



HAL
open science

Dynamics and restoration of abandoned farmland and other old fields in southern France

Pascal Marty, James Aronson, Jacques Lepart

► **To cite this version:**

Pascal Marty, James Aronson, Jacques Lepart. Dynamics and restoration of abandoned farmland and other old fields in southern France. Cramer V.A. & Hobbs R.J. Old fields. Dynamics and restoration of abandoned farmland, Island Press, pp. 202-224, 2007. halshs-01227596

HAL Id: halshs-01227596

<https://shs.hal.science/halshs-01227596>

Submitted on 4 Jan 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Marty P., Aronson J., Lepart J., 2007.

Dynamics and restoration of abandoned farmland and other old fields in southern France.

In: Cramer V.A. & Hobbs R.J., (coord.), Old fields. Dynamics and restoration of abandoned farmland, pp. 202-224. Island Press, Washington, D.C. and Covelo, Ca.

Chapter 11

Dynamics and Restoration of Abandoned Farmland and Other Old Fields in Southern France

PASCAL MARTY, JAMES ARONSON, AND JACQUES LEPART

Biogeographically, the French Mediterranean Region (FMR) is located in the northwestern quadrant of the Mediterranean Basin, where annual rainfall is relatively high: 600 to 800 mm in the lowlands. Annual rainfall is 1,200 mm or more in the mountains, that is, the southern Alps, Eastern Pyrenées, and southeastern edge of the Massif Central, known as the Cévennes, which mark the northern limits of the region. On the limestone plateaus farther inland, annual rainfall drops off, and its distribution gradually changes to a continental regime (figure 11.1).

The environmental and, over the past six millennia, ecological impacts of humans and their domesticated livestock have been profound in the FMR, as has been the case throughout the Mediterranean Basin. The results have been remarkably variable, given the geological and biological heterogeneity of the region. Beginning with the westward spread of the various Neolithic innovations some 8,000–10,000 YBP (Childe 1971), and accelerating rapidly since roughly 6,000 YBP (Guilaine 1991; Price 2000), Mediterranean peoples have reworked, reshaped, and transformed vegetation and whole landscapes again and again. Biological evidence of human influence is prominent in fossil pollen strata containing cereals, chestnut and walnut, as early as 2,600 to 6,000 YBP (Vernet 1997; Russo Ermolli and Di Pasquale 2002). During recent centuries, economic development and long-distance trade (Matvejevic 1999) also greatly contributed to the creation of anthropogenic landscapes (Vos and Stortelder 1992; Grove and Rackham 2001). As in the Mediterranean Basin generally, degradation of forest ecosystems has been a major, ongoing phenomenon (Lombard 1959; Thirgood 1981; Blondel and Aronson 1999). Since roughly 1500 AD, the shift toward a market-oriented

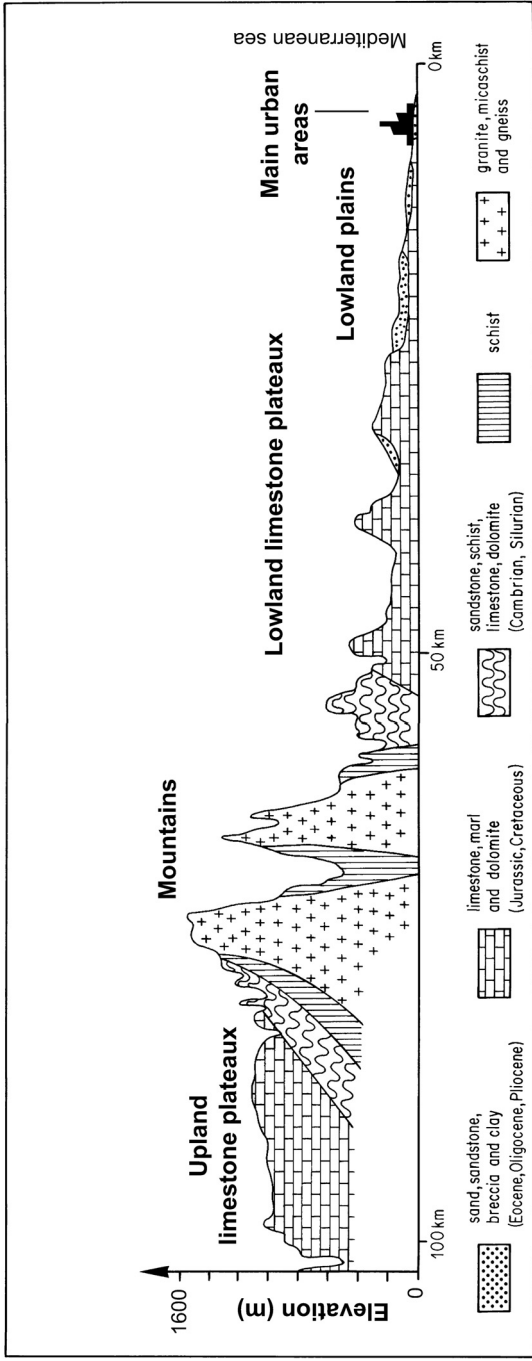


FIGURE 11.1. Physical features of the French Mediterranean region. Distances and elevation vary locally. After Le Floch et al. 1973 (*Atlas régional du Languedoc Roussillon*), modified by M. Debussche.

agriculture contributed to massive changes in agricultural and other land uses (Butlin and Dodgshon 1998).

In more recent times, three additional historical features should be considered: (1) the creation of a national railway network; (2) increasing specialization in wine production during the nineteenth century; and (3) a very active period of “forest restoration” in the FMR premontane areas, starting in the second half of the nineteenth century. Elucidating these drivers will help set the stage for the ensuing discussion of restoration and rehabilitation efforts now underway or envisioned for the future. Forest, farmland, and pasture land will be the three poles of attraction, just as they have been throughout the Neolithic and especially in the last 2,000 years. However, some of the drivers at work today are brand new. In this chapter, we compare the wide array of old field contexts present in the French Mediterranean region, the histories of their development, abandonment, and subsequent management regimes, and the various ongoing or potential interventions that are or could be applied in a spirit of restoration and management.

Transition to a New Landscape Design and Dynamic

At the end of the nineteenth century, human activity reached unprecedented levels in the FMR, which allowed, and at the same time required, intensive agricultural practices. Since this time, socioeconomic changes have progressively led to a very strong disjunction between areas of intensive agriculture (irrigated agriculture, vineyards) in the lowlands, and areas of abandoned fields in the uplands and premontane areas, where agriculture has dramatically declined. In these latter areas, natural vegetation dynamics has led to a resurgence of “preforest,” or young forest land cover (Lepart and Debussche 1992; Tatoni et al. 2004).

The increasingly ubiquitous old fields of the upland regions are of two kinds. In a narrow sense, they are areas cultivated and abandoned in the last thirty years. In a larger perspective, however, they include areas that were cultivated episodically until the middle of the nineteenth century and then subsequently used primarily for grazing. Cycles of cultivation, abandonment, and clearing were a very common land use strategy in the region (Marres 1935). If we adopt the dual definition, then issues of old field restoration take on much importance in the light of the choices to be made in landscape planning and management in almost every hilly or upland area in the French Mediterranean region. But what led to this transition? What is lost and what remains?

Socioeconomic Background

The national railway system set up in the nineteenth century ushered in the first phase of economic integration of the continental French territory. Railway networks made it possible for the first time to transport wine produced in the FMR to Paris and, in the opposite direction, to import cereals from more productive regions in the northern or southwestern regions of the country (e.g., the fertile farmlands near Paris and Toulouse). From the late nineteenth century, cereal production was no longer economically viable in the FMR and, concurrently, wine production became very profitable, especially in the lowlands near the coast and in the deep river valleys (Loubere et al. 1988). Elsewhere in the FMR, widespread agricultural abandonment took place in inland rocky hill and premontane areas as a direct result of the *Phylloxera* root rot crisis that occurred at the end of the nineteenth century (Stevenson 1980). At that time, the only way available to fight against *Phylloxera* was to flood the vineyards, and this technique was only suitable in the lowlands. Consequently, a great majority of the wine producers in upland areas were financially ruined during this period, and widespread abandonment of vineyards took place, even as specialization in wine production “took root” in the lowlands.

An additional factor that led to viticultural specialization in the lowlands was that resistant American grape varieties were imported and used as rootstocks, as a complementary and more sophisticated method to limit the ravages of *Phylloxera*. As this was expensive and time consuming, it led inexorably to greater specialization in wine production. Since livestock husbandry in the lowland region had traditionally been devoted to produce manure for cereal fields, and cereals were no longer being grown, animal breeding decreased dramatically during this period.

Some decades later, however, the development of irrigation techniques and canalization systems allowed a diversification of farm activities in the lowland areas to include fruit and vegetable production. These new activities also required specialization and thus contributed to the ongoing crisis of upland agriculture. Declining agriculture and animal breeding, along with the progressive abandonment of fuel wood exploitation, so transformed the upland areas that old fields soon became ubiquitous, except where urbanization was taking place in close proximity to cities, towns, and some villages.

The third important historical factor was that in the late nineteenth century the French government initiated a massive public works program called *Restauration des Terrains de Montagne* (RTM) in the generally deforested

mountains of the FMR. Their goal was to halt or reduce soil erosion and to restore forest cover. In modern terms (SER 2004), the aim was ecological rehabilitation rather than restoration, since a wide medley of mostly nonnative species were used, and no reference system was adopted. The results were mixed, in ecological terms (Vallauri et al. 2002), as were the socioeconomic spin-offs of these programs. Most pertinent to the discussion here is that they indirectly intensified the crisis of animal breeding systems in montane and premontane areas (Kalaora and Savoye 1986), because newly reforested areas were no longer available as grazing resources.

Agricultural Decline and Land Abandonment

In this section we examine old fields within a historical, agricultural, and ecological context. We focus on the trajectories of terraced landscapes, on the role of past cultivation in the dynamics of grazing areas, and on the balance between plantation and natural tree encroachment in old fields.

Terraces and Other Traces of Human-Built Landscapes

One of the most striking examples of old fields resulting from former intensive management of landscapes is the abandoned terraces found throughout the FMR and indeed in most of the northern Mediterranean Basin (Ambroise et al. 1993). Several local names existed for these terraces (Blanchemanche 1995) and many local adaptations and variations arose. Terraces were devoted to vineyards (e.g., the famous Banyuls wine terraces overlooking the sea), orchards (e.g., for chestnuts in the Cévennes region and, more generally, for olive trees) or mixed-crop farming. Blanchemanche (1995) argues that, in general, building a terraced landscape took approximately one century during the eighteenth and nineteenth centuries.

In the 1950s, because of their fragmented field pattern; the impossibility of mechanizing cultivation and harvesting on narrow terraces; and the high cost of maintenance of pathways, walls, and hydraulic networks, this kind of landscape was seen by scientists and planners as being archaic as compared with the widespread modernization, that is, industrialization, of European, Australian, and North American agriculture. Small farms with limited incomes in the FMR did not survive the development of productivist agriculture that began in the 1960s. However, as we shall see later, the death knell has not definitively tolled for the FMR terraces.

Old Fields and Grazing/Cultivation Rotation

In addition to terraces sensu stricto, discontinuous stone walls, stone fences, or sparse stone piles resulting from soil cultivation are present in most of the hilly uplands of the FMR. Practices and techniques for removing stones from fields and stacking them as field and property boundary markers existed throughout Europe (Blanchemanche 1995) and the Mediterranean region, and numerous remnants and vestiges exist throughout the FMR on the calcareous plateaus called “causses,” in the schist and granitic Cévennes, and elsewhere.

These stone walls and fences, occurring in what appear to have long been extensive pasture lands, indicate formerly dense patterns of old field markers (Fowler 1999) that can be used to reveal features of the past agricultural system. First of all, the agricultural system was based on a large and readily available supply of manpower and animal traction, which allowed the intensive exploitation of very small plots. Secondly, before the regional specialization that occurred after the development of a national transport network, cultivation and grazing coexisted and were highly interconnected. Grazing animals supplied manure and natural fertilizers for cultivated plots, and shifting cultivation practices allowed control of shrub and tree encroachment (Caplat et al. 2006). It is thus possible to describe the pre-productivist agricultural landscape as a core of permanently cultivated land with short fallow rotations to sustain soil fertility, and a belt of rangelands periodically cultivated for short periods followed by long fallows (twenty to forty years), during which time grazing was the dominant land use (Marty et al. 2003). Clearly, this sort of labor-intensive and time-consuming land use system is no longer viable in the FMR, and those concerned with restoration should not seek to recreate it except, perhaps, on a very small scale for heuristic or experimental purposes. Some private land owners and some municipalities are actively restoring stone walls at this time, as part of personal or collective campaigns to preserve a cultural heritage. In some few cases, there are innovative agricultural activities as well, including plant nurseries, flowers, bulbs, dye plants, out-of-season vegetables, and other speciality crops that command high market prices.

Ecological Dynamics in Old Fields

In the FMR, the main features of ecological dynamics are the consequences of two historical waves of tree plantation along with a strong trend of tree and shrub encroachment.

TREE PLANTATIONS OF THE RTM PROGRAM

Old fields of the two types we have described were in some areas converted to forest in the premontane and montane areas of the FMR, following the reforestation policies adapted in the second half of the nineteenth century. The RTM programs mentioned above were justified by the forest administration on the basis of a perceived need to restore forest on lands degraded by overgrazing (Larrère et al. 1980). RTM operations were essentially located on state or rural community-owned land, especially in the southern Alps, and in the Aigoual massif of the Cévennes, at the southeastern edge of the Massif Central. Local communities offered strong resistance to forest restoration because the so-called marginal lands being taken over by foresters were critical for the agricultural systems still in use, since they provided resources for sheep grazing and were publicly managed commons for use, above all, by poor peasants. Between 1880 and 1914, in the southern Alps alone, ca. 50,000 hectares were converted to forest (Douguédroit 1980).

FOREST NATIONAL FUND PLANTATIONS

After World War II, another plantation policy allowed not only the state and municipalities but also private owners to take advantage of state funding for tree planting (Marty 2004). The Forest National Fund was designed to enhance French capacity in timber production, especially for cardboard and paper. Between 1946 and 1990, approximately 2 million ha of trees were planted in France. In the Languedoc-Roussillon region of the FMR, no less than 100,000 ha were planted during this period. Funding and efforts were focused on the plantation of coniferous species that were a mix of some native and many nonnative species, including Douglas fir (*Pseudotsuga menziesii*), spruce (*Picea sitchensis*, *Picea abies*), black pine (*Pinus nigra*), fir (*Abies alba* and *Abies nordmanniana*) or Atlas Mt. cedar (*Cedrus atlantica*). Plantation sites were formerly deciduous forests and former fields and meadows located in uplands heavily impacted by agricultural decline.

In spite of such massive and widespread efforts to address the regional consequences of agricultural decline by forest tree planting, natural succession was in fact the main process observed on old fields. As documented by diachronic analysis of postcards and photographs (Debussche et al 1999) between the beginning and the end of the twentieth century (figure 11.2), natural succession on abandoned croplands (meadows and fields, terraces, vineyards and orchards) led to impressive amounts of spontaneous woodland regeneration with the native, deciduous, downy oak (*Quercus pubescens*), the evergreen holm oak (*Quercus ilex*), ash (*Fraxinus* spp.), beech (*Fagus sylvat-*

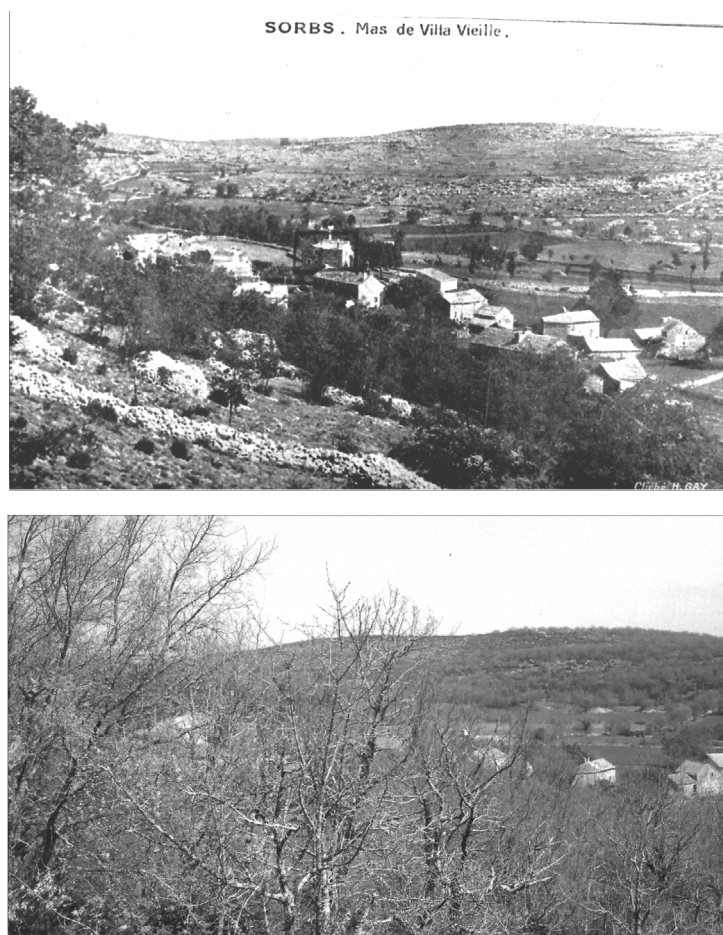


FIGURE 11.2. Landscape changes in Mediterranean limestone uplands. Dynamics of white oak (*Quercus humilis*). Causse du Larzac, Hérault, France. (a) Postcard, early twentieth century; (b) photo taken from the same site by O. Rousset, 1998.

ica) and the introduced, but naturalized, sweet chestnut (*Castanea sativa*) dominating the emerging secondary formations.

Alternative Futures for Old Fields

In the current context of agricultural decline, land abandonment, and the massive forestation and spontaneous woodland regeneration in old fields, the main issue for policy makers is to decide whether interventions must be undertaken to: (1) restore, with subsidies, cultural landscapes, with a mosaic of

agricultural terraces, orchards, woodlots, vineyards, and other typical rural Mediterranean land uses, including houses; or else (2) to accept, assist, and reinforce natural successional dynamics that contribute to forest recovery in old fields and other abandoned lands. As shown in figure 11.3, both of these actions would imply action directed to slow or counter the various emerging ecosystems, which are characterized by unprecedented species assemblages and unknown trajectories of ecological functioning. Such emerging ecosystems appear increasingly in the FMR and elsewhere around the world (see Hobbs et al. 2006 for discussion). They call for serious reflection and public consultation on the part of land managers, restorationists, and conservationists.

The third path, of course, is simply to succumb to, and consider as inevitable, the relentless transformation of rural areas, formed and sculpted by successive generations of people over millennia, into suburban and rural housing developments, while preserving some hunting grounds and walking areas for recreational use. At present, all three of these options are occurring, with far too little concerted effort devoted to developing a broad, long-term overview or land use planning scheme that includes the conservation and restoration of ecosystem services. If such a broad view were to be pursued for the FMR, there are three main questions to address:

- Where and when should we use passive or active restoration?
- Is there a way to nurture and maintain a healthy, self-sustaining agricultural system that is compatible with ecosystem and environmental management plans?

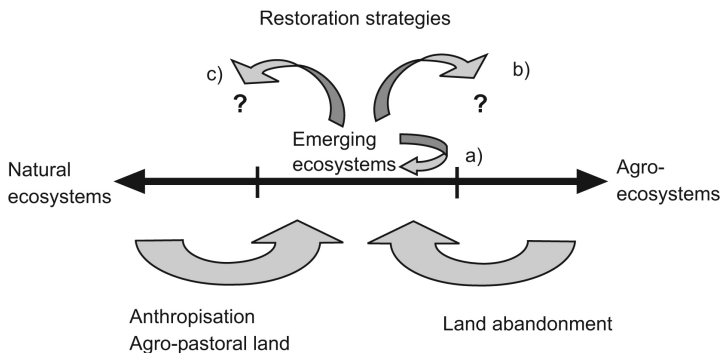


FIGURE 11.3. In the Mediterranean region, as elsewhere, natural ecosystems have been progressively transformed to agroecosystems. Nowadays, many natural and managed systems are in a state of flux as “novel” or “emerging” ecosystems. These can be self-perpetuating (a), or else, “restored.” But the question arises whether to restore them to (b) intensively exploited systems in cultural landscapes, or (c) to natural ecosystems. Modified from Hobbs et al. (2006).

- Is there a future for the cultural landscapes of the past, in part or in whole?

There is a wide range of situations and settings to be considered, as will be illustrated in the following section.

Restoring Forests and Other Natural Ecosystems in the FMR: Where, Why, and How?

In this section, we examine the debates regarding forest degradation and restoration. Overgrazing was often described as the main cause for ecosystem degradation and periods of cultivation were underestimated.

FOREST ECOSYSTEMS

There are two principal questions concerning the restoration of forests over which naturalists and foresters have had heated debate—the role of the forest and grazing lands, and the means for reestablishing forest. The restoration of Mediterranean forests was a very important objective in southern France in the nineteenth and early twentieth centuries. The state agency for water and forests (*Eaux et forêts*) launched a major program of reforestation of mountain lands that would reduce torrential floods and mudslides during heavy rains, and at the same time, establish land tenure rights for vast areas of silvicultural production. A number of approaches were proposed to restore or, more accurately, to rehabilitate these degraded lands. Over and above the physical engineering interventions that were often necessary, herbaceous, shrub, and coniferous tree cover was reestablished, via seeding or planting of seedlings. The use of deciduous trees was also tested (Vallauri et al. 2002). In the first half of the nineteenth century, methods used by French foresters, which were of largely German origin, were ill suited for mountainous regions of the FMR with its typically Mediterranean dry, hot season throughout summer (Chalvet 1998). It is not surprising that they suffered many failures as a result of ill-adapted species or provenances and near-total failure of direct seeding attempts. It was not until the large RTM projects of the nineteenth century that new silvicultural techniques better adapted to the Mediterranean climate and terrain were developed and applied. Yet deciding upon objectives remained a hotly debated topic.

ROLE OF FOREST AND GRAZING LANDS

For the biogeographer Charles Flahault (1927), everything apart from cultivated lands should be reforested. No place was to be given to grazing, which

he considered the primary evil leading to forest degradation. He based his arguments on the notion that primeval forest occurred almost everywhere in the FMR. Braun-Blanquet (1931) accepted this view, but argued that reforestation was inappropriate in certain situations. Kuhnholz-Lordat (1945) took a very different position: he militated for an agro-sylvo-pastoral equilibrium, based on the complementarity of these three types of land use. He also argued that field cultivation in the past was at least as important as grazing in the degradation and transformation of Mediterranean forests. His ideas were not readily accepted by French foresters, except for a minority who were more attentive to the needs of local populations. It was only in the 1980s that the idea of reconciling agriculture, animal husbandry, and forestry became widely accepted (Etienne et al. 1998).

MEANS AND GOALS FOR REESTABLISHING FORESTS

The overriding strategy in forest restoration was often quite simple: conifers were planted with the aim of establishing productive and profitable forests. This approach was applied, for example, in numerous RTM projects on degraded mountain soils throughout southern France. Black pines (*Pinus nigra* and *Pinus laricio*), spruce (*Picea abies*), Scots pine (*Pinus sylvestris*) and, at lower altitudes, Aleppo pine (*Pinus halepensis*) or maritime pine (*Pinus pinaster*) grew rapidly to a harvestable size. Their lumber and various timber products were economically attractive. In view of their success, reforestation with these valuable species was by far the most important type of forestry intervention. However, the transition toward mature stages of succession were not as easy to achieve as expected, except in some situations in uplands where beech (*Fagus sylvatica*) showed strong development in the understory (Kunstler et al 2005).

Ducamp, a senior forest engineer, advocated an alternative approach, since he considered fire as the main subject of concern in the Mediterranean region (1932, 1934). The introduction of pines in shrublands or open woodlands was known to greatly increase the risk of wild fire. However, late-successional stages of such forests should, in theory, become less prone to fire in general. Supporting evidence for this was available for beech (Joubert 1929). (This issue is of course still highly relevant and hotly debated to this day. Being inflammable is discussed as an adaptive evolutionary strategy for plant species that mainly germinate and reestablish themselves *after* a fire [Bond and Midgley 1995]. One example is the Aleppo pine, with its serotinous cones and massive seeding following fires.)

According to Ducamp (1931, 1932), instead of using pines for rapid forest

11. Dynamics and Restoration of Abandoned Farmland in Southern France 213

restoration, spontaneous regeneration, also known as autogenic restoration, should be attempted. He argued that promoting self-recovery in the forest environment was preferable not only in ecological terms but also for the purpose of achieving rapid economic results. Therefore, he argued, interventional actions should be based on field observations coupled with ecological knowledge. Ducamp's positions were, for his time, innovative and controversial. They were however implemented by the *Eaux et Forêts* Service over a short time period. But, for economic reasons, large areas were left without any intentional management, and forest stands began to spontaneously regenerate themselves (Debussche et al. 1999).

In the context of spontaneous regrowth, one group of trees of particular importance is the Mediterranean oaks, especially the deciduous ones that have been heavily impacted by past land use practices. Spontaneous recolonization by oaks is in general much slower than for conifers. Oak seedling reestablishment is greatly facilitated by the presence of shrubs, which serve as "nurse plants" and protectors from herbivores (Rousset and Lepart 2000). Young oaks can also appear under the cover of pines, but they do not grow well there due to the shade and perhaps also due to edaphic changes brought about by the pines, whose litter tends to make soils more acid (Kunstler et al. 2005).

Oak seedlings, which are very appetizing for most large animals, have great trouble establishing in the presence of domestic livestock. When ungrazed, however, oak and other tree seedlings become established during the earliest stages of succession, and a relatively dense formation of young trees can occur in as little as twenty years provided seed-bearing trees are nearby (Debussche et al. 1996). Whereas in the first half of the twentieth century, most grazing lands in the FMR had an appearance of permanency, due to the rare occurrence of spontaneously recurring woody plants, in recent years there has been a very notable acceleration in the rate of secondary succession, including the widespread establishment of pioneering woody plants such as the juniper (*Juniperus oxycedrus*) and growing numbers of oak seedlings as well. The establishment of dense woody vegetation takes approximately one century following abandonment (Escarre et al. 1983).

In the rare areas where seed-bearing beech trees (*Fagus sylvatica*) are still present, young beeches also appear spontaneously under cover of woody shrubs or even under pines. In lowland areas, the rate of succession changes as a function of the previous land use history and the presence or absence of grazing following agricultural abandonment. The numerous olive groves that were abandoned in the 1950s were rapidly recolonized by woody plants. Dead olive trees served as perches for fruit- and seed-eating migratory birds,

and in this way a large number of tree and shrub seeds arrived and quickly created a dense and diverse thicket (Debussche et al. 1982). In addition, these olive groves were in general on rather rough terrain, and consequently were infrequently grazed by livestock. By contrast, the former cereal fields and abandoned vineyards on flatland and bottomlands were successively colonized by herbaceous annuals and biannuals, and then by low-growing, woody plants, such as thyme, lavender, and rhizomatous and perennial bunch grasses, which come to dominate at the end of approximately fifty years.

Mediterranean Coastal Areas: From Fallow Land to Wetlands

It is no longer disputed that Mediterranean coastal areas are not natural ecosystems—without exception they are deeply modified by human activities. For the coastal marshes in and near the Camargue region, the key issue for conservation and for restoration is to define objectives combining ecosystem assessment and stakeholders' expectations. An example is the fallow fields in the lower valley of the Vistre River in the FMR, where restoration efforts were undertaken to transform fallow lands of limited ecological and naturalist interest and restore marsh lands with large colonies of tree-nesting herons, particularly the Squacco heron (*Ardeola ralloides*) (Mauchamp and Grillas 2002). Hunting regulations are stricter than in other similar ecosystems in order to protect the water bird communities.

This program also addresses the difficult issue of the choices to be made in restoration or conservation plans (Mathevet and Mauchamp 2005). Multi-objective restoration requires an assessment and prioritization of these at times conflicting objectives. Mauchamp and Grillas (2002) highlighted that, despite the general objective of reestablishing a flood plain, priorities among the objectives were not clearly identified, and stakeholders' views were not adequately assessed. They suggested limiting the number of objectives for such restoration plans and taking great care about the second stage of restoration: managing the restored ecosystems in the long term. After restoring an ecosystem locally, it is important to integrate it within a network of natural areas with global management guidelines while, at the same time, taking stakeholders' practices and strategies into account.

Restoring Cultural Landscapes

Past agricultural systems and rural area land use produced striking and original landscapes that are part of the cultural heritage of Europe (Antrop 2005;

11. Dynamics and Restoration of Abandoned Farmland in Southern France 215

Moreira et al. 2006), and especially its Mediterranean regions. Terraces, seminatural cork oak and sweet chestnut forests, and extensive polders in wetlands are among the most striking examples of human-made landscapes that survived for centuries but are now under serious threat due to recent agricultural and land use trends. Management measures aimed at restoring these landscapes are being tested and implemented in several areas.

REBUILDING TERRACED LANDSCAPES IN THE CÉVENNES REGION

Since the middle of the 1990s, interest in the terraced landscapes of the northwestern Mediterranean quadrant has been rekindled (Alcaraz 2001), based on their heritage value much more than on their economic potential. Several examples of successful local restoration exist. Some restored landscapes are labeled by the French Ministry of Environment (Laurens 1997), in order to develop tourism and food product marketing.

Terraced landscapes are used for the production of sweet chestnut orchards. Widely cultivated in the western Mediterranean (Pitte 1986), chestnut ecosystems are still intensively managed in some countries (e.g., Portugal, parts of Italy) but are almost totally abandoned in France. Decline in sweet chestnut production led to a shift from chestnut orchards to chestnut forests. In 1975, only 200 ha of productive orchards were left. But chestnut forest is considered by local people to be a cultural landscape and a part of their heritage. Evaluation of willingness to pay for chestnut landscape maintenance by Contingent Evaluation Method (Noublanche and Chassany 1998) showed that stakeholders who own vacation homes or retirement homes in the region are willing to pay the highest contribution. Terraced landscapes can be restored by the help of labeled niche products. Following the example of the Ardèche region, producers of the Cévennes region applied to the European Union for a Controlled Appellation of Origin (AOC), also known as PDO, or protected designation of origin. The objective was to reconcile agriculture production with cultural landscape restoration and not to fund management measures aiming only at maintaining aesthetic or cultural properties. Chestnut forests managed for timber production are another option but, in view of the great expense of managing the terraces, are unlikely to lead to restoration of terraced landscapes.

RESTORING CORK OAK WOODLANDS

Cork oak (*Quercus suber*) woodlands are located between 0 and 700 m above sea level in the northwestern Mediterranean and reach somewhat higher

altitudes in Morocco. In the French Mediterranean region, the three main areas where cork oak woodlands are found are the island of Corsica, French Catalonia (on the French-Spanish border), and the coastal hills of Provence, which are the only portions of the FMR where suitably sandy, acidic substrates are found (Quezel and Médail 2003). These ecosystems, when managed for cork exploitation, form a very typical Mediterranean landscape, as well as an ancient form of agroforestry (acorns collected for pigs, fuelwood gathering). Nonetheless, they are facing abandonment, and all attempts at conservation, management, and restoration must address two critical issues. First, since the 1980s, cork prices decreased dramatically and cork oak forest management in France was almost totally abandoned. In the coastal Maures massif of Provence, between Hyères and Frejus, abandonment led to scrub colonization of the understory (Amandier 2005). The highly destructive forest fires of 1989, 1990, and 2003 were all due indirectly to agricultural abandonment. Second, in the last few years, international demand for cork has increased significantly and exploitation of French cork oak has started again. But forest owners and cork producers in the past have tended to employ underqualified laborers lacking skill in the special task of removing cork bark from the trunk without damaging the tree and producing scars that allow attack from pathogenic agents. In response, populations of *Platypus cylindrus*, a tiny coleopterous insect, started to pullulate. This beetle can kill trees within two or three years and preferentially attacks recently exploited forests.

In light of these challenges, forest owners' organizations and professionals of the cork industry have tried to implement management measures in several ways to conserve and restore cork oak forest and landscape. They have sought to introduce sustainable management measures to reduce fire risk, to gather land owners together in order to decrease production costs, and to stop *Platypus* proliferation by regulating cork exploitation. A small Mediterranean Institute of Cork and Cork Oak has been created.

Scientific research and development on cork oak is very recent in France, as elsewhere. Results are scattered, and usually limited to a single discipline, that is, genetics, silviculture, the cork industry. The few broad, interregional studies are generally out of date. However, in 1996, a five-year, European network project was organized to evaluate the genetic resources of cork oak for appropriate use in breeding and gene conservation strategies (EUFORGEN). It was followed, in 2002, by a research and development program, funded by the European Commission, called Conservation and Restoration of European Cork Oak Woodlands (CREOAK). These efforts are evidence that interest in the conservation and restoration of cork oak woodlands exists among land owners and some policy makers. A grower's handbook was pro-

duced by the EUFORGEN group, and a broader book for general readers is in preparation by the CREOAK coalition.

RESTORING OPEN HABITAT FOR BIODIVERSITY

Open landscapes of seminatural habitat were extensively developed in the FMR at the beginning of the twentieth century. French literature is full of expressions of the uniqueness and aesthetic value of open, shrub-dominated landscapes. For example, André Gide (1952) famously compared them to biblical landscapes of the Near East. Such landscapes were present from the lowest calcareous hills up to the high-altitude limestone or primary plateaus (Debussche et al 1999). For the general public, however, up to the end of the twentieth century, open Mediterranean landscapes were generally seen as being without economic interest, and therefore without interest at all, especially in the uplands where tree plantations were perceived as a serious alternative for economic development (Lepart et al. 2000). Starting in the 1980s, however, awareness of the social and ecological consequences of agricultural abandonment throughout the FMR led scientists to begin studying the effects of land use changes on biodiversity (Magnin et al. 1995; Preiss et al. 1997). Consequences of the diminution of open habitat then became a major issue for conservation and led to important discussions about how best to manage for biodiversity conservation. The Grands Causses region provides an excellent example to highlight the main points and conflicts concerning open landscapes inherited from agropastoral practices.

Located on the southeastern edge of the Massif Central, the Grand Causses region is the largest area of seminatural calcareous grasslands in France. They are undergoing rapid and massive tree and shrub encroachment, even though land abandonment and the agricultural crisis are less severe than in other circum-Mediterranean uplands. During the 1990s, several management plans aimed at preserving seminatural, open habitat were designed. Agroenvironmental schemes were implemented by government agricultural agencies and extension officers. Management measures set in place by the Cévennes National Park were designed to increase pastoral use of rangeland resources in order to limit the growth and spread of pines, oaks, and other trees, such as *Amelanchier ovalis* and *Juniperus communis*, as well as shrub species, such as boxwood (*Buxus sempervirens*) and wild rose (*Rosa canina*). A scientific research and demonstration plan, funded by the European Commission (LIFE project), was launched. The goal was to restore open habitat and reinforce adapted management practices on farms. A wide group of stakeholders was involved (farmers, hunters, naturalists, NGOs,

state administrations, among others.). Notably, in the southern part of the Causse du Larzac, restored open habitat, created by cutting trees and shrubs, followed by well-managed sheep grazing, is common and frequently used as a case study for thinking about and testing options for future management scenarios.

Interdisciplinary research on the social and physical factors in landscape dynamics (Chassany et al. 2002) led to the conclusion that ruminant grazing pressure was the major issue to be considered in any conservation and restoration plan. The assumption was made that seminatural, open habitat was the result of, and dependent upon, traditional sheep breeding systems. Increasingly intensified and industrialized since the early 1960s, the emerging livestock husbandry systems no longer suppressed tree and shrub colonization (Rousset and Lepart 1999; Rousset and Lepart 2000). As a result, a series of agroenvironmental schemes (AES) were designed to encourage farmers to reuse rangeland resources. The results encouraged nature managers to actively eradicate the seedlings of unwanted trees and shrubs. The Cévennes National Park administration and various professional farming bodies, backed by regional public funding, also encouraged farmers to take on contracts to “restore” open rangelands by systematically cutting both seedling and adult pine trees. In 2003, ten contracts were signed, covering a total of 456 ha. The combination of the cutting of unwanted seed-producing trees and shrubs and increased grazing pressure is necessary to preserve seminatural grasslands in the area (Etienne 2001).

Conclusion and Restoration Goals: Woodlands, Open Spaces, or Both?

Discussions about how and why to restore Mediterranean woodlands are intense and have been reviewed recently (Aronson, Le Floc’h, and Ovalle 2002; Vallejo et al. 2006; see Clewell and Aronson 2006, for a general discussion of “Why restore?”). Here the first issue we have considered is where and when extensification and intensification can be deemed appropriate and feasible, depending on the specific site and setting. As we have seen, when restoration is decided upon, it must be asked whether it can yield clear enough benefits for local stakeholders to justify the cost and lost opportunities for other land uses. The second question is, to what extent can a broad landscape and bioregional approach embrace both kinds of restoration activities?

Until the 1970s, losses in forest cover due to fuelwood gathering, overgrazing, and fires were the primary concerns for the management of Mediterranean ecosystems in the FMR. Current trends in land cover changes, how-

11. Dynamics and Restoration of Abandoned Farmland in Southern France 219

ever, show that decreases in woodland areas are no longer the key issue for restoration and land management (Mazzoleni et al. 2004). After a period of scientific and technical research dedicated to forest restoration, land managers and conservation bodies have to face woodland colonization as the major vegetation change related to land abandonment.

In the current context, two scenarios are conceivable. The first one is to consider that old fields, both as a cultural heritage and as habitats required by fauna and flora with high conservation value, must be conserved or restored as open habitat. The second is to let the seminatural woodlands grow back, with little or no management. For the most part, this second option is not even envisioned, even though it would constitute a form of passive restoration. Instead, the general consensus—for both tangible and intangible reasons—seems to take the relatively recent cultural landscapes, with their mosaic of open and wooded areas, as the optimal reference (see Aronson and Le Floch 1995; Aronson, Le Floch et al. 2002; and Moreira et al. 2006 for discussion of the complex issue of references in the Mediterranean context).

One element on which a consensus has emerged in France is the idea of heritage responsibility for a given area (Molina et al. 1999). According to this rationale, a species is designated as a priority species if its population in an area is significantly important compared with its population in a wider reference area, for example, a country. Following this criterion of biotic or interspecies responsibility, open, seminatural habitat, among them old fields *sensu lato*, have much higher biodiversity value than woodlands in the French Mediterranean. In addition, open-habitat species are, in general, poorly represented outside of the Mediterranean region. Thus, if the open Mediterranean habitats are lost, then numerous plant and animal species would no longer be present anywhere in France. This rationale is a justification of the need for restoring old fields on the grounds of protecting biodiversity. Combined with the cultural heritage value, this argument lends strong support for old field restoration in the direction of maintaining open spaces. In particular, insofar as it remains economically viable, specialized agriculture represents the best strategy for preserving open spaces and a particular cohort of segetal, ruderal, and meadow species.

However, these operations will have an elevated cost, and current economic conditions in the Mediterranean hills and uplands do not support the levels of human labor and capital investment required to obtain and maintain such artificially restored habitats. Therefore, in some areas it would no doubt be preferable to take advantage of spontaneous woodland dynamics and simply let the woodlands and forests grow back. New ways and means, and new legislation, may soon appear for establishing landscape and

regional-scale planning criteria and models that maximize and enhance the panoply of values of Mediterranean landscapes, including forests, farmlands, and old fields maintained as open-space habitats. Such landscapes may require subsidies initially, but long term an optimal integration and use of the spontaneously growing woodlands should be found so as to realize total economic and cultural value of these landscape mosaics, including the urgent need to reduce the risk of catastrophic wildfire. In the future, research and planning must consider much longer time scales and larger spatial scales than what has been common in the past century (Merlu and Croitoru 2005).

In many cases, if nothing is done, an unknown, synanthropic, “emerging ecosystem” of disparate biological origins will result. Thus, there is a clear necessity for new kinds of evaluation, notably at the landscape scale. The criteria to be taken into account include biodiversity, ecosystem services, multiuse value for local populations, and heritage value.

Pluridisciplinary studies integrating socioeconomic and ecological data can be used to envision possible futures and assist in making decisions. In the European-funded Bioscene Program, scenarios based on the anticipation of policy changes were coupled with landscape modelling (<http://www.bioscene.co.uk/>). In a latter stage, sustainability assessment (Van der Vorst et al. 1999) of each scenario was conducted by adopting a participatory approach based on focus groups composed of local stakeholders. Taking into account both socioeconomic and ecological consequences, the assessment gave each scenario a score based on the points of view of stakeholders and experts. Needless to say, much more work of a transdisciplinary nature will be needed to achieve the kind of ambitious planning and action we call for at landscape and bioregional scales.

Acknowledgements

We extend our warm thanks to Viki Cramer, Christelle Fontaine, and two anonymous reviewers for helpful comments on the manuscript. JA gratefully acknowledges the European Commission for support of the CREAOK project FP5: QLRT-2001-01594 JL; PM acknowledges the European Commission for support of the BioScene project FP5 : EVK2-2001-00354, and the French *Ministère de l'Ecologie et du Développement Durable* for support via the research program DIVA (*Action publique, agriculture et biodiversité*).

REFERENCES

- Alcaraz, F. 2001. L'utilisation publicitaire des paysages de terrasses. *Études rurales* 157–158:195–210.

11. Dynamics and Restoration of Abandoned Farmland in Southern France 221

- Amandier, L. 2005. La suberaie des Maures en danger. *La feuille et l'aiguille* 58:3.
- Ambroise, R., P. Frapa, and S. Giorgis. 1993. *Paysages de terrasses*. Édisud, Aix-en-Provence, France.
- Antrop, M. 2005. Why landscapes of the past are important for the future. *Landscape and Urban Planning* 70:21–34.
- Aronson, J., and E. Le Floch. 1995. On the need to select an ecosystem of reference, however imperfect: A reply to Pickett and Parker. *Restoration Ecology* 3(1): 1–3.
- Aronson J., E. Le Floch, H. Gondard, and F. Romane 2002. Gestion environnementale en région méditerranéenne: Références et indicateurs liés à la biodiversité végétale. *Revue d'Ecologie (Terre et Vie)* (supplément 9): 225–40.
- Aronson, J., E. Le Floch, and C. Ovalle. 2002. Semi-arid woodlands and desert fringes. In *Handbook of ecological restoration*, Vol. 2., ed. M. Perrow and A. Davy, 466–85. Cambridge University Press, Cambridge, UK.
- Blanchemanche, P. 1995. *Bâtisseurs de paysages: Terrassement, épierrement et petite hydraulique agricoles en Europe*. 17e–19e siècles. MSH, Paris.
- Blondel, J., and J. Aronson. 1999. *Biology and wildlife of the Mediterranean region*. Oxford University Press, Oxford, UK.
- Bond, W. J., and J. J. Midgley. 1995. Kill thy neighbour: An individualistic argument for the evolution of flammability. *Oikos* 73:79–85.
- Braun-Blanquet, J. 1931. L'importance pratique de la sociologie végétale. *Bulletin de l'Association Française pour l'Avancement des Sciences*, 157–64.
- Butlin, R. A. and Dodgshon R.A. (eds.), 1998. *An historical geography of Europe*, Clarendon Press, Oxford
- Caplat, P., J. Lepart, and P. Marty. 2006. Landscape patterns and agriculture: Modelling the long-term effects of human practices on *Pinus sylvestris* spatial dynamics (Causse Mejean, France). *Landscape Ecology* 21:657–670.
- Chalvet, M. 1998. Connaissance sylvicole ou propagande? La transmission des savoirs sur la forêt méditerranéenne. In *Traditions Agronomiques Européennes. Elaboration et Transmission depuis l'Antiquité*, 105–16. Editions du CTHS, Paris.
- Chassany, J. P., C. Crosnier, M. Cohen, S. Lardon, C. Lhuillier, and P.L. Osty. 2002. Réhabilitation et restauration de pelouses sèches en voie de fermeture sur le causse Méjan: Quels enjeux pour quelle recherche en partenariat? *Revue d'Ecologie (Terre et vie)* (supplément 9): 31–49.
- Childe, V. G. 1971. The neolithic revolution. In *Prehistoric agriculture*, ed. S. Struever, 15–21. Natural History Press, New York.
- Clewell, A. F., and J. Aronson. 2006. Motivations for the restoration of ecosystems. *Conservation Biology* 20:420–28.
- Debussche, M., J. Escarré, and J. Lepart. 1982. Ornithochory and plant succession in Mediterranean abandoned orchards. *Vegetatio* 48:255–66.
- Debussche, M., J. Escarré, J. Lepart, C. Houssard, and S. Lavorel. 1996. Changes in Mediterranean plant succession: Old-fields revisited. *Journal of Vegetation Science* 7:519–26.
- Debussche M., J. Lepart, and A. Dervieux. 1999. Mediterranean landscapes changes: Evidence from old postcards. *Global Ecology and Biogeography* 8:3–15.
- Douguédroit, A. 1980. Les périmètres de reboisement dans les Alpes du Sud. *Revue Forestière Française* (numéro spécial “sociétés et forêt”):37–46.
- Ducamp, R. 1931. Stratégie et tactique—Science et technique forestière. *Revue des Eaux et Forêts* 69:553–65.

- . 1932. Au pays des incendies—la vérité en marche. *Revue des Eaux et Forêts* 70: 380–393.
- . 1934. Dans la sylvie considérée sous ses formes naturelles permanentes, il ne saurait y avoir place pour les pins du stade régressif. *Bulletin de la Société Forestière de Franche-Comté et des Provinces de l'Est*, juin, 8.
- Escarré, J., C. Houssard, M. Debussche, and J. Lepart. 1983. Evolution de la végétation et du sol après abandon cultural en région méditerranéenne: Étude de succession dans la garrigues du Montpelliérais (France) *Acta Oecologica, Oecologia Plantarum* 4:221–39.
- Etienne, M. 2001. Pine trees: Invaders or forerunners in Mediterranean-type ecosystems. A controversial point of view. *Journal of Mediterranean Ecology* 2:221–31.
- Etienne, M., J. Aronson, and E. Le Flo'h. 1998. Abandoned lands and land use conflicts in southern France. Piloting ecosystem trajectories and redesigning outmoded landscapes in the 21st century. In *Landscape degradation and biodiversity in Mediterranean-type ecosystems*. Ecological Studies Series No. 136, ed. P. W. Rundel, G. Montenegro, F. Jaksic, 127–40. Springer, Berlin.
- Flahault, C. 1927. Le boisement des terres incultes et des montagnes. *Bulletin de la Société Centrale Agricole de l'Aude*: 249–54, 277–88, 345–63
- Fowler, P. 1999. A limestone landscape from the air: Le Causse Mejean, Languedoc, France. *Antiquity* 73:411–19.
- Gide, A. 1952. *Poésie, journal, souvenirs*. Gallimard, Paris.
- Grove, A. T., and O. Rackham, eds. 2001. *The nature of Mediterranean Europe. An ecological history*. Yale University Press, New Haven.
- Guilaine, J. 1991. *Pour une archéologie agraire*. Armand Colin, Paris.
- Hobbs, R. J., S. Arico, J. Aronson, J. S. Baron, P. Bridgewater, V. A. Cramer, P. R. Epstein, et al. 2006. Novel ecosystems: Theoretical and management aspects of the new ecological world order. *Global Ecology and Biogeography* 15:1–7.
- Joubert, A. 1929. Les quatre incendies de la forêt de Valbonne. *Revue des Eaux et Forêts* 67:534–40.
- Kalaora, B., and A. Savoye. 1986. *La forêt pacifiée. Sylviculture et sociologie au XIXe siècle*. L'Harmattan, Paris.
- Kuhnholz-Lordat, G. 1945. La silva le saltus et l'ager de garrigue. *Annales de L'Ecole Nationale d'Agriculture de Montpellier* 26:1–78.
- Kunstler, G., T. Curt, M. Bouchaud, and J. Lepart. 2005. Growth, mortality, and morphological response of European beech and downy oak along a light gradient in sub-Mediterranean forest. *Canadian Journal of Forest Research* 35:1657–68.
- Larère, R., A. Brun, B. Kalaora, O. Nougarede, and D. Poupardin. 1980. Reboisement des montagnes et systèmes agraires. in *Revue Forestière Française*, special issue « Société et forêts »:20–36.
- Laurens, L. 1997. Les labels “paysages de reconquête,” la recherche d'un nouveau modèle de développement durable. *Nature Sciences Sociétés* 5:45–56.
- Lepart, J., and M. Debussche. 1992. Human impact on landscape patterning : Mediterranean examples. In *Landscape boundaries. Consequences for biotic diversity and ecological flows*, ed. A. J. Hansen and F. Di Castri, 76–105. Springer-Verlag, New York.
- Lepart, J., P. Marty, and O. Rousset. 2000. Les conceptions normatives du paysage. Le cas des Grands Causses. *Natures Sciences Sociétés* 8(4): 16–25.
- Lombard, M. 1959. Un problème cartographique: Le bois dans la méditerranée musulmane (VIIè-XIè siècle). *Annales ESC* 14(2): 234–54.

11. Dynamics and Restoration of Abandoned Farmland in Southern France 223

- Loubere, L. A., P. Adams, and R. Sandstrom. 1988. Saint-Laurent de la Salanque: From fishing village to wine town. *Agricultural History* 62(4): 37–56.
- Magnin, F., T. Tatoni, P. Roche, and J. Baudry. 1995. Relationship between landscape change and gastropod communities along an old field succession in Provence (Mediterranean France). *Landscape and Urban Planning* 31:249–57.
- Marres, P. 1935. *Les Grands Causses, étude de géographie physique et humaine*. Arrault et Cie, Tours, France.
- Marty, P. 2004. *Forêts et sociétés. Logiques d'action des propriétaires privés et production de l'espace forestier. L'exemple du Rouergue*. Publications de la Sorbonne, Paris.
- Marty, P., E. Pélaquier, B. Jaudon, and J. Lepart. 2003. Spontaneous reforestation in a peri-Mediterranean landscape: History of agricultural systems and dynamics of woody species. In *Environmental dynamics and history in Mediterranean regions*, ed. E. Fouache, 179–86. Elsevier, Paris.
- Mathevet, R., and A. Mauchamp. 2005. Evidence-based conservation: Dealing with social issues. *Trends in Ecology and Evolution* 20:422–23.
- Matvejevic, P. 1999. *Mediterranean. A cultural landscape*. University of California Press, Berkeley, Los Angeles, CA.
- Mauchamp, A., and P. Grillas. 2002. Quels objectifs de restauration pour un ancien polder de la basse vallée du Vistre? *Revue d'Ecologie (Terre et vie)* (supplément 9): 51–64.
- Mazzoleni, S., G. Di Pasquale, and M. Mulligan. 2004. Reversing the consensus on Mediterranean desertification. In *Recent dynamics of the Mediterranean vegetation and landscape*, ed. S. Mazzoleni, G. Di Pasquale, M. Mulligan, P. Di Martino, and F. Rego, 281–85. John Wiley and Sons, Chichester, UK.
- Merlu, M., and L. Croitoru, eds. 2005. *Valuing Mediterranean forests: Towards total economic value*. CABI, Oxfordshire, UK.
- Molina, J., J. Mathez, M. Debussche, H. Michaud, and J. P. Henry. 1999. Méthode pour établir une liste régionale d'espèces protégées. Application à la flore du Languedoc-Roussillon. In *Les plantes menacées de France*, L. J. Y. Brest. *Bulletin de la Société Botanique du Centre Ouest* (numéro spécial): 399–420.
- Moreira, F., A. I. Queiroz and J. Aronson. 2006. Restoration principles applied to cultural landscapes. *Journal for Nature Conservation* 14: 217–24.
- Noublanche, C., and J. P. Chassany. 1998. Le rôle des acteurs locaux dans la valorisation économique du paysage. Le cas de la Vallée Française en Cévennes. *Revue de l'Economie Méridionale* 46(183): 289–99.
- Pitte, J. R. 1986. *Terres de Castanides, Hommes et paysages du Châtaignier de l'Antiquité à nos jours*. Fayard, Paris.
- Preiss, E., J. L. Martin, and M. Debussche. 1997. Rural depopulation and recent landscape changes in a Mediterranean region: Consequences to the breeding avifauna. *Landscape Ecology* 12:51–61.
- Price, T. D. 2000. *Europe's first farmers*. Cambridge University Press, Cambridge, UK.
- Quezel, P., and F. Médail. 2003. *Ecologie et biogéographie des forêts du bassin méditerranéen*. Elsevier, Paris.
- Rousset, O., and J. Lepart 1999. Shrub facilitation of *Quercus humilis* regeneration in succession on calcareous grasslands. *Journal of Vegetation Science* 10:493–502.
- Rousset, O., and J. Lepart. 2000. Positive and negative interactions at different life stages of a colonizing species. *Journal of Ecology* 88:401–12.
- Russo Ermolli, E., and G. Di Pasquale. 2002. Vegetation dynamics of south-western Italy

- in the last 28 kyr inferred from pollen analysis of a Tyrrhenian Sea core. *Vegetation History and Archeobotany* 11:211–19.
- SER (Society for Ecological Restoration, Science and Policy Working Group). 2004. *The SER international primer on ecological restoration*. http://www.ser.org/content/ecological_restoration_primer.asp (accessed 20 January 2006)
- Stevenson, I. 1980. The diffusion of disaster: The *Phylloxera* outbreak in the Département of the Hérault, 1862–80. *Journal of Historical Geography* 6:47–63.
- Tatoni, T., F. Médail, P. Roche, and M. Barbero. 2004. The impact of changes in land use on ecological patterns in Provence (Mediterranean France). In *Recent dynamics of the Mediterranean vegetation and landscape*, ed. S. Mazzoleni, G. Di Pasquale, M. Mulligan, P. di Martino, and F. Rego, 107–20. Wiley and Sons, Chichester, UK.
- Thirgood, J. V. 1981. *Man and the Mediterranean forest*. Academic Press, New York.
- Vallauri D., J. Aronson, and M. Barbéro. 2002. An analysis of forest restoration 120 years after reforestation on badlands in the southwestern Alps. *Restoration Ecology* 10:16–26.
- Vallejo, R., J. Aronson, J. G. Pausas, and J. Cortina. 2006. Restoration of Mediterranean woodlands. In *Restoration ecology: The new frontier*, ed. J. van Andel and J. Aronson, 193–209. Blackwell Science, Oxford, UK.
- Van Der Vorst, R., A. Grafé-Buckens, and W. R. Sheate. 1999. A systemic framework for environmental decision-making. *Journal of Environmental Assessment Policy and Management* 1:1–26.
- Vernet, J. L. 1997. *L'Homme et la forêt méditerranéenne de la préhistoire à nos jours*. Erance, Paris.
- Vos, W., and A. Stortelder. 1992. *Vanishing Tuscan landscapes. Landscape ecology of a submediterranean-montane area (Solano Basin, Tuscany, Italy)*. Centre for Agricultural Publishing and Documentation, Wageningen, The Netherlands.