The Project "FAGUS Forests of the Apennines: Good practices to conjugate Use and Sustainability"

Cilento, Vallo di Diano and Alburni National Park is the coordinator of the Life+ Nature project FAGUS: Forests of the Apennines: Good practices to conjugate Use and Sustainability, with a budget of € 1,244,038 of which 68% funded by the European Union.

The main objective of the FAGUS project is to ensure the long-term conservation of priority habitats 9210* and 9220* in the National Parks of Cilento, Vallo di Diano and Alburni and Gran Sasso and Monti della Laga.

The species that characterise the habitats 9210* "Apennine beech forests with Taxus and Ilex", and 9220* "Apennine beech forests with Abies alba or Abies nebrodensis" are yew, holly and silver fir. These species became progressively rare in Apennine beech forests both because of management practices that are not specifically planned for the habitat conservation, and because of grazing, which often impacts the regeneration of these species. Traditional management of Apennine beech forests impacts also other species that belong to those taxonomic groups that are limited by the lack of deadwood and of senescing trees, and by a homogeneous forest structure. Among these taxonomic groups are saproxylic beetles and fungi (i.e. that depends on dead or rotting wood), vascular plants, lichens and birds.

The FAGUS project aims at developing and testing management strategies able to integrate the conservation of priority forest habitats (9210* and 9220*) with the sustainable use of forest resources. The project will develop and carry out specifically designed silvicultural interventions which, besides providing wood resources to the local population, will favor the structural heterogeneity of six beech forest stands, with positive repercussions on the biodiversity of several taxonomic groups, which comprise several species of community interest under the Habitats Directive (92/43/EEC).

Specific objectives are to:

1. Develop sustainable management strategies for the habitat 9210* and 9220*
2. Enhance the levels of biological diversity for vascular plants, lichens, birds, saproxylic beetles and fungi
3. Monitoring the habitats to assess the effects of the conservation actions
4. Promote the participation of relevant stakeholders to point out the advantages of sustainable management of the habitats.

Part of the project staff during a monitoring visit in the Cilento, Vallo di Diano and Alburni National Park. Photo: C. Cogoni.

The project sites

The LIFE FAGUS project was realized within the area of two national parks, the Gran Sasso and Monti della Laga National Park and the Cilento, Vallo di Diano and Alburni National Park. The project actions involved six different areas distributed in three Sites of Community Importance (SCIs), two in the Cilento, Vallo di Diano and Alburni National Park ("Monti Alburni - IT8050033", "Motola - IT8050028") and one in the Gran Sasso and Monti della Laga National Park ("Gran Sasso - IT711020") with a total area of about 70 hectares. Despite the geographical distance, the three SCIs share several abiotic and biotic elements. All the areas fall within the temperate climatic region, although the influence of the Mediterranean climate is still relevant in the hilly areas of the SIC "Monti Alburni" and "Motola". The lithological composition of the SCIs is predominantly calcareous, with karst phenomena in the sites of the Cilento, Vallo di Diano and Alburni National Park.

Within the SCIs, beech forests are widespread, other vegetation types relatively common are Turkey oak forests, or dry grasslands dominated by *Bromus erectus* on limestone, or mesophilous grasslands dominated by *Brachypodium rupestre* predominantly on clay soils.

All the three SCIs included in the project are characterized by a rich fauna of high conservation interest. Among the mammals it is worthwhile to mention the wolf (*Canis lupus*) and the wild cat (*Felis silvestris*), or the chamois (*Rupicapra ornata*) in the Gran Sasso area. There are also birds favored by the presence of senescent trees, such as the middle spotted woodpecker (*Dendrocopos medius*) and the collared flycatcher (*Ficedula albicollis*). Among the amphibians, we can mention the Apennine yellow-bellied toad (*Bombina pachypus*) or spectacled salamander (*Salamandrina terdigitata*). Several species of invertebrates associated with forest habitats (e.g. *Cerambyx cerdo* and *Rosalia alpina*) also occur.

Location of the project areas in Italy and within the two National Parks.

Alburni Mountains in the Cilento and Vallo di Diano National Park. Photo: M.M. Azzella

Beech forests in the Gran Sasso SCI. Photo: D. Di Santo

The Habitats

• Habitat 9210* - Apennine beech forests with Taxus and Ilex

The priority habitat 9210* includes beech forests with yew and holly in the tree and shrub layer. In Italy, it occurs along the Apennine chain and the Maritime Alps, usually in the supratemperate bioclimatic belt, both on limestone and marls, and siliceous substrates.

These forests are relatively rich in species in the tree, shrub and herb layer. The tree species most frequently found are beech (*Fagus sylvatica*), holly (*Ilex aquifolium*), yew (*Taxus baccata*), silver fir (*Abies alba*), maples (*Acer platanoides*, *A. pseudoplatanus*). In the understorey several geophytes (species with underground storage organs such as bulbs or rhizomes) that bloom in early spring commonly occur, e.g. *Scilla bifolia*, anemones (*Anemone apennina*, *A. nemorosa*, *A. ranunculoides*), *Adoxa moschatellina*, *Allium ursinum, Corydalis cava*, and several orchids (*Cephalanthera damasonium*, *C. longifolia*, *Platanthera chlorantha*, *Neottia nidus-avis*).

Within the project areas the habitat is represented by forests managed as high forests or, less often, as coppice with standards.

Cluster of yew saplings in the area of Prati di Tivo (habitat 9210). Photo: W. Mattioli.*

• Habitat 9220* - Apennine beech forests with silver fir

Beech forests with *Abies alba* and *Abies nebrodensis* included in the priority habitat 9220* have a scattered distribution along the Apennine chain. They host several endemic species as well as species typically occurring in the montane belt of southern European mountains.

Tree species that are frequently found within these communities are beech (*Fagus sylvatica*), silver fir (*Abies alba*), and maples (*Acer platanoides*, *A. pseudoplatanus*, *A. lobelii*). The understorey is generally similar to the one of the habitat 9210*.

Habitat 9220 in the area of Incodaro. Photo: F.M. Sabatini*

Mixed beech and silver fir forests may derive from specific ecological and management conditions. For instance, these woodland may occur on steep slopes, where shallow soil makes silver fir more competitive. In some cases, silver fir, being less shade-tolerant than beech, has taken advantage of the presence of small gaps that were created to produce charcoal.

Silvicultural Interventions

The silvicultural interventions that were carried out for the project (concrete conservation actions) had the goal of integrating biodiversity conservation and the use of forest resources by local communities, according to a model oriented towards the development of structural features that are typically found in old-growth forests.

The aim of the interventions was to:
- Increase the structural and compositional heterogeneity;
- Increase the share of target species that characterize the habitats 9210* and 9220*;
- Create deadwood and microhabitats;
- Ensure an amount of timber that would satisfy the needs of the local communities that own the project areas.

Canopy gap intended to increase the structural and compositional heterogeneity. Photo: D. Di Santo

The interventions accounted not only for the protection of target species, but also of tree and shrub species that are relevant to wildlife, of relatively rare tree species, of trees with nests holes and cavities, of large trees, of trees with epiphytic lichen species of conservation concern, and of standing dead trees and lying deadwood. The increase of structural and compositional heterogeneity was addressed through the creation of small gaps in the canopy specifically located on the regeneration of target species or of beech, and near individual trees or clusters of tree species other than beech. In order to create diverse light conditions and to favor plant diversity large gaps were created. Within these, logged trees were left and part of the small and medium woody debris was piled to provide shelter to wildlife.

The interventions included the creation of standing dead trees, snags, uprooted trees, and leaning trees, as well as habitat trees. These include trees with nest holes, basal slits, and den trees. Basal slits start processes of wood decay that favor several species related to deadwood. Den trees are relevant as nests and shelters for wildlife.

The creation of deadwood and of habitat trees took advantage of what was already carried out by the LIFE Bosco della Fontana (NAT/IT/99/6245), but also harvesting, and transporting activities took into account several good practices. In order to apply these correctly, the personnel of the enterprises that performed the actions was trained through courses that provided specific information on the operational protocols.

Nest hole on a beech tree of the project area of Prati di Tivo
Photo: D. Di Santo

Table resuming the interventions included in the concrete conservation actions of the LIFE FAGUS project.

Actions		PNCVDA			PNGSML		
		Corleto	Ottati	Motola	Prati di Tivo	Venacquaro	Incodaro
C.1/C.2	Intervention area (ha)	19.64	10.70	0.73	5.86	16.03	6.16
	Logged volume (m^3)	1734	766	28	387	996	680
	Yield ($m^3 ha^{-1}$)	88.29	71.59	38.36	66.04	62.13	110.39
	Harvest percentage (%)	11-12	10-15	10	6-12	10	20
	Firewood (m^3)	1094	553	0	308	825	174
	Other wood (m^3)	336	90	0	35	87	34
C.3/C.4	Ling deadwood (m^3)	304	123	28	44	84	472
	Number of gaps	23	17	2	10	11	21
	Gap area (ha)	0.76	0.35	0.04	0.19	0.30	0.50
C.5/C.6	Standing dead trees	24	18	1	7	21	7
	Snags	20	6	0	5	18	6
	Uprooted trees	7	12	0	5	18	4
	Leaning trees	6	7	0	2	5	4
C.7/C.8	Nest holes	19	14	0	7	16	4
	Basal slits	12	8	1	3	13	4
	Nest holes and basal slits	12	14	1	4	16	6
	Den trees	20	9	0	6	18	9

Methods and results of biodiversity monitoring

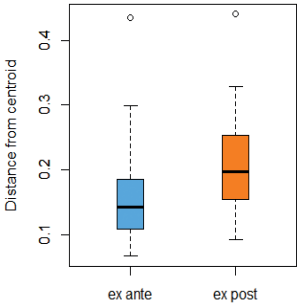
The monitoring actions of the FAGUS project followed an experimental design known as BACI (Before/After; Control/Intervention) that is based on the comparison, before and after the interventions, between the areas subjected to the concrete actions (*intervention* – I) and those left in their original status (*control* - C).

During the years 2013 and 2016, in 33 sampling units within the project areas we sampled forest structure and the diversity of five groups of organisms: vascular plants, epiphytic lichens, saproxylic fungi and beetles, and birds. Forest structure was sampled through the protocol used in the National Inventory of Forests and Forest Carbon Stocks. Vascular plants were recorded in a circular area of 1,256 m^2; epiphytic lichens were sampled on the 3 trees with a circumference greater than 50 cm closer to the center of each monitoring area. The occurrence of saproxylic fungi was sampled on woody debris with diameter greater than 10 cm within a circular area of 530 m^2. Saproxylic beetles were recorded by both sealing woody debris of different decay classes, and by window flight traps. Finally, bird species diversity was estimated by listening points.

Monitoring of vascular plants and saproxylic beetles (windowflight trap) in the area of Monte Motola. Photo: S. Ravera.

Data analysis did not point out substantial changes in species richness. Whereas it was possible to detect an increase in the degree of diversification in species composition within the project areas, i.e. the degree of species turnover across the sampling units within each stand increased, especially for vascular plants. Indeed, this parameter reflects more directly than species richness the aim of the project, i.e. an increase in structural heterogeneity aimed at the diversification of species composition.

An interesting result is relative to two species of saproxylic beetles that are listed in the annex II of the Habitats Directive, *Rosalia alpina* and *Morimus*, which were found in the project areas only after the concrete conservation actions.



Degree of compositional variation in vascular plant species within forest stands before and after the conservation actions.

Individual of Rosalia alpina *in one of the project areas of the Gran Sasso and Monti della Laga National Park. Photo: D. Di Santo.*

Individual of Morimus asper *on a beech tree. Photo: S. Burrascano.*

Methods and results of the monitoring of forest structure

The sampling of forest structure was carried out within *ad hoc* sampling areas that were signaled by stakes, with an accurate recording of the spatial coordinates of the center. Within the sampling areas, diameters of all living trees and shrubs were recorded (according to different diameter thresholds) together with the height of part of the individuals that served to calculate wood volumes based on specific volume tables. Also deadwood components were measured: dead downed trees, snags, standing dead trees, stumps and coarse woody debris. All these deadwood elements were classified according to their decay stage.

The silvicultural interventions caused substantial changes in forest structure, and especially on the target species, by determining an increase in their number of individuals and their average size

Variation in the parameters of the target species due to the silvicultural interventions in the two national parks.

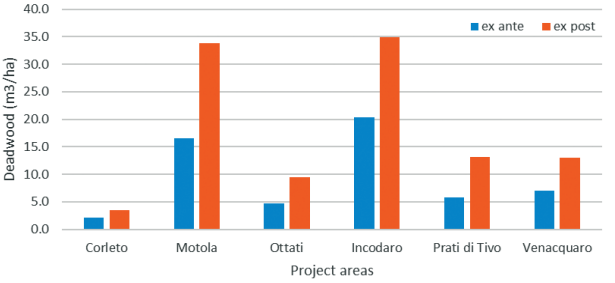
National Park	Number of stems/ha (%)	Basal area/ha (%)	Mean diameter (cm)
PNCVDA	+3,96	+2,46	+1,55
PNGSML	+2,00	-1,41	-0,37

The negative values of basal area and mean diameter of the target species within the Gran Sasso and Monti della Laga National Park derive from some specific actions even so aimed at the increase of forest structural heterogeneity and at the development of the target species. Especially, in some cases one or two suckers were left for a single yew individual with multiple stems, and some silver fir trees were logged within the silver fir plantations of the area of Incodaro to promote the species regeneration.

The silvicultural interventions allowed also to increase the total amount of deadwood within the project areas with an average increase of about 8.5 m^3/ha per area. This allowed already to record positive effects on the diversity of saproxylic beetles and, in the next years, will likely cause the further colonization of deadwood by other organisms related to this resource that is generally rare in traditionally managed forests.

Deadwood released in one of the canopy gaps created in the project areas within the Gran Sasso and Monti della Laga National Park. Photo: D. Di Santo

Average deadwood amount in the project areas before and after the concrete conservation actions.



Dissemination actions

The effectiveness of the dissemination activities that have taken place during the five years of the project is demonstrated by the constant interest shown by users of different professional and geographical areas.

The continuous updating of the website and of the Facebook page, along with the placement of information panels and the publication of newsletters, a brochure, a leaflet, calendars and press releases distributed in several occasions gave the maximum visibility on local, national and international scale to the LIFE FAGUS, from its birth to its last results.

Particular importance has been given to the dissemination across the forestry sector (forestry enterprises, technicians and public employees) and to the stakeholders. In addition to the eight participatory meetings open to the whole population, forestry enterprises were involved through specific training courses addressing the staff responsible for concrete conservation actions in order to ensure the actions' success. These courses included both a theoretical and a practical part, and reached a total of 36 participants. Moreover, a publication in the magazine "Sherwood - Forests and Trees Today" and the "Handbook of Good Practices" have been produced for the forestry professionals, the latter illustrating operational protocols, and intervention modalities, productivity and costs that will ensure the replicability of the concrete actions of the project.

The involvement of schools in educational activities has been highly satisfactory, with more than 1000 students attending per each school year.

At the national and international level, the LIFE FAGUS has been promoted in 11 conferences by presenting posters and oral communications, attracting considerable interest, especially among the scientists involved in the management of the Natura 2000 areas. Preliminary results have been published in an open access article by the influential international magazine "Ecological Indicators".

In order to advertise the project as much as possible, LIFE FAGUS also participated to the "LIFE & Foreste" event, organized by the "Compagnia delle Foreste" in collaboration with "DREAm Italia", which took place to celebrate the 25th anniversary of the Program LIFE.

Students in a beech forests during the dissemination actions of the project. Photo: P. Leone.