Chapter

MANAGEMENT APPROACHES FOR PROTECTED AREAS OF CULTURAL AND BIOLOGICAL SIGNIFICANCE: THE BEECH POLLARDS OF AIAKO HARRIA NATURAL PARK

Stella J. M. Cousins[1] and Ashley E. DuVal[1*]
[1]Yale School of Forestry and Environmental Studies,
New Haven, CT USA

ABSTRACT

The Basque Country is home to Europe's largest remaining stands of pollarded beech forest. Within Aiako Harria Natural Park in the Gipuzkoa Province of Spanish Basque Country, an estimated 800 ha of pollarded beech (*Fagus sylvatica* L.) forest compositionally dominate the landscape. These trees were pollarded continuously over centuries to provide ship parts and charcoal for Basque industry. Recent studies have supported the role of senescing pollards, abundant sources of standing dead wood, in promoting local biodiversity through habitat creation and a food source for saproxylic invertebrate species. Despite this recent revival in interest, there remains limited public awareness of the cultural and ecological importance of pollards. Park managers are at a critical point in administering maintenance to promote the long-term survival of these culturally modified trees, which are threatened by structural instability resulting from a lapse in management. Building upon a historical and ecological overview, this paper draws from our observations in Aiako Harria as well as other case studies to highlight important considerations for protected area managers in promoting and managing landscapes of cultural and ecological importance. Suitable best practice approaches include an inventory and scientific study, increased outreach and education to build greater public awareness, a multiple use management approach, and integration of cultural and biological frameworks for valuing the pollard forests.

Keywords: pollard, *Fagus sylvatica*, Basque country, biodiversity, saproxylic, veteran trees, cultural heritage, managed landscape, culturally modified tree

[*] Corresponding authors: stella.cousins@alumni.yale.edu, ashley.duval@yale.edu.

INTRODUCTION

Aiako Harria Natural Park, typical of the Spanish Basque country, is characterized by landscapes altered by the long legacy of the Basque people and their utilitarian relationship with the environment. Throughout the region, the signature of settlement and management is evident in a mosaic of centuries-old pasturelands and contemporary conifer plantations, but the landscape also bears more subtle hints from ancient times. Roman mines and the early port at Irun evidence land use and resource extraction dating back at least to the first century BC (Barandiarán, 1973; Benito, 1988). Within the park, stone circle monuments known as *cromlechs* recall settlements from 1000-600 BC (Altuna and Areso, 1977), and single-chamber megalithic tombs called *dolmens* from the neolithic age suggest a history of pastoralism in the mountains of Aiako Harria since 3000 BC. The steep pastures were cleared by shepherds more than 4,000 years ago, when the pedunculate oak (*Quercus petraea* (Matt.) Liebl.), rare on the landscape today, was a dominant species. Forests dominated by beech (*Fagus sylvatica* L.) became common in the area 3,500 years ago (Elosegi, personal communication 3/17/10). While stone and structural artifacts provide obvious indications of prehistoric occupation, the extensive record of Basque settlement is evidenced by clues in the natural landscape as well. Centuries of grazing, cultivation, and land clearing have transformed the region's hardwood forests into today's characteristic high elevation grasslands and heath. In Aiako Harria Natural Park and many other locations in the region, extensive tracts of forest are compositionally dominated by pollarded beech and oak trees managed for hundreds of years as a renewable source of fuel, timber and fodder. These culturally modified trees represent a threatened form of traditional ecological knowledge as only a handful of aging individuals hold firsthand experience in their management. As both important cultural artifacts and living components of a dynamic ecological system, the pollards pose unique management challenges. There have been significant changes to forest structure since the lapse of routine pollarding. The dense, closed beech canopy has shaded out advanced regeneration resulting in a single uniform age class that dominates the forest. With many of the pollards nearing or surpassing the traditional time between cutting cycles, the stands in the park today are top-heavy and prone to breaking in windstorms or under their own weight. The loss of many larger pollarded trees in recent years underscores the necessity of management interventions to secure them for future generations.

The daunting size and gnarled forms of the pollarded trees set against a closely grazed understory provide arresting landscapes that attract hikers and picnickers to the park. However, for those who frequent the mountains of the Basque Country, the presence of these gnarled trees is ubiquitous and often unnoticed. In a region renowned for 2,000 year old Roman mines, 3,000 year old cromlechs and cave art dating back 18,000 years, the historical value of pollarded trees that represent over 200 years of traditional management have largely escaped notice. Recently, a visit of ancient tree enthusiasts on a European tour of pollarding practices drew international recognition to the trees as a unique and threatened cultural heritage (Read, 2006). Teams of resource managers, arborists and biologists have since conducted studies on the regeneration of maiden (not pollarded) beech forests, the biodiversity and ecological state of these stands, and local knowledge of traditional pollarding techniques used by charcoal makers (General Directorate for Woodlands and the Natural

Environment, 2005). Recently, the Woodland Trust, a British organization focusing on ancient and veteran tree preservation, has expressed interest in how data gained from the study of these pollards could inform their own pollard and veteran tree management practices and vice versa (Read, 2007).

This analysis seeks to address the underlying management issues posed by a biocultural landscape through a review of comparable systems where some success managing protected areas for mixed values has been achieved. We begin with a historical overview leading to a discussion of the present status of the pollarded stands, current management practices, and their associated values.

THE POLLARDED BEECH FORESTS

History

Aiako Harria Natural Park contains more than 800 hectares of pollarded forests, composed primarily of European beeches and, less commonly, pedunculate oak (*Quercus robur* L.), European ash (*Fraxinus excelsior* L.), and Iberian white birch (*Betula celtiberica* Rothm. & Vasc.). These pollarded beech forests in the mountainous Basque region comprise perhaps the largest extant aggregations of pollard-managed forest left in Europe. The tradition of pollarding has an long history of practice in Europe, where fossil oak pollards discovered near the River Trent in the UK were dated at more than 3,400 years old (Butler, 2006). As a silvicultural and silvo-pastoral technique, pollarding was once widespread in Europe but is relatively uncommon today (Petit and Watkins, 2003).

In Gipuzkoa Province, pollarding became common on a large scale during the 16th and 17th centuries when improved technologies for melting iron and crafting ships coupled with population growth drove up the demand for forest products. Due to the region's abundant mineral resources and water, the demand for iron was met by foundries and furnaces stocked with charcoal from nearby forests. The region transitioned to large-scale use of iron ore with the advent of industrial iron melting through river foundries, marking a change in the processing capacity from the small melting ovens operating during the Middle Ages (Elosegi, personal communication 3/17/10). At the same time, the needs of merchants, fishermen, and the Spanish Navy were rapidly expanding to serve newfound trade routes. Shipbuilders could pay for curved timbers for ship ribs and needed strong, Y-shaped timbers for critical joints, driving demand for pollarded forms (Rozas, 2004; Aragon Ruano, 2001). As the expansion of local enterprises drove population growth in the region, the beech pollard areas were managed for the fodder and nut crops needed to sustain livestock. Free range grazing of sheep, horses, and cattle was common throughout the region, following traditional routes of transhumance and extensively utilizing forested areas. Pigs were also released on a seasonal basis to consume mast (Rozas, 2003; Loidi, 2005).

Thus, pollard management developed in the region along two product-focused pathways, while accommodating pastoral uses. Trees to be sent to sea were carefully selected and topped at about 3m above ground to encourage horizontal growth of two to three selected branches. Called *guiados*, the branches of these trees were typically guided with weights and careful attention to perfect their form. Cutting and shaping of other branches would occur

every 10-12 years (slightly more often for beech trees) until the development of the primary branches was complete 70-100 years later (Aragon Ruano, 2001). Each visit would include removal of the smaller sprouts since the last cutting. In the end, the entire tree would be harvested for timber. In contrast, charcoal production provided a more frequent harvest and flexibility of use. These pollards, known as *trasmochos,* were typically cut back using axes every 10-20 years, removing some or all of the branches from the single trunk, similarly at about 3m above ground. Straighter stems of small diameter were ideal for use in the furnaces for manufacturing iron and in limekilns, as well as for domestic purposes. These two types of management would have likely intermixed, with more accessible locations favored for *guiados* and the steeper, more remote terrain utilized solely for *trasmochos* (Fenley, 1950; Aragon Ruano, 2001; Loidi, 2005; Read, 2006). New methods of pollarding were developed out of the necessity for multiple uses, and quickly proved to be an effective means of satisfying resource demands. In 1548, the government of Gipuzkoa recognized their importance for the people of the region, and mandated that more trees be pollarded (Aragon Ruano, 2001; Read, 2004).

Over the next two hundred years, demand for wood for in the Basque region continued to increase, and forested areas dwindled. Lowland forests were displaced by agriculture as populations expanded, and the demand for wood grew (Kenk and Guehne, 2001; Onaindia and Mitxelena, 2009). Forests in municipal control, such as those that now comprise 83% of Aiako Harria Natural Park, were somewhat protected from these pressures by virtue of their status as public utility property. Some of the most frequented pollarded sites in the province, such as Oieleku and Artikutza, retained native forest and pollarding activities as they were poorly suited for farming and distant from town centers. The 20th century saw further changes in land use, with widespread agriculture abandonment and reforestation with exotic species. As demand for traditional wood products such as charcoal and structural timbers declined drastically, forestry practices transitioned towards management for paper pulp, and still more native forests were converted to plantations of exotic conifer species (Garcia-Ruiz et al., 1996; Rescia et al., 1997, Schmitz, 1998; Loidi, 2005). In the second half of the 20 th century, regular cutting of beech and oak in the high hills became too labor intensive to warrant establishment of new pollards on a commercial scale. This followed a period of decline in charcoal making, which was abandoned altogether in the 1960s with the exception of the regions of Urbasa and Lokiz in Navarre where the tradition continues, however limited (A. Elosegi, personal communication 16 March 2010). Many pollarded forests were removed and replaced with plantations, and while thousands of hectares remain in the mountains of the Basque Country under different forms of land ownership, only a few hundred hectares remain within the protection and jurisdiction of Aiako Harria Natural Park.

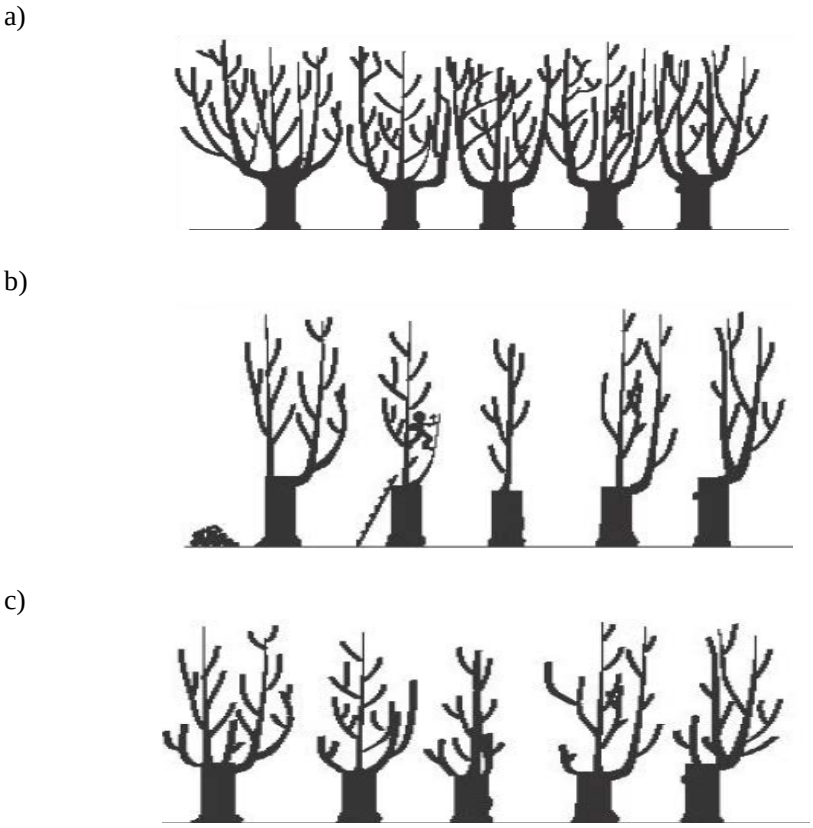

Figure 1. The pollarding management cycle. A. Pollarded trees one year prior to cutting; B. immediately following a cutting, and; C. one to a few years following a cutting, with branches resprouting from the bole. Adapted from Loidi, (2005).

Present Condition

In the park today, the pollards provide habitat for a variety of species but they present interesting and urgent management challenges due to their continuously changing condition. Some of the senescing individuals have already succumbed to disease and decay, lost limbs in storm events or simply split and collapsed under their own immense weight. This process provides a pulse of coarse woody debris to the forest floor and its inhabitants (Figure 1B, 1C). In areas free of grazing, a significant threat to the relict pollarded trees also comes from competition and shading by uncut, or maiden, beeches. The process of tree death and decay may be ecologically ephemeral, but it nevertheless provides a rich habitat for species characteristic of mature forests. The trees, often hundreds of years old, have attributes such as nest holes, soft wood, and woody debris and serve as a refugia to a suite of species uncommon in Europe by virtue of the rarity of these habitats (Franklin et al, 1987; Ódor and Standovár, 2001; Grove, 2002; Christensen et al, 2004). Although the pollarded beech forests were once thought of as “biodiversity deserts,” recent surveys of the plant and animal communities found in the park have revealed diverse assemblages of insects, lichens, and fungi established upon the decaying wood of the senescing trees (General Directorate for

Woodlands and the Natural Environment, 2005). A new species of lichen was documented in 2008, along with observations of 57 species of lichens and lichenicolous fungi documented in the Park for the first time in the Basque country, and some for the first time in continental Europe. Pollard forests support a wide diversity of invertebrates; at least 268 species of insects in 68 families are found in the Oieleku area, 109 of which are saproxylic (species consuming and inhabiting wood). The cerambycid *Rosalia alpina*, a European Protected Species, occurs in the decaying woods (Carte, 2008; Etayo, 2008). The recent LIFE project stresses protection of habitat for this species as well as *Lucanus cervus* and *Osmoderma eremita*, two other protected beetles that rely on rotting wood. Some of these endangered species combine xylophagous larvae with adults who feed on grass or pollen, necessitating the combined management of dead wood with open glades. Within the past decade, Park managers have embarked on a series of investigations focused on the beech forests with perpetuation of this biodiversity in mind.

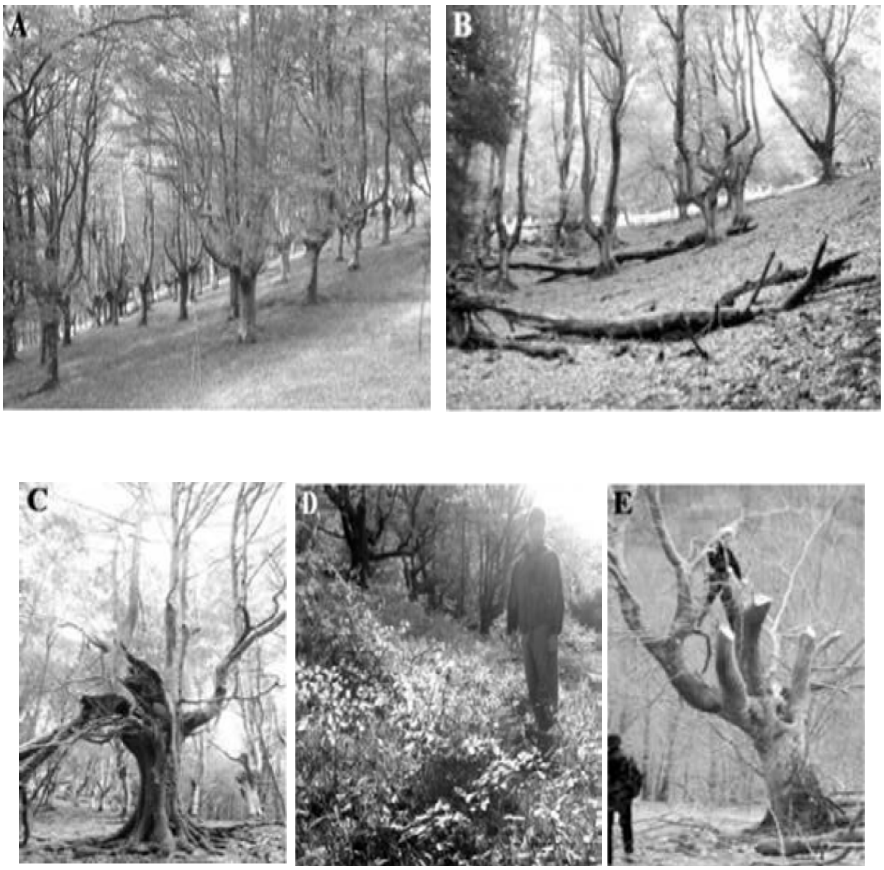

Figure 2. Status of decay and regeneration in the pollard forests of the Basque Country. A. Pollarded beech forest with grazed understory, Oieleku recreation area. B. Senescing individuals provide abundant woody debris for the forest floor, Artikutza. C. Increasingly heavy branches on abandoned individuals cause eventual collapse, Artikutza. D. In an experimental exclosure, beech seedlings and other understory vegetation fill the gap created by a recently collapsed pollard. Near Oieleku. E. Use of traditional methods to reinstate pollarding for a beech at Urkizu. Images courtesy A, B, C, D.: S. Cousins; E.: H. Read.

A number of livestock exclusion plots were established to secure regeneration of woody species (Figure 1D) and former plantation sites have been replanted with beech saplings (General Directorate for Woodlands and the Natural Environment, 2005).

Pollarded trees may live for twice the typical lifespan of an unmodified forest beech because of management, but these will advance into structural instability in the next 10-20 years if not carefully pruned or returned to a pollarding system (Read, 2006; A. Elosegi, personal communication, October 21 2009). In a few locations, the trees are just barely out of their traditional cutting cycle. With the susceptibility of top-heavy pollards to storms and decay, intervention is essential to ensure the future of these forests. One of the outcomes of the collaboration between the Woodland Trust and the Basque Biodiversity Center has been a trial of both modern and traditional cutting techniques for pollarded trees (as seen in Figure 2E). The results of this study are being monitored and are expected to provide important information on the suitable methods and costs associated with continuing pollard management in some areas of the park (Read, 2007). Through the LIFE project focused on Aiako Harria Natural Park, 27 conservation actions have been completed, the majority of which focused on native hardwood forests. The program concentrates efforts on the restoration and conservation of habitats and species of community interest through innovative methods, and stresses demonstrational and educational aspects. Park managers have also recently secured a LIFE+ grant for the period 2010-2013, which is focused primarily on the beech pollards (Segura, 2009).

KEY QUESTIONS

The current condition of Aiako Harria's pollard forests poses a number of management concerns. The most pressing is to determine how transitional landscapes should be managed as senescing trees are replaced by forests that differ in structure and composition. A second concern is the provision of long-term management, which is costly and labor-intensive, and no longer driven by the need for ship parts or fuel. The third and most fundamental challenge is that of balancing biological and cultural values in protected area management. Every forest type and management approach carries a different set of conservation values and trade-offs. The pollards can be valued for their role in conserving both local biodiversity or cultural heritage. Management in line with these different values encompasses distinct mechanisms for valuation, actions, and financial support. Conservation groups, NGOs, and various international organizations increasingly recognize the value of applying an inclusive and holistic approach to managing areas of natural and cultural importance. These approaches should be considered as a possible theoretical basis for future management decisions taken in the park.

CASE STUDIES

What follows is an abbreviated review profiling a range of approaches to management and preservation of sites that have both ecological and cultural importance. The case studies that follow showcase approaches to the management of biocultural landscapes and resources

under a wide range of circumstances with the goal of illuminating potential management paths for both the beech pollards at Aiako Harria and for other sites with multifaceted biocultural values.

BURNHAM BEECHES AND COUNTRYSIDE MANAGEMENT IN THE UNITED KINGDOM

Burnham Beeches

The Burnham Beeches is a National Nature Reserve and Site of Special Scientific Interest owned by the City of London and located in Buckinghamshire, England. This 220-hectare reserve contains heathlands, bogs, and 80 hectares of wood pasture, dominated by beech and oak pollards; many of the individuals are thought to be 400 years old or more. In the mid 19th century pollarding ceased for a period of 160 years, and grazing animals were removed in the mid 20th century. Management in the Burnham Beeches has focused on preservation of veteran trees, as most of the older beeches are hollow from decay. The City's stated goal is to structurally improve 50 trees per year. This involves the use of a professional arborist who can be responsible for reducing the size and instability of the trees and is a considerable investment. In addition to tree maintenance, 500 new pollards have been created in the reserve. Prior to embarking on this program, reserve managers conducted experimental treatments to younger, uncut beech trees in order to discern the best conditions for securing new growth from beech trees on this site. By examining the light environment, balance of branches, and cutting method, they have developed techniques that can stimulate growth in specimens over a century old. Managers have also reintroduced light grazing to open the shrubby understory with traditional methods, and they have instituted a monitoring program for vegetation and ground invertebrate populations. Because visitors from nearby London frequent the Burnham Beeches, safety is also a factor in their preservation efforts. Pruning has been conducted on hazard trees when necessary. Managers of the Burnham Beeches involve and benefit from the commitment of interest groups and volunteers, including their own volunteer program for site maintenance, private donors, the Woodland Trust, and others. The Reserve has twelve full time staff and a comprehensive management plan (Read and Frater, 1999; Barnard et al, 2005, Read et al, 2007).

The methods at Burnham Beeches focus on individual tree preservation because the resource is limited in extent and particularly fragile. Furthermore, managers have emphasized not only the product - an extremely aged and gnarled tree - but also the process: the continuous cultivation of the pollards. Their self-described purpose is "to manage the veteran trees, semi-natural ancient woodland, heath and mires in order to perpetuate them and their associated features for the future [and to] encourage public access and involvement and foster greater understanding of the site" (Read and Frater, 1999). These management methods would be suitable on a small scale in locations where preservation of individual remarkable trees or sites is desired. Sites accessible by road and those frequented for their impressive stature would also be candidates for similar approaches: within Aiako Harria, both Castillo del Ingles and Oieleku may be suitable. However, these methods are very labor intensive and demand great care and time in their execution. The cooperation of an interested public has

been a key ingredient for Burnham Beeches and is a necessary ingredient even in a complex plan of "tree surgery" such as the one underway at the Reserve (Barnard et al, 2005; Read, 2007). Management of exceptional trees through careful arborist work and public understanding of the importance of the trees has been successful, and Park managers in the Basque Country can exchange techniques and information with their colleagues in pollard preservation.

Woodland and Landscape History in the United Kingdom

The Burnham Beeches is only one example of many woodland sites in Britain protected for coincident cultural and ecological values. The preservation of historically-managed landscapes is a well-established institution in the United Kingdom, as exemplified not only by pollarded trees, but also by copses, wood-pastures, hedgerows, meadows, and entire pastoral landscapes (Rackham, 1990). This work is generally incorporated within the practice of countryside management, and itself has a long history of integration with conservation efforts. In the 1860s and following, The Commons and Footpaths Preservation Society promoted conservation of the New and Epping Forests for their outstanding history, resulting in the preservation of “Ancient and Ornamental” woodlands that had been managed in coppice systems for centuries (Tubbs, 1964; Peterken, 1996). In fact, woodlands’ cultural value has been a dominant force in the establishment of reserves throughout the U.K., and continues to inspire local involvement in their study and maintenance (Rackham 1990). Additionally, the benefits of perpetual human involvement with forest ecosystems have been extensively documented by ecologists with an interest in landscape heterogeneity and the protection of rare habitats in these ancient inhabited landscapes (Peterken 1977, Read and Frater 1999). For the last three decades, managers of ancient woodlands have strived to incorporate both environmental and historical preservation goals into their activities. Their ample documentation of these endeavors can serve as a resource for park managers in similar undertakings.

Culturally Modified Trees

Culturally modified trees, (CMTs), are trees that have been modified by traditional cultural practices that frequently result in particular distinguishing features (Ostlünd 2002). The most frequently cited practices resulting in the creation of CMTs across a number of regions and societies include bark stripping for fibers, building materials, and use of the cambium layer as a food source. Scarring and burning of tree trunks was practiced by some indigenous groups to mark boundaries, while trunk carvings and notches indicate placement of natural shelves laid between trees to dry hay and fodder (Mobley 1992; Zackrisson 2000; Mallea-Olaetxe 2000). Pollarding can be viewed as another form of cultural modification for utilitarian purposes. CMTs are useful today in helping us learn about the diets, materials, migrations and sacred rituals that defined ancient cultures, including those that are no longer in practice (Prince, 2001).

The Basques in particular have been linked to various CMTs, such as arborglyphs, used by shepherds to communicate both in the Spanish Basque country and in Basque farming and

herding communities of the American West (Mallea-Olaetxe, 2000). The pollard beech forests of the Basque country share many characteristic features with other regions where CMTs are common: they have been forested continuously and used by native people in the region, including contemporary farmers (Ostlünd, 2002). Like many other CMTs, pollards have a long history of subsistence and commercial use. Though few studies have been conducted specifically on the loss of CMTs, recent research indicates a decline of this resource in the 20th century. This coincides with declines in the modified trees' economic importance, and much of their disappearance is attributable to harvesting activities unrelated to earlier cultural practices. In British Columbia, trees registered as CMTs are protected by complex laws. Trees may not be logged if they are dated older than 1846 and registered as CMTs, and some First Nation management plans in this area claim a 20-30 meter protective zone around the tree (Perreault, 2002). The pressures on CMTs include both logging and management that encourages removal of aged or "damaged" trees. Scandinavian forest management, for example, emphasizes this practice, although some proponents attest that the presence of CMTs within a forest reserve indicates that it should be regarded and managed as a cultural landscape (Ostlünd, 2002). In Sweden there was little awareness or prioritization of CMTs by authorities responsible for forest management and attention focused instead on the actual archaeological remains rather than the culturally modified ecosystem and trees themselves (Ostlünd, 2002). However, increased interest in the history of Scandinavian forests has resulted in more information campaigns and government sponsored programs aimed at protecting the cultural values of the forests themselves. In the Basque Country, as in Sweden, there are no specific protections or designations for CMTs within forest reserves or elsewhere. The Swedish model of an advocacy-based, public information campaign may serve as an implementable model to redefine public perception of forests as a shared cultural as well as natural heritage.

UNESCO WORLD HERITAGE SITES, WORLD HERITAGE FOREST PROGRAMME AND BIOSPHERE RESERVES

UNESCO is one of the premiere organizations promoting the management and protection of natural and cultural heritage. Since 1972, when UNESCO adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage, World Heritage sites have promoted international cooperation in the conservation of the world's cultural and natural heritage by encouraging participation of local populations in the preservation of designated sites. Today, the World Heritage list includes 936 properties, of which 725 are classified as cultural, 183 natural, and 28 mixed, amongst 153 of the 187 States Parties that have ratified the World Heritage Convention. Two of the 28 mixed natural-cultural World Heritage Sites are located in Spain, Ibiza and Pyrénées at Monte Perdido. The latter, established in 1997, is a transboundary site shared between Spain and France, and parallels Aiako Harria in its representation of threatened traditional forest and agricultural practices (UNESCO WHC). UNESCO also leads the World Heritage Forest Programme, a system of 104 forest sites that together account for some 76 million ha and 13% of all IUCN protected forests (DuVal and Crane, 2011). The World Heritage Forest Programme includes the

Primeval Beech Forests of the Carpathians in Slovakia and Ukraine, granted universal importance as a genetic reservoir of beech species and other species dependent upon these forest habitats (UNESCO WHFP). Biosphere Reserves, maintained through UNESCO's Man and the Biosphere Programme, has the proposed mission of promoting an interdisciplinary research agenda and building capacity to improve the relationship of people with their environment around the world (UNESCO MAB). Since the early 1970s the Man and the Biosphere Programme has targeted the ecological, social, and economic dimensions of biodiversity loss by using a network of Biosphere Reserves as a platform for knowledge sharing, research and monitoring, education and participatory decision-making. Within this program, an area of 220 km^2 situated on the Bay of Biscay was designated the Urdaibai Biosphere Reserve in 1984 in recognition of the unique Cantabrian holm oak forests (*Quercus ilex* L.), an abundance of vascular plants and birds, and various historical artifacts from the prehistoric, Roman and Middle ages. It is currently implementing a management, land use and development plan promoting tourism, agriculture and forestry (UNESCO MAB2).

We highlight these UNESCO programs as important early contributions to a socio-ecological approach in managing and protecting resources, programs that have recognized the world heritage value of forest systems similar in nature to the pollarded beech and oak forests of Aiako Harria. However, we must emphasize that these examples are offered as a model and a framework but that management solutions must incorporate good governance at all scales. Designation from international agencies like UNESCO may bear cultural and political sensitivities if the autonomy of local authorities is bypassed in the process. While Urdaibai is the only Biosphere Reserve in Basque country, it is a rare example of a Biosphere Reserve that is not also a government-designated protected area. Local biologists point out that plantations of exotic species like eucalyptus and Monterey pine are extensive within the "core" area. While collaboration at multiple levels of government can facilitate a consistent support network for conservation efforts, local or municipal programs should have the prerogative to advance and contribute feedback to designations and management within their purview.

Finca De Fitor

The Fitor Estate, located in the Area of Natural Interest (EIN) Gavarres, Catalonia, is a Natura 2000 site recognized as an example of good management practice (Natura 2000 Networking Programme, 2005). Fitor is a 1300 hectare private holding managed by the Botey Serra family for multiple uses. The location is home to a variety of Species of Community Interest, including some of the same invertebrates found in Aiako Harria Natural Park. A featured species in their management plan is the two-tailed pasha, (*Charaxes jasius* L.), which is the largest butterfly in Europe and feeds on strawberry madrone (*Arbutus unedo* L.) trees. The estate has more than 650 species of plants and is situated at an ecological crossroads: the intersection of Mediterranean, Atlantic, and Euro-Siberian biogeographic regions. Laurels (*Laurus nobilis* L.), introduced by monks more than one thousand years ago, have naturalized along the stream corridors. The estate also has preserved and restored a number of historic structures, including the Mas Plaja house, which has been continuously occupied since the 13th century. Tile ovens and ice pits from the Middle Ages and traces of

Roman lead and silver mines are distributed on the forested hills. Remnants of even earlier cultures are found in numerous grave markers and upright stones of prehistoric origin.

Beginning about 700 years ago, locals began to harvest bark from the cork oaks (*Quercus suber* L.), and have managed the landscape for cork production ever since. Other commercial enterprises utilize the natural forests and fertile soils through commercial cultivation of trees and ornamental greenery, primarily strawberry madrone and eucalyptus trees. The estate also earns some revenue from use as a tourist retreat and private hunting ground. Within the past 100 years, depression, civil war, and a forest fire have ravaged the productivity of the forest. When the estate was acquired around 1950, many of the trees were 200 or more years old and failing in their production of cork. Since that time the family has used the estate as extensive experimental grounds, inviting scientific study and carrying out their own commercial and forestry trials. Meanwhile, they have rehabilitated the oak forests to now produce 100 tons of cork annually, about 2% of the annual Catalan supply. On the whole, the family sees the estate's purpose as "enriching the cultural and natural landscape of Europe" (Botey Serra 2004). Management strategies are geared toward multifunctionality: cork production, live nursery products, historic preservation, and tourism form an interrelated network of revenues and services. The Fitor Estate features ancient monuments, modern forestry, and regionally important biodiversity. While private ownership facilitates a highly flexible and adaptable standard of management that is harder to achieve in a protected area of more complex governance, the model of traditional practice combined with interpretation and commercial activity is worth consideration.

RECOMMENDATIONS

Continued Inventory and Study

The first recommended action is the development of a baseline inventory of the pollarded forests, as preservation experts have already suggested (Read, 2004). Current understanding of the extent of these beech pollard forests and their relative importance is based on an estimate of the area that they cover, which has been cited as 800 ha (Read, 2006). However, there has not been any comprehensive pollard inventory conducted to date (I. Aizpuru, personal communication, October 19 2009). An accurate, up-to-date characterization of the pollarded trees in the park, including number, exact location, density, and condition, would improve ongoing management of the resource in a number of ways. First, it would establish the quantity and record the location of these forests and trees, providing a ready reference for public information and strengthening the case for additional and ongoing funding by confirming their global uniqueness. Secondly, a survey of pollards would help categorize stands of forests based on their condition as 1) those which are at high risk of collapse; 2) those which would yield the most benefits from conversion to maiden beech stands; and 3) those which might be managed using traditional methods. This would help park managers prioritize areas for treatment, experimentation, or preservation. Managers should engage local stakeholders including park users and local schools or universities in the inventory process. For example, members of the Mountaineering Federation regularly hike the region and take great pride in the park's natural resources and beauty; engaging park usergroups can help

connect participants relate more directly to the cultural as well as natural components of the landscape, while minimizing the cost of operations and maintenance for the park. A participatory approach to inventory has been successfully utilized by urban forestry groups and serves the dual function of teaching critical science and job skills as well as promoting proficiency with GPS units and other survey and monitoring equipment (Margerum, 1999; Alexander, 2008).

A complete inventory of the pollards could help identify trees that may be suitable for landmark status as a Singular Tree. Singular Trees are designated by the Basque government based upon their extraordinary or noteworthy characteristics such as size, age, history, beauty, or situation, and are afforded special protection. Currently there are 26 such trees in the country, 11 of which are in Gipuzkoa (Basque Government, 2006). Designating a few selected pollard beeches as Singular Trees could generate visibility and awareness of the unique history that gave rise to the pollards, which would benefit all pollarded beeches and oaks within the park.

Finally, it will be useful to continue investigation of ecological processes in the pollarded forests. Park managers have already begun this process by conducting trials in establishing regeneration where senescent pollards have provided an open understory, and through extensive study in forest diversity (Carte 2008, Etayo 2008, I. Aizpuru, personal communication, October 19 2009). Next steps might include a study of gap dynamics and composition of stands with focus on the regenerating forests that will gradually replace the senescing pollards, and characterization of the pollard forest as a human-created plant community for management and education purposes (Whitney and Adams, 1980; Marcucci, 2000; Rozas, 2004). Further study and data collection will help to inform the long-term plans for management of the forest.

Public Awareness and Education Campaign

Complementary to a thorough inventory, a targeted community-outreach campaign is needed to highlight the local cultural heritage and global importance of the Basque pollarded forests. Our own limited interactions with park user groups, such as a group of mountaineers from the nearby city of Bilbao, supported statements made by park staff that there was little public awareness as to how these trees had been formed and their specific relevance to Basque history in the region. Indeed, many of the local park users had grown up familiar with the common spectacle of the pollards and consequently gave them little thought. However, in recent years, park rangers have noted that foreign tourists in particularly are expressing specific interest in the pollards. This is likely a consequence of the widespread publicity efforts amongst ancient tree enthusiasts through forums such as the Ancient Tree Forum, particularly in Great Britain. Signage of any sort relating to the pollards was virtually absent from the park at the time of our assessment. The only visual media linking the present form of the pollards to their traditional uses in charcoal making seen during our trip was an informational panel in the museum of the Basque Center for Biodiversity located in Busturia, 125 km from Aiako Harria, although we were informed that closer panels exist. Increasing signage in high traffic and heavily pollarded regions of the park such as the picnic area at Oieleku, around the Castillo del Ingles, and at trailheads such as the Arritxulo hostel area,

would provide a cost-effective and efficient means of educating park users about the importance of pollards in Basque history.

Interactive modes of outreach and education should be coupled with passive methods of public information like signage. We recommend that teams of arborists and the remaining traditional charcoal makers collaborate by organizing public demonstrations in the park to ensure that this unique form of local knowledge is not lost to future generations. Demonstration charcoal mounds have already been suggested as another potential activity with both local and tourist appeal (A. Elosegi, personal communication, October 21 2009).

Multiple Use Management

Basques have a long tradition of harnessing the economic potential of working forests. This has left an indelible mark upon the landscape, exemplified most recently by the plantations of Monterrey pine (*Pinus radiata* D.Don.), red oak (*Quercus rubra* L.) and other exotic species that dominate the park and surrounding lands today. Accordingly, the pollard forests should be utilized in a number of ways to promote biodiversity, cultural awareness, scientific progress in the management of veteran and lapsed trees, and even generate revenue where possible. We therefore recommend that following the inventory, various pollarded areas be ascribed different uses and purposes. For example, continued management and pollarding would not be practical on some of the steepest slopes where they occur, but the dead wood from pollard boughs could provide an important source of slope stabilization and erosion control while encouraging understory and herbaceous growth by protecting regeneration from grazing pressure. Some of the best-preserved sites, particularly those surrounded by other cultural relics like the cromlechs near Oieleku and Castillo del Ingles, should be left as "museum sites" for public enjoyment and recreational use. These sites should be highly promoted to tourists and hikers, and would make great locations for multi-language informational signs. Other less accessible sites should be selected as experimental plots to learn more about management and pruning responses, and the environmental heterogeneity of the terrain should be utilized to provide lessons for the management of veteran trees under a great deal of different conditions including slope, aspect, and tree age. Finally, some areas should be preserved for demonstrations of traditional pollarding and charcoal making practices.

Integrative Cultural-Biological Framework for Valuing Pollards

A largely biodiversity-centric justification for pollard conservation was employed by park managers in accordance with the LIFE project grant, which lasted from 2006 to October of 2009. Natura 2000 does not differentiate between the value of natural landscapes versus those created or modified by human influence, although the former dominate its preservation efforts. Although the classification of the pollards as a Natura 2000 site has granted them increased visibility and targeted them for continued research, the result has been that the pollards are valued largely for their contributions to the region's invertebrate biodiversity. If this management value were the only one in consideration, it could be reasoned then that the

best management approach would simply be to leave the trees to lapse and break, creating a broader mosaic of dead and dying wood types to promote habitat formation and biodiversity. This is a hypothetical extreme, but nonetheless illustrates the dangers in assuming too narrow a framework for justifying a course of management actions. In a discussion of preserving the "semi-natural" or human-modified landscape for its natural values, Alexander (2008) explains this dichotomy. If we were to attempt to apply the accepted meaning of "wilderness" to the Old World, it can readily be seen that no place can claim total isolation from human influence.

THE LIFE+ POLLARD PROJECT

Although the 2010-2013 Life + project is still in progress, the details and actions to date indicate a project and approach closely aligned with the values and recommendations of this paper. The justifications for a Life project exclusively treating beech pollards, (Table 1) are split between values that touch upon the ecological importance, cultural heritage, and global rarity of the pollards, as well as the importance of immediate action for conservation.

Similarly, the actions that have been proposed range widely in nature from biodiversity monitoring goals reminiscent of the prior Life+ Nature project to ambitious unprecedented efforts to document and transmit traditional knowledge (Table 2).

This classification system represents the author's analysis of the frameworks by which the pollard beeches have been valued and classified as part of the Life+ Project. After assigning values, the Actions and Justifications broke down as follows: Conservation (13); Ecology (11); Cultural Heritage (8); Outreach and Education (6); Global Rarity (4).The 2010 Life+ Pollard Project assumes a diverse and integrative approach to addressing the multiple management concerns of the beech pollards in Aiako Harria Natural Park. The Actions and Justifications of this project that were disclosed by the time of this writing are aligned with key components articulated in this paper; for instance, continued inventory, public awareness and environmental educational, and some multiple use management. Finally, an integrative cultural-biological framework for valuing pollards is exemplified by the diversity of values identified. The actions and justifications listed here represent an initial synopsis and are not necessarily comprehensive of the project aims, leaving room for further integration of some of the recommendations made in this article may have been incorporated since the 2010-2013 Life + Project description.

While many action points are included specifically for public outreach, there is still no mention of improving awareness and visibility of pollards and their unique history within the park itself, where park user groups would be most efficiently accessed. We strongly recommend therefore that signage be increased within the park in addition to the other means of exposure. Secondly, there is an enormous quantity of pollarded individuals over a large area, estimated at 150,000 modified beeches, oaks and ashes over 800 ha. (I. Portu, personal communication January 15th 2010).

Table 1. Justifications of a Life Project on Beech Pollards

	Justification	Values
1	Habitat of vital importance for the conservation of biodiversity/ ecological role of individuals	Ecology
2	Habitat threatened with extinction in the short-medium term.	Ecology/ Conservation
3	Global Rarity- major concentrations of old beech pollards found only in Romania, England, Hungary and northern Spain	Global Rarity
4	Important part of the heritage and cultural legacy of the Basque Country, and Europe	Cultural Heritage/ Global Rarity
5	Limited timescale for action	Conservation
6	Better understanding of distribution and ecology of habitat needed to inform management decisions	Ecology/ Conservation
7	Important roles as connection habitats	Ecology
8	Importance of raising public awareness as to the historical, natural and cultural heritage represented by trees	Cultural Heritage/ Outreach and Education
9	Informing private land owners of the uniqueness	Global Rarity/ Cultural Heritage/ Outreach and Education
10	Preserving a native Western Europe heritage	Cultural Heritage
11	Only the Basque country still harbors living individuals with the traditional knowledge of management- valuable cultural legacy	Global Rarity/ Cultural Heritage
12	LIFE+ the most powerful instrument in carrying on the tradition of knowledge, management	Conservation
13	Lack of other conservation initiatives in this area	Conservation
14	Geographic importance of Basque Country as a connecting territory	Ecology (Landscape)

Source: I. Portu, personal communication, January 15th 2010).

According to the actions, only 162 ha have been ascribed a specific ecological or conservation purpose, leaving many more hectares of pollarded stands available for use in recreation or experimental treatments for managing senescing pollards. To have such a surplus of candidate trees available is a great resource and can progress scientific knowledge on the management of structurally unstable pollards while involving the public through engagement of local schools and universities. Finally, despite the wide range of social and biological values cited in our analysis of the project's actions and justifications, very few points actually combined values of social and biological nature for the purpose of management. The action that best embodied an integrative approach was the documentation and transfer of tree pollarding techniques to help sustain habitat features. In many ways, this action summarizes what we see to be the enormous potential of this project to link social and ecological values and research in a meaningful and transferable way. This point makes the direct link between traditional human intervention and habitat stability, both structural and compositional, as being not only mutually compatible, but worthy of further study, understanding and perpetuation through the transfer of such techniques to future generations.

Table 2. Proposed Actions of the 2010 Life+Pollard Project

	Action	Values
1	Protection of 12 ha of pollard forests to guarantee saproxylic habitat	Ecology
2	Improvement of habitat features on 150 ha of acidophilic beechwood in Gipuzkoa	Ecology
3	Increased knowledge on biodiversity values, management requirements of pollarded trees	Ecology
4	Public acquisition of areas hosting target species	Conservation
5	GIS mapping of priority habitats in project area	Conservation
6	Documenting and transfer of tree pollarding techniques to help sustain habitat features	Cultural Heritage/ Ecology/ Conservation
7	Elaboration and implementation of a long-term management strategy for pollarded trees in the project area	Conservation
8	Creation of a European network of forestry habitats with pollarded trees supporting saproxylic spp	Ecology/ Conservation
9	Cataloguing invertebrate species, preparing management plans	Ecology/ Conservation
10	Creation of a web, informative bulletins, press conferences, news in specialized publications	Outreach and Education
11	Talks, trainings and regional and international technical conferences	Outreach and Education
12	Digital cartography of pollarded copses, interest at appropriate management scale	Conservation
13	Training new generations of pollarders	Cultural Heritage/ Outreach and Education
14	Collection of traditional and modern pollarding techniques in a Good Practice Guide	Cultural Heritage/ Conservation/ Outreach and Education

Source: I. Portu, personal communication, January 15th 2010.

CONCLUSION

Efforts to protect the cultural landscape often overlook the natural components that make them unique. This is a loss for cultural preservation as well; as Aldo Leopold explains, “The rich diversity of the world’s cultures reflects a corresponding diversity in the wilds that gave them birth” (1949) (quoted in Alexander, 2008). The Basque Country is a region rich in cultural and natural resources, which are epitomized by the remaining pollard beech forests of

Aiako Harria. The year 2010 was declared by the UN to be the International Year of Biodiversity, and the year 2011 has followed as the UN International Year of Forests with the theme "Forests for People." The pollarded forests of Aiako Harria, along with the various case studies referenced in this paper, remind us of the long legacy forests have in serving the eclectic needs and values of people, and the reciprocal obligation that people hold to manage them wisely and sustainably. Though enjoyed and admired locally for many years, the ecological importance and global uniqueness of the pollarded trees of Aiako Harria are only beginning to come into focus. The forests they characterize are both for and by people; through versatile management, the same individual trees have remained relevant to the needs and values of changing societies for over two hundred years. Never before has public interest in the connections between sustainable resources use, biodiversity and culture been higher. Aiako Harria provides an ideal opportunity for furthering discussions and promoting management practices favorable to preserving biocultural diversity.

ACKNOWLEDGEMENT

The authors would like to acknowledge Tamara Muruetagoiena for her generous assistance and guidance throughout the project.

REFERENCES

Alexander, M. (2008). Management Planning for Nature Conservation: A Theoretical Basis and Practical Guide. The Netherlands: Springer Science +Business Media B.V.

Altuna, J. and Areso, P. (1977). Excavaciones en los cromlechs de Oyanleku (Oyarzun, Guipúzcoa). *Munibe*, 29, 75-76.

Aragon Ruano, A. (2001). El bosque guipuzcoanoen en la Edad Moderna: Aprovechamiento, ordenamiento legal y conflictividad. *Munibe*, Suplemento 14, 285pp. San Sebastián: Sociedad de Ciencias Aranzadi.Barandiarán, I. (1973). Irún romano. *Munibe*, 25, 19-28.

Basque Government 2006. Basque Country Network of Protected Natural Spaces: Aiako Harria.

Benito, A. M. (1988). Cerámicas del yacimiento submarino del cabo de Higer (Hondarribia), *Munibe*, 40, 123-163.

Barnard, A., Hartup, M. and Read, H. (2005). *Burnham Beeches Management Plan*. April 2005-March 2010 Full plan. City of London. Retrieved October 1st, 2009 from http://217.154.230.218/NR/rdonlyres/3560F960-F4D4-4F35-AE82-57B80D72816C/0/OS_BB_manageplan0510.pdf

Botey Serra, J. (2004). Finca de Fitor. The Conservation of Europe's Natural and Cultural Heritage through Estate Mangement by Family Forestry. Retrieved October 1st, 2009 from http://www.natura.org/natura2000management/doc/es_fitor_sitedescription.pdf

Butler, J. (2006). Ancient Pollards and Maidens - securing their future. Paper presented at the First European Colloquium on Pollards, Vendôme, October 26-28 2006. Retrieved October 10 2009 from http://www.maisonbotanique.com/dyn/17acte_8_butler.pdf

Carte, S. P. (2008). Inventario y seguimiento de la entomofauna del hayedo de Oieleku (Oiartzun, Parque Natural de Aiako Harria). *LIFE/Natura 2000 report*. Retrieved October 1st, 2009 from http://www.lifeaiakoharria.net/datos/documentos/insectos%20Oieleku2007.PDF

Christensen, M., Heilmann-Claussen, J., Walleyn, R. and Adamcik, S. (2004). Wood Inhabiting Fungi as Indicators of Nature Value in European Beech Forests. In M. Marchetti (Ed), *Monitoring and Indicators of Forest Biodiversity in Europe–From Ideas to Operationality*. (pp. 229-238). European Forest Institute Proceedings No. 51

Department of Environment and Regional Planning. Retrieved October 1st, 2009 from http://www.ingurumena.ejgv.euskadi.net/r49-4975/en/contenidos/informacion/enp/en_1086/aia_normativa_i.html

DuVal, A., Crane, P.R. (2011). World Heritage sites and the future of forests. World Heritage Review 61, 8-17.

Etayo, J. (2008). Estudio de los líquenes y hongos liquenícolas de Aiako-Harria. *LIFE/Natura 2000 report.* Retrieved October 1st, 2009 from http://www.lifeaiakoharria.net/datos/documentos/Estudio%20de%20los%20l%C3%ADquenes%20de%20AH_2008.pdf

European Commission. (2008). Commission Decision of 12 December 12 2008 adopting, in accordance with Directive 92/43/EEC, a second list of updated sites of Community importance for the Atlantic biogeographical region. *Official Journal of the European Union,* C (2008) 8119.

Fenley, J. (1950). Pollarding: Age-Old Practice Permits Grazing in Pays Basque Forests. *Journal of Range Management*, 3, 316-318.

Ferrini, F. (2006). Pollarding and its effects on tree physiology: a look to mature and senescent tree management in Italy. Paper presented at the First European Colloquium on Pollards, Vendôme, October 26-28 2006. Retrieved October 10 2009 from http://www.maisonbotanique.com/dyn/17acte_10_ferrini.pdf

Franklin, J., Shugart, H. and Harmon, M. (1987). Tree Death as an Ecological Process. *BioScience*, 37, 550-555.

Garcia-Ruiz, J. M., Lasanta, T., Ruiz-Flano, P., Ortigosa, L., White, S., Gonzalez, C., and Marti, C. (1996). Land-use changes and sustainable development in mountain areas: a case study in the Spanish Pyrenees. *Landscape Ecology*, 11, 267-277.

General Directorate for Woodlands and the Natural Environment. (2005). *LIFE-Nature Project 2005-2009: Conservation and Restoration of Aiako Harria SCI (LIFE05 NAT/E/000067).* Retrieved October 1st from http://www.lifeaiakoharria.net/datos/documentos/forest_portu.pdf.

Grove, S. (2002). Saproxylic Insect Ecology and the Sustainable Management of Forests. *Annual Review of Ecology and Systematics*, 33, 1-23.

Kenk, G. and Guehne, S. (2001). Management of transformation in central Europe. *Forest Ecology and Management*, 151, 107-119.

Kurlansky, M. (1999). The Basque History of the World: The Story of a Nation. New York: Penguin Books.

Loidi, J. (2005). The Cantabrian-Atlantic oak and beech forests: Human influence throughout history. *Botanika Chronika*, 18, 161-173.

Mallea-Olaetxe, J. (2000). *Speaking through the aspens: Basque tree carvings in California and Nevada.* University of Nevada Press, Reno and Las Vegas. 237 pp.

Marcucci, D. J. (2000). Landscape history as a planning tool. *Landscape and Urban Planning*, 49, 67-81.

Margerum, R. (1999). Integrated environmental management: the foundations for successful practice. *Environmental Management*, 24, 151-166.

Ódor, P. and Standovár, T. (2001). Richness of Bryophyte Vegetation in Near-Natural and Managed Beech Stands: The Effects of Management-Induced Differences in Dead Wood. *Ecological Bulletins*, 49, 219-229.

Onaindia M. and Mitxelena, A. (2009). Potential use of pine plantations to restore native forests in a highly fragmented river basin. *Annals of Forest Science*, 66, 305.

Peterken, G. F. (1977). General Management Principles for Nature Conservation in British Woodlands. *Forestry* Vol. 50 No. 1 197

Peterken, G. F. (1996). Natural Woodland: Ecology and Conservation in Northern Temperate Regions. Cambridge University Press, Great Britain

Petit, S. and Watkins, C. (2003). Pollarding Trees: Changing Attitudes to a Traditional Land Management Practice in Britain 1600–1900. *Rural History*, 14, 157-176.

Perreault, P. A. (2002). Culturally Modified Tree (CMT) Management in Niaka´pamux Territory: Shaping First Nations Participation through Consultation. Master of Science Thesis, The University of British Columbia, Vancouver, British Columbia.

Rackham, O. (1990). *Trees and Woodland in the British landscape*. Revised edition. J. M. Dent and Sons Ltd., London.

Read, H. J. and Frater, M. (1999). *Woodland Habitats*. Routledge, New York.

Read, H. J. (2004). A study of practical pollarding techniques in northern Europe: Report of a three month study tour, August to November 2003. Retrieved October 1st, 2009 from http://frontpage.woodland-trust.org.uk/ancient-tree-forum/atfinternational/images/1%20Front%20Acknowledgements%20and%20contents.pdf

Read, H. (2006, October). A brief review of pollards and pollarding in Europe. Paper presented at the First European Colloquium on Pollards, Vendôme, October 26-28 2006. Retrieved October 1st 2009 from http://www.maisonbotanique.com/dyn/12acte_2_read.pdf

Read, H. (2007). Pollarding Beech trees in the Basque Country: report of work carried out in February 2007. City of London, Leitza Town Council (Navarra) and Aiako Harria Natural Park (Gipuzkoa).

Read, H., Forbes, V., Young, J. (2007). Specialist survey of all old pollards at Burnham Beeches and Work Programme for 2007/8 to 2015/06. Retrieved October 1st, 2009 from http://www.pro-natura.net/Pollards-Burnham-Beeches.pdf

Rescia, A. J., Schmitz, M. F., Martin de Agar, P., De Pablo, C. L., and Pineda, F. D. (1997). A Fragmented Landscape in Northern Spain Analyzed at Different Spatial Scales: Implications for Management. *Journal of Vegetation Science*, 8, 343-352.

Rozas, V. (2003). Regeneration patterns, dendroecology, and forest-use history in an old-growth beech–oak lowland forest in Northern Spain. *Forest Ecology and Management* 182, 175-194.

Rozas, V. (2004). A dendroecological reconstruction of age structure and past management in an old-growth pollarded parkland in northern Spain. *Forest Ecology and Management* 195, 205-219.

Schmitz, M. F., Atauri, J. A., De Pablo, C. L., De Agar, P. M., Rescia, A. J., and Pineda, F. D. (1998). Changes in land use in Northern Spain: Effects of forestry management on soil conservation. *Forest Ecology and Management* 109, 137-150.

Segura, F. (2009). Hemos pedido ayuda a la UE para salvar las hayas trasmochas. Diario Vasco May 27, 2009.

Tubbs, C. R. (1964). Early Encoppicements in the New Forest. *Forestry.* 1964 37(1):95-105

UNESCO Man and the Biosphere Programme. Accessed December 2009 from http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme/

UNESCO World Heritage Convention. Accessed December 2009 from http://whc.unesco.org/en/list

UNESCO World Heritage Forest Programme. Accessed December 2009 from http://whc.unesco.org/en/forests

Whitney, G. and Adams, S. D. (1980). Man as a maker of new plant communities. *Journal of Applied Ecology* 17, 431-448.

Zackrisson, O., Östlund, L., Korhonen, O. and Bergman, I. (2000). The ancient use of *Pinus sylvestris* L. (Scots pine) inner bark by Sami people in northern Sweden, related to cultural and ecological factors. *Vegetation History and Archaeobotany* 9, 99-109.