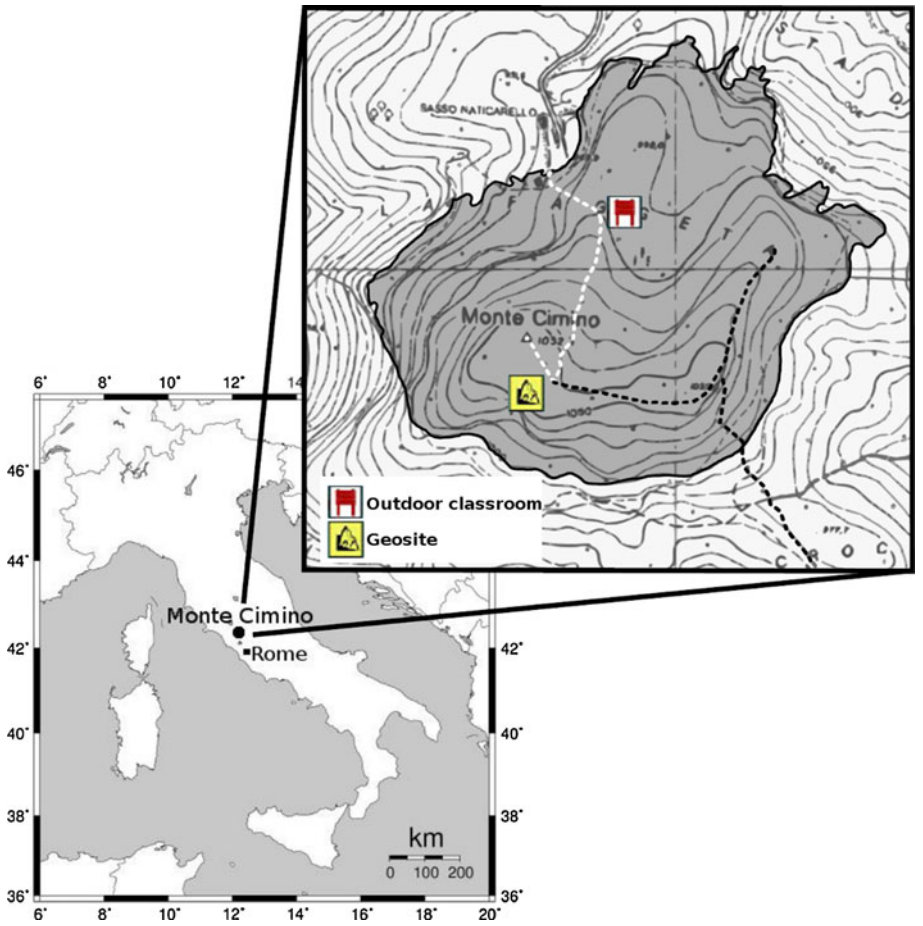

Fig. 1 Geographical location and aerial view of the old-growth beech forest of Monte Cimino (*light gray area*). *White dashed line* represents the path of the Nature Trail, *black dashed line* represents an older trail crossing the beechwood

silvicultural intervention. As a consequence frequent cuttings occurred only occasionally until 1949 (Lo Monaco 1983). Since then, no other logging practices have been performed in the Faggeta, so that in the past 60 years the only human impact on the forest has been recreational visitation and the partial removal of fallen trees.

At present the beech forest is evolving from an impressive single-layer canopy, where trees can reach 50 m in height, to a multi-aged structure thanks to gaps opened by the fallen trees. The maximum age of trees slightly exceeds 200 years (Table 1). The stand is characterized by the presence of several large trees and the amounts of basal area and volume (Table 1) are within the ranges found in other old-growth forests of Europe and North America (Keddy and Drummond 1996; Nilsson et al. 2003; Piovesan et al. 2005). Deadwood is scarce (19 m^3 ha^{-1}) and it is far from the range values found in other old-growth forests (Christensen et al. 2005). This lack of deadwood can be explained by the fact that until 2007 most downed logs were removed from the Faggeta by the local community.

Table 1 Geographical and structural features of the beech forest of Monte Cimino

Latitude (°)	Longitude (°)	Elevation (m a.s.l)	Slope (%)	Aspect	Stand area (ha)	N[a] (n ha^{-1})	Stature[b] (m)	DBH_{max}^{c} (cm)	G[d] (m^2 ha^{-1})	V[e] (m^3 ha^{-1})	Max age[f] (years)	Age 5[g] (years)
42.4083	12.2033	1000 (950–1050)	0–35	–	62	197	46	146	48	707	207	202

[a] Number of trees ha^{-1}(diameter at breast height > 2.5 cm)

[b] Mean height of the tallest trees in the stand

[c] Maximum stand diameter

[d] Basal area

[e] Volume of living trees

[f] Maximum stand age

[g] Mean age of the five oldest trees in the stand

The Nature Trail "The old-growth forest"

The site is well known by local communities, such as the nearby city of Viterbo (about 60,000 inhabitants), and it represents one of the most remarkable sites of natural interest in the entire province, especially in summer, when people visit the beechwood forest looking for refreshment. During summer Sundays of 1983 (August–September) Lo Monaco (1983) registered an average number of about 600 daily visitors in the Faggeta and from 50 to 80 during midweek days in the same period. These data probably underestimate the present number of tourists. Despite the forest's importance, before the beginning of this project tourist facilities in and around the Faggeta were almost absent or damaged, the trails inside the forest were not clearly marked, no information panels were present. Field operations for the development of the Nature Trail started in November 2007 with the removal of all barriers and wire nettings installed during the last 20–30 years to restrict parts of the forest from the public. New no-restricting wooden fences were built to spontaneously convey visitors inside the Nature Trail, in order to protect beech regeneration and wild flora. The health status of all trees proximal to the trail was assessed by performing the Visual Tree Assessment (VTA) analysis (Mattheck and Breloer 1995). About 20 individuals shown to be damaged or precarious were felled, but tree felling was made in such a way as to simulate a natural windbreak. Some of the logged stems were then retained inside the forest to increase the total amount of deadwood while the rest of the wood was offered to local people as fuelwood.

The trail was bordered with several aluminium panels of different sizes divided in three different groups: 10 description panels (DPs) installed on low visual impact wood kiosks (with size ranging from 80 × 110 to 90 × 120 cm); 15 indicator panels (IPs) sized 50 × 50 cm, and various 50 × 50 cm admonishing panels (APs) set on wooden stakes strategically located on the trail. Each panel was composed of a description text, which had central importance in the DPs and in the IPs while minimal in the APs, and a graphical part, where drawings, graphs and other kinds of images (botanical tables, photos, maps) were used to make easier the comprehension of the panel.

Results and discussion

Features of the Nature Trail

The final path of the Nature Trail covers a total distance of 535 m with an altitudinal range of 66 m (starting at 980 m a.s.l. and ending at 1046 m a.s.l.) (Table 2). It includes two principal points of interest: an *outdoor classroom* (Fig. 2) after 170 m, where a wooden-made classroom was reproduced by using part of the stems of logged trees, and a *geosite* at the end of the trail, where visitors can observe some of the several huge trachitic rocks that are widespread inside the forest and that are visited every week by dozens of climbers.

The large amount of information to be transmitted was divided into three groups, each represented by different sets of panels (Table 2). A key role is played by the DPs (Figs. 2, 3, 4), which enclose the most substantial part of the educational message. The DPs are firstly dedicated to the floristic and faunal characterization of the Faggeta. A special focus was the illustration of the historical background of the stand, including the analysis of its evolution from a productive toward a recreational forest. Most of the DPs are devoted to the explanation of structural and ecological features of an old-growth forest (Fig. 3). Special efforts were lavished for providing the public with scientific knowledge to

Table 2 Features of the Nature Trail "The old-growth forest"

Technical features			
Length (m)	Height difference (m)	Mean slope (%)	Waypoints
535	66	12	2 (Outdoor classroom; Geosite)
Panels features			
Type	Number	Size (cm)	Content
Description panels (DPs)	10	80 × 110–90 × 120	Structure, ecology, biodiversity of temperate old-growth forests Basic concept in silviculture History of the Faggeta
Indicator panels (IPs)	15	50 × 50	Structural phases; deadwood elements; tree species.
Admonishing panels (APs)	>20	50 × 50	Safety rules; emergency numbers; behavioural suggestions.

Fig. 2 The outdoor classroom located inside the old-growth beech forest of Monte Cimino. At the bottom it is possible to see four DPs

recognize those aspects of the forest structure that are lacking inside managed stands but are instead distinctive of natural undisturbed and old-growth forests (e.g. presence of large-dimensioned senescent trees; multi-layered structure; abundance of deadwood). This point was extremely important given public concern about the increasing number of windbreaks and the appearance of dead or dying trees, which were interpreted by local people not as a consequence of increasing forest naturalness but as premonitory signs of the forest's death. In fact the most widespread traditional forest thought still argues that the absence of active management leads forest stands to death in so much that someone, among forest professionals and decision makers, was even asking for return to active silvicultural management inside the Faggeta in order to "save" the forest! The main message was explaining that the forest is not dying but just evolving, and that if in a managed stand the economical value of

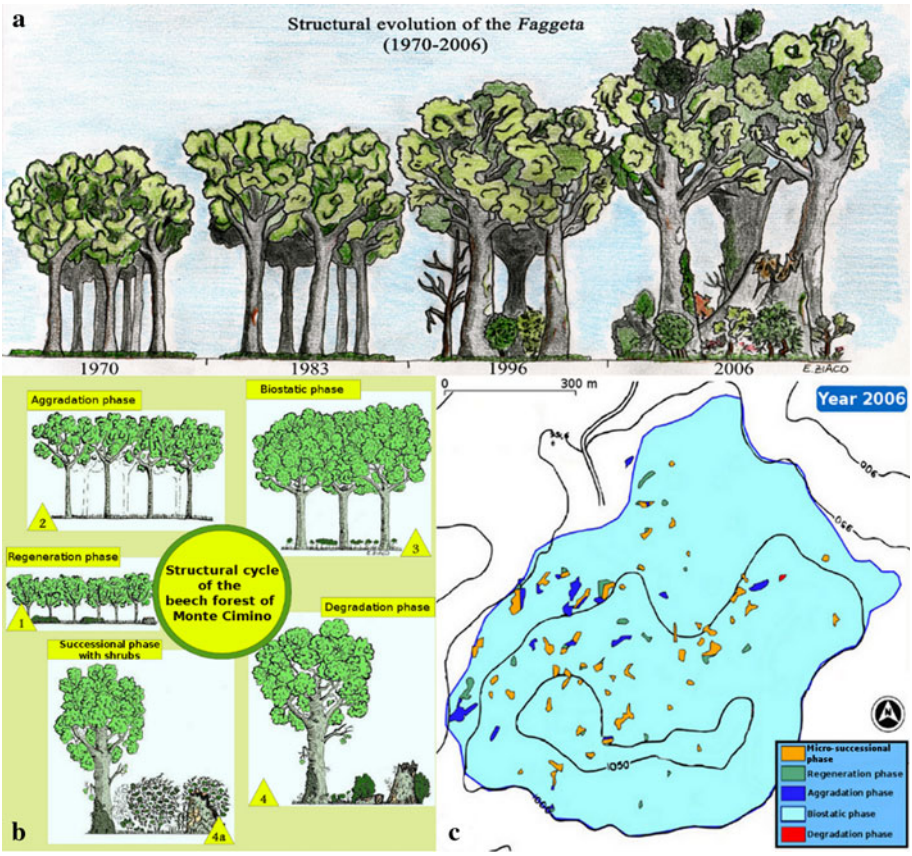

Fig. 3 Drawings extracted from the DP "the old-growth forest". **a** Structural evolution of the beech forest according to results reported in different studies (years below); **b** structural cycle of a temperate beech forest; **c** the forest mosaic of the beech forest of Monte Cimino as mapped in 2006

woody products may actually decrease after the interruption of interventions because of emerging wood pathogens, the forest ecosystem as a whole moves toward a new natural balance, with dramatic increase of ecological value and biodiversity which are, to the contrary, lower in forests under active management.

Some basic notion of silviculture was also introduced in the DPs, including an overview of the most common silvicultural systems (e.g. the differences between high-forests and coppice stands), and a concise explanation of technical concepts like basal area, annual growth increment, and rotation period. Elements of tree physiology are furnished in the DP named "life of a tree" (Fig. 4a). There is an introduction to dendrochronology as well, and for this reason the cross section of one of the logged trees has been cleaned and the related series of tree-ring widths has been digitalized and included in a panel nearby (Fig. 4b). In the geosite attention was focused on the geological features and the evolution of Monte Cimino and the surrounding areas and an entire DP was dedicated to this topic.

The IPs are scattered along the trail to highlight some specific aspects of the old-growth forest, like the occurrence of a given structural phase or to point out the presence of tree species other than beech. Four groups of IPs have been produced to mark each phase of the

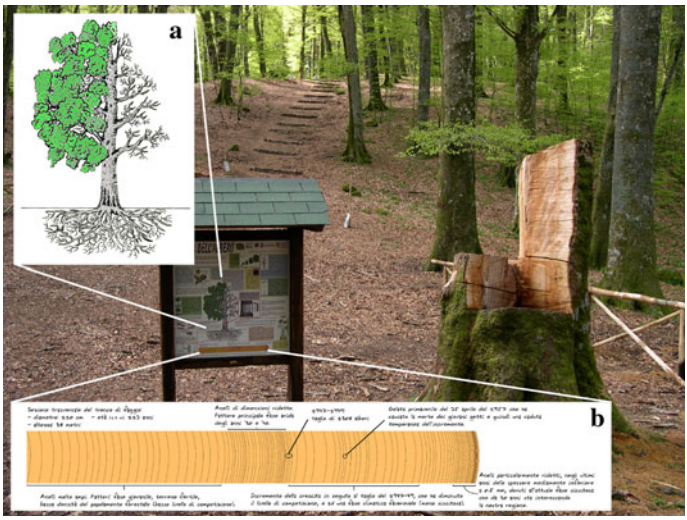

Fig. 4 The DS named "Life of a tree". **a** One of the drawings used to describe tree physiology; **b** graphical reconstruction of tree-rings series related to the tree on the right (this tree was cut after VTA analysis)

Fig. 5 Indicator panels describing the **a** micro-successional/regeneration and **b** degradation phases (this tree fell naturally); **c** the IP named "There's life in the dead tree" placed close to a downed tree that had been felled (after VTA analysis) simulating a natural windbreak

structural cycle of the forest: micro-successional phase (characterized by the presence of shrubs, mainly *Sambucus nigra*) and regeneration phase (Fig. 5a); aggradation phase; biostatic phase; degradation phase (Fig. 5b) (according to Oldemann 1990). These panels are placed along the trail close to patches representative of the different phases. The IP named "There's life in the dead tree" (Fig. 5c) focuses on deadwood as a structural and functional component of forest ecosystems, and as an important aspect of forest biodiversity (Christensen et al. 2005; Ódor et al. 2006; Winter and Möller 2008). The fundamental ecological role of CWD was actually one of the most challenging messages to deliver to the public, because of the historical lack of knowledge about deadwood caused by traditional forest thought, which theorized the negative action of deadwood as nesting sites for pathogens detrimental to forest health. To overcome this wrong tradition we stressed the importance of deadwood as nesting and/or feeding sites for that part of local fauna that particularly strikes public sensibility, like Badger (*Meles meles*), Red squirrel (*Sciurus vulgaris*), Fat dormouse (*Glis glis*), and different species of Woodpeckers (*Sitta europea*; *Dendrocopos major*; *Picoides minor*). Furthermore, we described the decaying

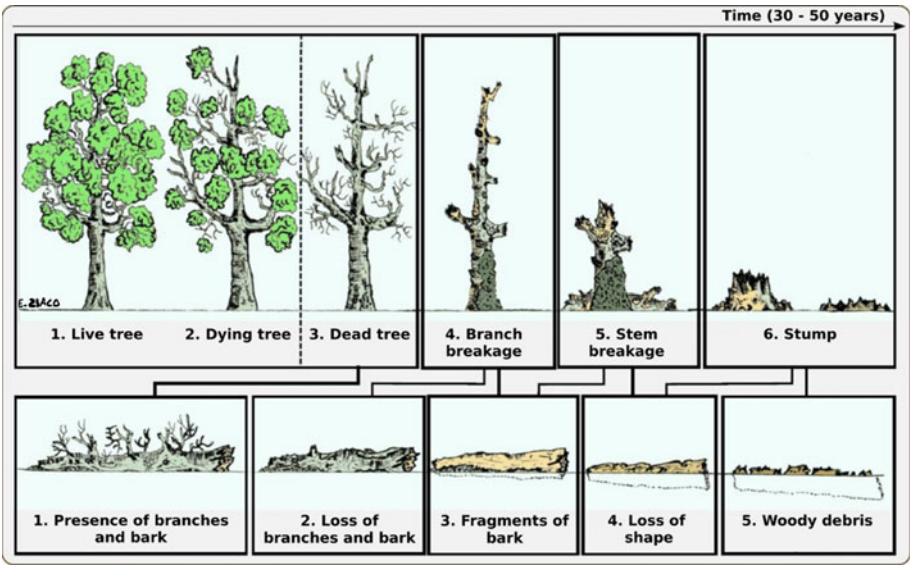

Fig. 6 Decaying process of deadwood elements in temperate forest ecosystems (extracted from the DP "The old-growth forest"): different decay classes are described for standing dead trees (*top*) and downed dead trees (*bottom*)

process of trees, identifying various steps toward the complete disappearance of dead woody elements in the forest (Fig. 6).

The last group of panels are the APs, which report no educational information but relate safety rules and emergency numbers. Each AP was thought of as a suggestion about those good practices visitors should conscientiously follow inside the forest in order to protect both their own safety and the wilderness. The APs are comprised of short warning messages and represent a constant effort to make tourists feel like part of the ecosystem, the health of which depends on their actions as well.

The results of the project, including the contents of all panels, have been reported in a book, freely distributed during the inauguration of the Nature Trail on October 2008 (available at http://www.daf.unitus.it/dendro).

Educational trails as learning processes

Despite that several national and international studies have been performed inside the Faggeta, there is a substantial lack of knowledge of this gorgeous old-growth forest among the public and decision makers (Shanley and Lòpez 2009). The educational trail aims at communicating this large body of scientific findings to the general public, to prevent potential damages related to tourist activities without limiting the recreational value of the forest, and to promote a shared understanding of the site. It is not easy to communicate old-growth forests to a general and non-specialized public because old-growth forests have mainly intrinsic value (Peterken 1996), especially where they are extremely scarce, as in the Italian landscape. For this reason, losing old-growth forests would not only represent a tremendous damage to biodiversity, but also for our culture and history. Unfortunately, public opinion tends to value nature because of material or physical benefits it provides for humans (Gagnon Thompson and Barton 1994), so ecosystem services are often treated as

"free" and few among common people and decision makers understand how dangerous it would be to lose these services (Daily et al. 2000).

The synthesis of such a complex topic like old-growth forests makes necessary a great effort to evaluate a few well-defined points to develop in the educational program (Jensen and Middleton 1990). Planning an educational trail in the old-growth implies clear decisions about the strategy for attaining at least three important targets: i) clarity of the environmental message; ii) scientific effectiveness of the program; iii) catching the attention of visitors without missing points i) and ii). Following these indications, only a few themes were selected to be broadened along the educational trail. In the DPs we selected the information stream to supply by integrating facilitations for an immediate understanding (images and/or drawings) with scientific precision, to stimulate the observer and create the foundations for deeper exploration (Jensen and Middleton 1990). The educational trail is thought of as a learning process that encloses three different approaches to environmental education: education in the environment, education about the environment and education for the environment (Lucas 1980). The Nature Trail is based primarily on field observation (education in the environment). The visitor is educated to have a deeper perception of the surrounding environment: he is provided with the tools to understand the impact of human actions on the ecosystem, the relationships among different plant and animal species that share the forest ecosystem and the interactions between its biotic and abiotic components (education about the environment). If the tourist has the chance to foster his own idea about what he is looking at, he will probably attain a better inclination toward conservation of forest ecosystems; he will probably pay more attention to the environmental agenda of decision makers, and he will be able in the future to understand which decision maker is promoting an environmental-friendly policy (education for the environment).

Particular efforts have been made for children's approach to the forest. The educational trail has been promoted to primary schools in the entire province and groups of students and teachers have been invited to visit the trail. Children are most endangered by the loss of confidence with nature (Kassas 2002); consequently most of the environmental training must focus on them. The outdoor classroom was designed to be a substantial help for both students and teachers, students benefiting of open air classes to experience a direct contact with nature, and teachers being stimulated to go out with their students. From this point of view, old-growth forests can potentially represent wonderful natural outdoor laboratories (Gilg 2004).

Conclusions

Old-growth forests are ecosystems requiring both better conservation and comprehension by the general public. Their scarcity suggests to strictly protect them from logging: classifying old-growth forests as strict forest reserves would not represent an insurmountable sacrifice in Europe since they are extremely rare (Gilg 2004). At the same time, they would provide precious information for reducing the impact of silviculture practices on managed forests (Schnitzler and Borlea 1998). Comprehension of old-growth forests is required for both common people but even for forest professionals who are often short of experience with natural and semi-natural forest structures and dynamics in the temperate zones due to a long tradition of managing uniform, even-aged monoculture stands (Larsen and Nielsen 2007). Saving old-growth forests from logging doesn't imply excluding people from visiting these forests, provided that visitors are deeply aware about the importance and

fragility of such ecosystems. However, public education toward environmental awareness implies a reframing of environmental values, removing traditional public perceptions of nature as a mere provider of goods (Grumbine 1994). The Nature Trail inside the beech forest of Monte Cimino, may represent a low impact strategy for preserving forest aesthetic functionality, limiting potential damages to the forest itself while increasing its importance for nature conservation.

At the present most of the people, stakeholders, foresters and political authorities are informed that the Faggeta is not in a die back phase, but is evolving to a more natural old-growth status. The educational program embodied in the old-growth forest Nature Trail was an important step in the conservation of this impressive stand: now the local community has realized that a "natural forest" can evolve without the help of man, so there are no risks of cutting in the Faggeta.

Acknowledgments This research was conducted within the UE DOCUP Program-Target II "Enhancement of regional environmental heritage" and the 2007AZFFAK PRIN project: "Climate change and forests—dendroecological and ecophysiological responses, productivity and carbon balance on the Italian network of old-growth beech forests". We thank the Province of Viterbo, and particularly M. Busatto, L. Modonesi and L. Schiavoni for technical support. The map of the different structural phases was developed with contribution of Fabio Natalini. Discussion with Proff. L. Portoghesi and B. Schirone were helpful for the development of the trail.

References

Báez AL (2002) Sky walk–sky trek: a successful community project in the mountains of Monteverde, Costa Rica. Mt Res Dev 22(2):128–131

Balmford A, Beresford J, Green J, Naidoo R, Walpole M, Manica A (2009) A global perspective on trends in nature-based tourism. PLoS Biol 7(6):e1000144. doi:10.1371/journal.pbio.1000144. Cited 30 Sep 2010

Bauhus J, Puettman K, Messier C (2009) Silviculture for old-growth attributes. Forest Ecol Manag 258:525–537

Bengtsson J, Nilsson SG, Franc A, Menozzi P (2000) Biodiversity, disturbances, ecosystem function and management of European forests. Forest Ecol Manag 132:39–50

Bookbinder MP, Dinerstein E, Rijal A, Cauley H, Rajouria A (1998) Ecotourism's support of biodiversity conservation. Conserv Biol 12(6):1399–1404

Che D (2006) Developing ecotourism in first world, resource-dependent areas. Geoforum 37:212–226

Christensen M, Hahn K, Mountford EP, Ódor P, Standovàr T, Rozenbergar D, Diaci J, Wijdeven S, Meyer P, Winter S, Vrska T (2005) Dead wood in European beech (*Fagus sylvatica*) forest reserves. Forest Ecol Manag 210:267–282

Daily GC, Söderqvist T, Aniyar S, Arrow K, Dasgupta P, Ehrlich PR, Folke C, Jansson AM, Jansson BO, Kautsky N, Levin S, Lubchenco J, Mäler KG, Simpson D, Starrett D, Tilman D, Walker B (2000) The value of nature and the nature of value. Science 289:395–396

Emborg J, Christensen M, Heilmann-Clausen J (2000) The structural dynamics of Suserup Skov, a near-natural temperate deciduous forest in Denmark. Forest Ecol Manag 126:173–189

Ericson JA (2006) A participatory approach to conservation in the Calakmul biosphere reserve, Campeche, Mexico. Landscape Urban Plann 74:242–266

Food and Agricultural Organization of the United Nations (FAO) (2010) Global Forest Resource Assessment FAO forestry papers 163. Food Agricultural Organization, Rome

Frelich LE, Reich PB (2003) Perspectives on development of definitions and values related to old-growth forests. Environ Rev 11:9–22

Gagnon Thompson SC, Barton MA (1994) Ecocentric and anthropocentric attitudes toward the environment. J Environ Psychol 14:149–157

Gilg O (2004) Forêts à caractère naturel: caractéristiques, conservation et suivi. Cahiers Techniques de l'ATEN:74. ATEN, Montpellier (in English)

Gordon NJ (1994) The spread of ecotourism: some planning implications. Environ Conserv 21:248–255. doi:10.1017/S0376892900033233 Cited 30 Sep 2010

Grove RH (1995) Green imperialism. Colonial expansion, tropical island Edens and the origins of environmentalism, 1600–1860. Cambridge University Press, Cambridge
Grumbine RE (1994) What is ecosystem management? Conserv Biol 8(1):27–38
Hough M (1984) Environmental education and forest management in Ontario, Canada. In: Steiner F, Van Lier H (eds) Land conservation and development–examples of land-use planning projects and programs. Elsevier, Devon, pp 375–404
Jensen EC, Middleton BA (1990) Educating the public about old-growth forests. Northwest Environ J 6:315–330
Kareiva P (2008) Ominous trend in nature recreation. Proc Natl Acad Sci USA 105(8):2757–2758
Kassas M (2002) Environmental education: biodiversity. Environmentalist 22:345–351
Keddy PA, Drummond CG (1996) Ecological properties for the evaluation, management, and restoration of temperate deciduous forest ecosystems. Ecol Appl 6:748–762
Kimmel JR (1999) Ecotourism as environmental learning. J Environ Educ 30(2):40–44
Knapp H, Fichtner A (eds) (2011) Beech forests: a joint natural heritage of Europe, BfN-Skripten, Vol 285 Vilm Putbus. German Federal Agency for Nature Conservation, Bonn
Larsen JB, Nielsen AB (2007) Nature-based forest management-where are we going? Elaborating forest development types in and with practice. Forest Ecol Manag 238:107–117
Liira J, Sepp T, Parrest O (2007) The forest structure and ecosystem quality in conditions of anthropogenic disturbance along productivity gradient. Forest Ecol Manag 250:34–46
Lo Monaco A (1983) Proposte per un piano di valorizzazione naturalistica della "Faggeta" del Monte Cimino. Thesis, University of Florence, Italy (in Italian)
Lucas AM (1980) Science and environmental education: pious hopes, self-praise, and disciplinary chauvinism. Studies Sci Educ 7:1–26
Marvier M, Grant J, Kareiva P (2006) Nature: poorest may see it as their economic rival. Nature 443:28
Mattheck C, Breloer H (1995) The body language of trees: a handbook for failure analysis. Research for Amenity Trees 4, HMSO, London, pp 240
Nilsson SG, Niklasson M, Hedin J, Aronsson G, Gutowski JM, Linder P, Ljungberg H, Mikusìnski G, Ranius T (2003) Densities of large and dead trees in old-growth temperate and boreal forests. Forest Ecol Manag 161:189–204
Ódor P, Heilmann-Clausen J, Christensen M, Aude E, van Dort KW, Piltaver A, Siller I, Veerkamp MT, Walleyn R, Standovár T, van Hees AFM, Kosec J, Matočec N, Kraigher H, Grebenc T (2006) Diversity of dead wood inhabiting fungi and bryophytes in semi-natural beech forests in Europe. Biol Conserv 131:58–71
Oldemann RAA (1990) Forest: elements of silvology. Springer-Verlag, Berlin, p 624
Pergams ORW, Zaradic PA (2008) Evidence for a fundamental and pervasive shift away from nature-based recreation. Proc Natl Acad Sci USA 105:2295–2300
Peterken GF (1996) Natural woodland: ecology and conservation in northern temperate regions. Cambridge University Press, Cambridge, p 522
Piovesan G, Di Filippo A, Alessandrini A, Biondi F, Schirone B (2005) Structure, dynamics and dendroecology of an old-growth *Fagus* forest in the Apennines. J Veg Sci 16:13–28
Piovesan G, Biondi F, Di Filippo A, Alessandrini A, Maugeri M (2008) Drought-driven growth reduction in old beech (*Fagus sylvatica* L.) forests of the central Apennines, Italy. Glob Change Biol 14:1–17
Pontailler JY, Faille A, Lemée G (1997) Storms drive successional dynamics in natural forests: a case study in Fontainebleau forest (France). Forest Ecol Manag 98:1–15
Schnitzler A, Borlea F (1998) Lessons from natural forests as keys for sustainable management and improvement of naturalness in managed broadleaved forests. Forest Ecol Manag 109:293–303
Shanley P, Lòpez C (2009) Out of the loop: why research rarely reaches policy makers and the public and what can be done. Biotropica 41(5):535–544
Takeda L, Røpke I (2010) Power and contestation in collaborative ecosystem-based management: the case of Haida Gwaii. Ecol Econ 70(2):178–188
United Nations (UN) (1993) Earth summit-agenda 21. UN, New York
United Nations Educational, Scientific and Cultural Organization (UNESCO) (2007) Decisions adopted at the 31st session of the World Heritage Committee 23 June–2 July. UNESCO, Christchurch, pp 145–146
Winter S, Möller GC (2008) Microhabitats in lowland beech forests as monitoring tool for nature conservation. Forest Ecol Manag 255:1251–1261