THE DADIA–LEFKIMI–SOUFLI FOREST NATIONAL PARK, GREECE: BIODIVERSITY, MANAGEMENT AND CONSERVATION

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The Dadia forest complex: stand development and forest management

Stylianos Gatzogiannis and Konstantinos Poirazidis

After the Dadia Reserve was established in 1980 the two main protection zones (buffer zone and core zone) were managed differently from each other. In the former, management was continuous and after repeated rotations of intensive management, forest stands of intermediate density, mainly in the thin-pole stage, now dominate. Mature stands with large trees are scarce and consist entirely of Turkish Pine. In the core zone, the forest was left unmanaged, which allowed stands to expand and become denser. This resulted in the degradation of habitats for raptors, and wildlife generally. To mitigate these effects, a management plan for the core zone was prepared in the early 1990s and subsequently implemented. Evidence for a clear impact of various management regimes upon critical parameters of the ecosystem should be the starting point for management proposals for the Dadia forest. Suggested measures should not only emphasize forest and biodiversity conservation but should also meet the requirements of traditional production, such as forest exploitation and livestock rearing.

Keywords: Forest management, forest structure monitoring, management proposals

An introduction to the Dadia forest complex

The Dadia forest is situated in a low altitude zone (10 to 640 m asl), the natural vegetation of which belongs, according to Dafis (1972), mainly to the sub-zone of xerophilous deciduous oaks (*Quercion confertae*) of the para-Mediterranean zone (*Quercetalia pubescentis*). In places, specific conditions and human interference have contributed to the degradation and fragmentation of these oak woodlands, opening the gate for the dynamic spread of the Turkish Pine *Pinus halepensis* ssp. *brutia* in the area. The result of this process today, is the widespread presence of very varied, mixed pine-oak forests of high biodiversity.

The high conservation value of the Dadia Forest as a habitat for birds of prey was discovered in the 1970s. In this same decade, a development project funded by the World Bank entitled "Evros" was launched. It entailed an intensive effort to develop forestry in the wider area. This project included measures such as infrastructure improvement (building new roads), intensive silviculture and exploitation (tree-felling) and extensive re-afforestation.

The International Union for the Conservation of Nature and Natural Resources (IUCN) and the WWF International, the two bigger conservation organizations, realized that these changes would have a grave impact on the habitats and populations of raptorial birds. In collaboration with the Secretariat of the National Council for Environment and Planning of the Ministry of Coordination, they prepared a study to evaluate the Evros uplands as a habitat for birds of prey (Hallmann 1979). The conclusions of the study formed the starting point and basis for the designation of the Dadia Forest Special Protection Area (i.e. a Nature Reserve) on 13 August 1980.

From a forestry point of view, the buffer (or peripheral) zone of the Reserve and the two zones of strict protection (cores or nuclei), were treated in a completely different manner. Although this zonation did not reflect a real ecological division of the area, it became accepted and used successfully, even today, for the spatial planning of management and conservation measures for birds of prey and their habitats (Fig. 1). (The zonation has remained essentially unaltered since the establishment of the National Park in 2006, when some new areas were also included.)

The Dadia–Lefkimi–Soufli forest complex covers an area of 42,455 ha and had been under intensive systematic management (according to prescribed forest management plans) only after the 1970s. Timber production and the needs of game and livestock had been the principal management goals.

Activities such as logging, hunting and livestock grazing were practiced following sustainability rules, dictated by the forestry legislation which, at the same time, incorporated only a few measures for the conservation of wildlife (aversion to threats, risk mitigation, etc.). The designation of the reserve has led (since the early 1980s) to the banning of all or some such activities in part of the forest, especially in the strict protection zones (cores). Initially, in these 7,291 ha core zones any kind of production activity was banned in order to protect important nesting areas of the threatened avifauna.

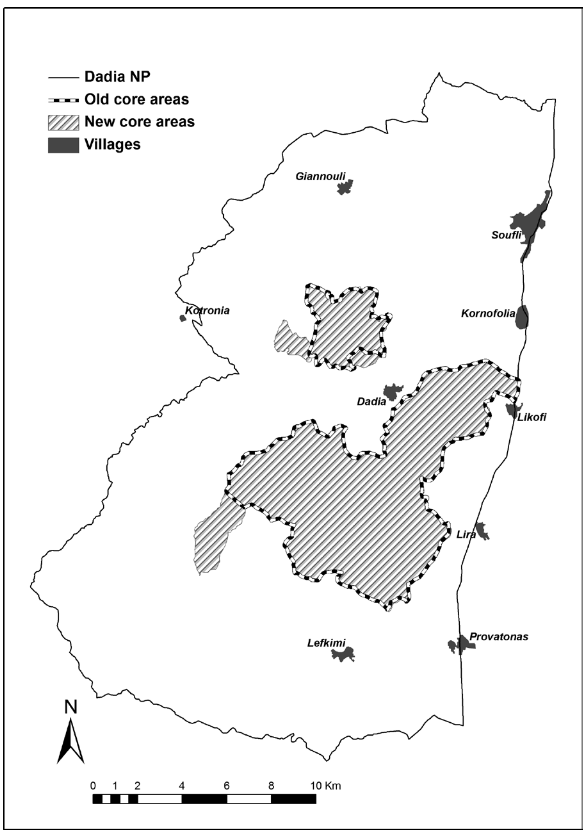

Fig. 1. The boundaries of the protected areas of Dadia Forest. The external boundaries have remained unaltered whilst the core zones were slightly extended in 2006 (new core zones of the DNP) compared to those of 1980 (old core areas of the nature reserve).

This decision was the onset for a differentiated management status between the zones of strict protection and the buffer zone, but it also provoked a different development course for certain important parameters of the ecosystem. In those parts of the forest where management was uninterrupted, stand development continued as in the past, both in relation to land-cover proportions and land-use types, as well as in relation to the internal structure of the forest (density, competition between tree species, etc.).

After the 1980s, the internal relationships of the forest in the core zones certainly changed course. On the one hand, woodland expanded at the expense of clearings and grasslands, and on the other, stands became denser, mainly because logging and other forest work ceased. In the past, logging and other forest operations maintained less dense woodland formations whilst permitting some kind of human control over inter-specific competition between tree species, within the stands.

However, it was soon widely acknowledged that this development would definitely lead to an alteration in the habitats for birds of prey, and would have a negative impact upon wildlife populations generally. Although it was not possible to predict precisely the impacts of this alteration, some changes were so obvious that they led to a gradual, though slow change in attitudes towards the management of the core zones, and the measures that should be used to arrest or mitigate their effects.

This change of attitude towards the management of the Dadia forests, coincided with a worldwide change in the management philosophy of protected areas that had arisen a few years earlier. People had become aware that areas of high natural value, with rare and threatened wildlife, cannot survive only by being given absolute protection and exclusion of humans, but rather, by combining measures that enhance wildlife, without radically disturbing the pre-existing dynamic balance. Exclusion can still be a potential management measure, but only in cases where it is deemed absolutely necessary, for example, where human activity is judged incompatible with a certain conservation goal or, when nature reserves are created for the monitoring and study of natural processes, free of human intervention. Such nature reserves can provide useful guidance to how protected areas, and also forests intensively managed for wood production or other aims, should be managed. Natural and undisturbed forest stands can provide reference indices with which we can compare and evaluate managed forests, as we shall see below.

Thus, in the early 1990s, in line with this new management philosophy, it was deemed necessary to develop: (1) a Specific Environmental Study (SES, an equivalent to a Master Plan) for the protected area according to the Greek Environment Law (1650/1986), which, at the same time, would prescribe that the area's status should be raised from that of Nature Reserve to that of National Park; (2) a Specific Forest Management Plan for the core zones; and (3) a scheme to monitor changes in the natural and anthropogenic features of the forest.

The preparation of the SES (Adamakopoulos et al. 1995) permitted an in-depth assessment of biodiversity conservation issues and also specified actions and measures needed to tackle the related problems on a mid-term time scale. The measures proposed for the protection zones in the protected area, simultaneously functioned as an example which set the basic principles for the establishment of an integrated, long-term and sustainable management of the natural resources of the wider area.

Specific Environmental Studies play an additional role: as they are followed by the publication of legal decrees (Presidential or Ministerial) they lead to a legal consolidation of the conservation status of an area, and its inclusion in the network of protected areas. Thus, following the above SES, a Joint Ministerial Decree (Government Gazette 126/7.2.2003) turned the Dadia Forest Nature Reserve into the Dadia–Lefkimi–Soufli Forest National Park (DNP). The Management Agency of the park was established with the same decree, while a later decree (G.G. 911/13.10.2006) defined the protection zones (see Fig. 8 in the introduction chapter to this volume).

In the meantime, the new and specific core-zone forest management needs, which could not be fulfilled through past forest management plans, had to be met through a Specific Forest Management Plan. This plan, although delayed, was accomplished in 1995 (Gatzogiannis et al.1995) and has since formed the basis for the implementation of the first logging and other operations within the core zones, after the designation of these zones as strictly protected areas in 1980. Monitoring and tracking of trends at ecosystem level is the cornerstone for planning management interventions in any natural system. In the case of DNP, the monitoring system established in 2000, which uses measurements made every five or ten years, is able to track ongoing changes, forms the basis for interventions, and checks intervention effects on important ecosystem parameters (Poirazidis et al. 2002).

Present situation and forest dynamics

The analysis of the horizontal and internal/vertical structure (profile) of the forest permits us, on the one hand, to get information on developmental stages and trends, and on the other, to analyse their potential interactions with the populations of birds of prey and wildlife in general.

The horizontal structure of the forest concerns the spatial distribution of the land-cover categories, as these are used in established forestry practice, i.e. Forest Covered (D), Partly Covered Forest areas (MD) and Agricultural areas and remaining land-cover types (AG), and it also emphasizes composition and spatial distribution of the tree species constituting the forested areas (Gatzoyiannis 1999).

The horizontal structure of the DNP forest was obtained from monitoring data collected in 2000 with the assistance of remote sensing methods and GIS. Satellite images (IKONOS, pixel size 1 m, four bands) were used for the vegetation mapping. These images were visually interpreted for the preparation of a vegetation cover map in vector format. The digitization of each polygon was done using three parallel criteria: vegetation type (14 classes), type of mixed forest (per group and per individual) and percent cover of mixed forest (see Fig.5 in the introduction chapter to this volume). For each polygon, a database was built during the digitization

Table 1. Contribution of each land-cover type (ha) in the DNP area from a forestry point of view.

Land-cover types	Core zones	Buffer zone	Total	%
D: Forested areas	5829	26428	32257	74.5
MD: Partly forested areas	1215	2771	3986	9.2
AG: Agricultural and other areas	247	6815	7062	16.3
Total (ha)	7291	36014	43305	100

Table 2. Contribution (ha) of each forest stand category (according to tree species composition) to the forested areas of DNP.

Forest stand type	Core Zones	Buffer Zone	Total	%
Psp: Pure Pine stands	3547	2150	5697	18
Psp/*.*: Mixed pine/oak stands, etc	865	8488	9353	29
Qsp: Pure oak stands	776	6932	7708	24
Qsp/*.*: Mixed oak/pine stands, etc	545	8060	8605	26
BL: Various evergreens and deciduous species	96	798	894	3
Total (ha)	5829	26428	32257	100

process. The contribution of each category depicted in that figure can be seen in Tables 1 and 2.

Vertical structure pertains to the internal structure of forest units, expressed in terms of "layers". The qualitative and quantitative description of layers in each stand can be achieved from data collected in sampling plots.

In the Dadia forest, within the framework of a monitoring system, we deployed statistical sampling techniques to make an inventory of vertical structure. A sampling network consisting of 123 permanent plots (up to 0.1 ha in size) was marked in the field. These covered the basic plant communities of the forest in proportion to their occurrence and provided data for important stand density indices that could be related to the quality of habitats for raptorial birds, such as Stand Basal Area (G), Stand Density Index (SDI), etc. Of course, this network of sampling plots should also be able to produce data for a general assessment of the ecosystems of the area, and provide baseline data that could be used for the preparation of a forest model, and for planning sustainable management interventions for the entire forest area.

If properly processed, the data from the sampling plots permit different kinds of analyses. For example, defining density indices and other basic features of forests is the first step towards being able to statistically follow ongoing changes and trends. A series of such indices is shown in Table 3 and in Figs 2 and 3 for the entire spectrum of forest formations.

A more detailed image of stand densities and their predicted development, a development influenced by management manipulations prior to the survey, is given for Turkish Pine by the diagrams of Fig. 4.

This diagram shows the theoretically predicted growth of stand basal area (Gmax, p = 0.9/0.7/0.5) as a result of a specific management regime (mainly the intensity of thinning). The exact position of observed densities (Gpbr_da) on this system of curves, permits the evaluation of the current stand stage, as well as of the management applied prior to the survey. This diagram has an additional practical importance since it can be used to quantitatively define future forestry goals and also give us detailed predictions of the impacts of future management on stand densities.

The above data showed that on both forest and stand level, stands of intermediate density predominate (Crown Cover: 0.6–0.8 and 0.4–0.6 with SDI: 250–500 and 500–750), while there is, proportionately, much less of sparse and dense stands, respectively (Fig. 2). Additionally, at tree-level, the thin-pole stage (diameter at breast height, DBH <20 cm) dominates, while mature stands of the large-tree stage (DBH >34 cm) are very few and consist entirely of Turkish Pine (Fig.

Table 3. Typical descriptive features of the forest formations of DNP resulting from the survey of all sampling areas of forest stands (N = 123 plots). SDI: Stand Density Index; N ha^{-1} (number of stems per ha); G: Basal area of the stand (m^2 ha^{-1}); V: Stand volume (m^3 ha^{-1}); T: Mean age of the dominant trees in the stand (years).

Indices	Min.	Max.	Mean	Standard deviation	Error (%)
SDI	74.67	1000.13	466.91	200.52	7.7
N ha^{-1}	130	2900	1012.85	596.97	
G	2.60	50.11	19.64	8.84	
V	8.32	416.05	101.14	68.80	
T	3.39	151.08	55.04	33.54	

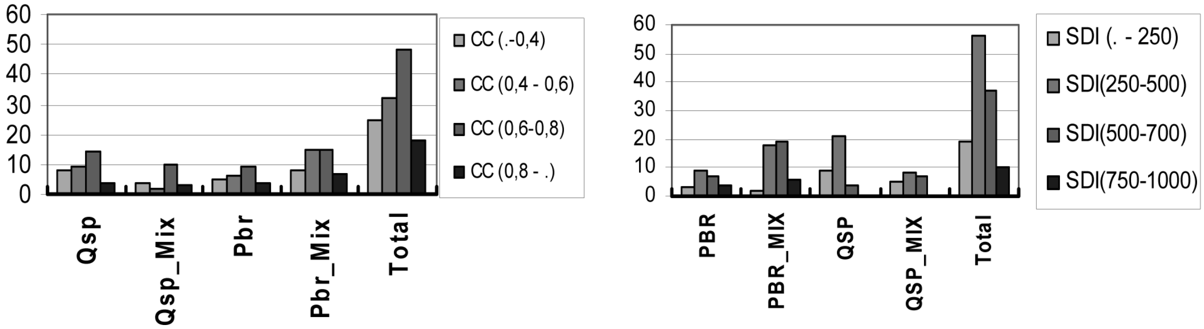

Fig. 2. Structure of forest stands in relation to crown cover (CC) and the stand density index (SDI).

3). This means a lack of both mature Turkish Pine and oak stands, which is attributed to past management and more specifically, to the extensive, large-scale "regeneration" and "final" cuttings. It is encouraging, however, that those clear-cuttings have ceased in a large part of the oak woodlands and have been replaced by thinning that helps their conversion from coppice to tall forest.

Finally, the knowledge of stand profiles, in combination with information on the spatial composition and structure of the various forest units, gives us insight into the functions of Dadia forest. It also permits us to proceed towards a total evaluation from an ecosystem perspective and from the aspect of protecting the natural processes that take place. More research and more advanced analyses are needed to explore these dynamics and these are the goals of the scientific team monitoring the changes in the Dadia forest.

Cause and effect analysis and future perspectives

From a phyto-sociological point of view, under the influence of natural factors, the main forest formations would develop towards a "climax" stage of mixed oak-pine forest with a clear dominance of oak in most environments. However, fires – which exert a constant impact upon sub-Mediterranean forests, such as those in Dadia – in combination with human activities (especially logging and livestock grazing), have created another regime of dynamic balance, characterized by intense fluctuations in the composition and structure of the forest.

According to historical evidence and studies of the present forests, large fires that were evident in the decades prior to the 1960s, in combination with intensive and uncontrolled logging of oak, led to the creation of relatively large clearings. Turkish Pine, as a light-demanding, pioneer species, established itself through natural regeneration and occupied these clearings and formed pure stands. Today, these cover more than 60% of the total forest area, but without having totally displaced the oak from it. Oaks, through their regenerating ability, have managed to maintain a dynamic presence to the present day and are deemed to be the most important factor for the forest's future composition and structure.

In addition, the ability of Turkish Pine to colonise deforested areas relatively fast, combined with its ability to recover quickly after serious disturbances, has also led to the decline of "partly forested" areas, which today cover just 17% of the total forest area.

Previous forest management, especially during the post-World War II period, has been equally decisive in defining subsequent forest development. Up to 1963, there was in fact no systematic forest management, only some basic regulations about cutting fuel-wood to meet local needs. During this period, clear-cutting and land-clearing to create cultivable areas were crucial for the future landscape development.

Organized forestry exploitation started in 1969 with the preparation of the first management study and, par-

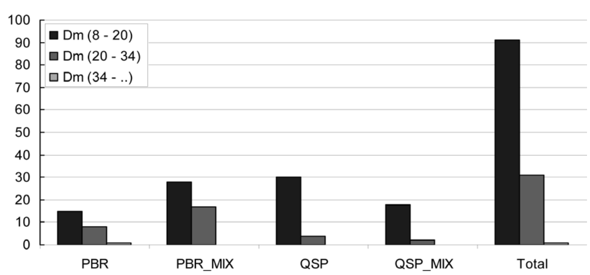

Fig. 3. Forest stand structure from the aspect of development stage (as defined by the average diameter (Dm) of the trees).

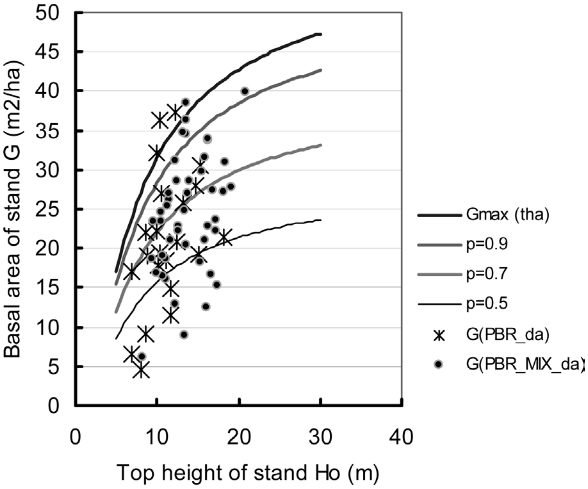

Fig. 4. Relative position of the pure (G pbr_da) and mixed (Gpbrmx_da) Turkish Pine stands of the Dadia Forest in the wider system of density classes of Turkish Pine on the island of Thasos. Gmax = the maximum density level achieved by undisturbed stands; p = G/Gmax stand density levels; p = 0.9, high density stands lightly thinned; p = 0.7, stands with intermediate density and thinning; p = 0.5, low density stands as a result of heavy thinning (Gatzogiannis 2002).

ticularly after 1977, with the establishment of the Soufli Forest Service Department. During that period, the building of infra-structure and systematic timber exploitation started in earnest after the completion of all necessary studies. Although forest management was already practiced following some sustainability principles, and with a certain sensitivity to conservation matters, the clearly timber-oriented management objectives did not permit the prediction of, and pro-action against, some negative effects on the wildlife of the area. The most important of these effects are listed below:

- Logging often resulted in over-harvesting mature trees which caused the loss of potential nest sites for large birds of prey.
- Logging operations took place close to nests and especially during the breeding period, caused nest displacement, pair formation disruption or nest desertions.
- The creation of forest roads and fire-break rides had piecemealed previously unbroken forest tracts which resulted in habitat disturbance especially in areas of high road density and use.
- During the EVROS development project, clear-cuttings of open and mature oak woodland and its later re-afforestation with other species, caused an important deterioration of the nesting and hunting habitats of birds of prey, such as Honey Buzzard *Pernis apivorus*, Lesser-spotted Eagle *Aquila pomarina*, Booted Eagle *Hieraaetus pennatus*, and of woodpeckers and other species that used these areas.
- Re-afforestation also took place in areas used for livestock grazing and this contributed to its decline, with negative effects on wildlife. The lives of large raptorial birds are closely connected with traditional nomadic livestock-keeping, which not only provides a main resource of food for vultures, in the form of dead animals, but also through grazing which helps to maintain forest clearings.
- This situation worsened even more by the predominant forest service policy to consider grazing and livestock as being less important than timber production. Finally, demographic and social changes aggravated these conditions further, and today it is certain that the physiognomy and density of the forest will change, with negative repercussions for raptorial birds, unless serious, large-scale measures are taken to arrest this development.

Future management of the Dadia Forest

The evidence for a clear impact of various management regimes upon critical parameters of the ecosystem, as well as data on the dynamics of ongoing alterations are the starting point for the formulation of management proposals for the Dadia forest. Naturally, suggested measures should emphasise forest conservation as a principal factor for the conservation of raptors and biodiversity in general. However, they should also meet social needs associated with the traditional productive activities of the area, such as forest exploitation and livestock rearing. External factors potentially threatening to disturb or degrade the habitats of raptorial birds, such as erosion, fires and direct persecution, complement the context within which management measures have to be designed.

Only robust scientific reasoning and predictive models of ecosystem trends, fed with data from systematic monitoring, can form the basis for proper measures aimed at maintaining and enhancing raptor habitats. The data gathered so far, together with local experience in forest management, have already resulted in a number of suggestions for the conservation and enhancement of the habitats of the birds of prey. These suggestions –

some of which have already been partly implemented – are:

- Shifting the past philosophy of forest stand manipulation towards avoiding clear-cuttings and "negative thinning"; revising the criteria for choosing trees that will comprise the future forest stands; modification of rotation times to meet specific conservation needs; promotion of more intensive thinning in places to gradually strengthen the fire-resisting ability of the forest. Such measures would permit the gradual incorporation of biodiversity conservation into the current production-oriented procedures.
- Logging and other forestry works must be avoided in situations where these may cause disturbance, such as at nest sites.
- The timing and intensity of logging and other disturbing operations must be modified, so that the breeding activity of threatened species, is not disrupted.
- Forest clearings must be maintained through tree-cutting and grazing in order to arrest forest sprawl and expansion.
- Under proper regulations, grazing by nomadic or non-nomadic livestock must be encouraged and enhanced. It should also be allowed to expand all over the protected forests (buffer and core zones).
- The designation of a number of natural, undisturbed sites as local reserves, must be promoted in every managed forest tract, to act as sources of base-line reference data and as wildlife refuges.
- The preservation of the last areas of mature oak woodland must be ensured, both in the buffer zone and in the wider area of the Evros Prefecture. Such areas must be considered as protected Natural Monuments.

Although the above measures constitute only an initial shift of the forest management applied so far towards meeting the specific needs of wildlife conservation in the area, a substantial modification of the overall forest management paradigm is even more necessary today. This is because failure to keep track of modern sustainable development concepts, threatens to cancel or render ineffective, even the above measures which form a minimum fulfilment of wildlife conservation needs. Thus, it is today necessary to instigate progress to issues such as:

- Resolution of the problem of authority overlap – and thus loss both of efficiency and accountability – between government services involved in the area's management.
- The creation of a competent and effective management authority.
- The updating of the institutional framework of forest management, by incorporating the consideration of ecological parameters in decision-making about natural resource management.
- The application of modern technology and scientific findings to forest management, and the adoption of modern practices in sustainable management.
- Making national forest policies conform to the priorities set by the European forest and environment policy.

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