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CONSERVATION ISSUES

Efficacy of Management Policies on Protection and Recovery of Natural Ecosystems in the Urdaibai Biosphere Reserve

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ABSTRACT: Knowledge of landscape patterns and dynamics is essential for land use planners and natural resources managers. They need to know how landscapes have changed in order to determine the consequences and efficacy of the management policies and implement future decision-making. This study characterized the landscape of the Urdaibai Biosphere Reserve, which has been affected by the introduction of exotic tree species since the beginning of the 20th century. We examined the dynamics of this landscape between 1991 and 2009 and the consequences of having been declared a UNESCO Biosphere Reserve in 1984. Most of the Urdaibai Biosphere Reserve potential vegetation (80%) is mixed-oak (*Quercus robur* L.) forest, but, currently, this forest is found in only 6.5% of the area. Most of the current vegetation (54%) comprises *Pinus radiata* and *Eucalyptus* sp. plantations. Over the period studied, land use had changed in only 11.8% of the area. Nearly 30% of the change was the replacement of traditional grasslands, crops, and heathlands by *P. radiata* and *Eucalyptus* sp. plantations. However, 22% of the change had reflected a recovery of the native vegetation, namely mixed-oak and Cantabrian evergreen-oak (*Quercus ilex* subsp. *Ilex*) forest, coastal sandy areas, or broad-leaf plantations. This recovery of the native vegetation has countered the tendency towards landscape degradation observed since 1957. Thus, despite the small change described, the first effects of conservation and environmental recovery policies can be detected. Nevertheless, there remains much to be done for recovering the natural ecosystem; the most difficult obstacles include the fact that most of the land is privately owned and an existence of the administrative complexity gives rise to problems that exist between different Administrations.

Index terms: conservation policies, landscape pattern, land use changes, northern Spain

INTRODUCTION

Landscape change is an important theme in landscape ecology (Bürgi et al. 2004; Bolliger et al. 2007; Leyk and Zimmermann 2007; Van Doorn and Bakker 2007). The landscape is a dynamic system; it integrates the effects of all natural processes and human interventions, and it accommodates and changes in response to them. Some changes occur very rapidly, and the natural environment does not have time to adapt; thus, it sustains significant impact (Alados et al. 2004). This reduces ecological capacity, diversity, and scenic beauty, and has, in the past, damaged cultural landscapes that were considered highly valuable (Bastian et al. 2006).

Proper landscape management and conservation must, therefore, consider the relationships between landscape patterns and the processes that caused them (Alados et al. 2004; Domon and Bouchard 2007). Understanding landscape structure is a prerequisite for determining the state of the landscape and for identifying the processes that have given rise to that state (Wascher 2003). Knowledge of those processes and the extent of the changes is necessary to design proper strategies for management and restoration (Bender et al. 2005; Grant and Murphy 2005; Plieninger 2006).

In past centuries, the Urdaibai landscape followed a traditional agro-silviculture-grazing model, in which the role of the farm was very important as a self-sufficient entity. This resulted in a wide variety of crops and resources that ensured high landscape diversity (Atauri 1995). In the 1950s, industrialization in the area initiated a crisis in the rural world. The immediate consequence of this crisis was a rural exodus, with consequent farm abandonment, and the spread of fast-turnover forest plantations (Groóme 1990). The returns from the first harvests of timber, together with the policy of subsidizing forest plantations, motivated the landowners to devote their land holdings to tree plantations as the landowners went to work in industry. This gave rise to an enormous expansion of monocultures of *P. radiata* and *Eucalyptus* sp. in the area. These monoculture plantations of fast growing evergreen species, together with the type of management applied, gave rise to environmental problems, including soil loss and compaction (Merino and Edeso 1999; Merino et al. 2004), nutrient loss (Merino et al. 2004), and surface water turbidity caused by increased surface runoff. Although a large part of Urdaibai was covered by *P. radiata* plantations by the 1980s, the remainder of the area was covered by a diverse, pleasant landscape that included villages, traditional farmhouses surrounded by grasslands and crops, and urban nuclei. In those areas, various natural systems of extraordinary importance flourished with acceptable levels of conservation. In 1984, the International Panel for Coordination of the MAB Program of UNESCO decided to include this region in the International Biosphere Reserve Network with the aim of protecting its integrity. The reserve included the zones of *P. radiata* and *Eucalyptus* sp. plantations; because these zones were situated in the high areas of water catchment, and their management could have a large effect on the lower zones that were considered valuable. Including these tree plantation zones in the reserve made it possible to establish some limitations in their management, with the aim of minimizing the potential negative effects they might have on the areas of interest.

In 1989, the Basque Government established a special legislation for the Urdaibai Biosphere Reserve (UBR). This legislation established the zoning of the UBR, determined authorized and prohibited uses in the different zones, and regulated urban development. The aim of this legislation was to minimize the risks of environmental deterioration, due to the current techniques of exploiting *P. radiata* and *Eucalyptus* sp. plantations. It also aimed to protect the integrity and promote the recovery of the natural ecosystems, in terms of natural, scientific, educational, cultural, recreational, and socio-economic interest. Currently, after two decades of this legislation, land use planners and natural resources managers need to know how landscapes have changed in order to determine the consequences and efficacy of the measures taken and to inform those who will be involved in future decision-making (Ward et al. 2007).

This study provides a categorization of the current landscape (2009) of the UBR and an evaluation of its dynamics between 1991 and 2009. The principal aims were: (1) to determine the current state of the UBR landscape and identify potential problems; (2) to examine changes in landscape patterns from 1991 to 2009 as a starting point for a continuing analysis of landscape dynamics; (3) to analyze the efficacy of the established legislation in the conservation and recovery of the natural environment; and, finally (4) to identify management actions that might accelerate restoration and promote the development of a sustainable economy for the inhabitants.

METHODS

Study area

The study was undertaken in the UBR of the northern Iberian Peninsula (43º19´N, 2º40´W) (Figure 1). The UBR is bordered by the Oka River water catchment in Bizkaia and occupies an area of 220 km^2 with approximately 45,000 inhabitants. Economic activity is essentially based on metallurgy, ocean fishing, and development of local natural resources, particularly farming, grazing, and forestry.

The UBR's climate is temperate and humid, regulated by the Cantabrian Sea, which ensures uniformity in atmospheric variables. The principal characteristics of this climate are its slight thermal oscillations (average temperature 12.5 ºC), uniform rainfall distribution throughout the year (average annual rainfall 1200 mm), and relative lack of frost.

The UBR is a diverse, pleasant landscape with villages, traditional farmhouses, and urban nuclei where a wide spectrum of flora and fauna can be observed. Within the wide range of ecosystems, various natural systems of extraordinary importance are present with acceptable levels of conservation. Outstanding areas include the estuarine or maritime system that was declared the Ramsar zone in 1992, the karstic system that supports extensive Cantabrian evergreen-oak forests (*Quercus ilex* subsp. *Ilex*), and a coastline with beaches and cliffs. These three zones were declared Sites of Community Interest in the Natura 2000 Network, and the UBR was designated a Special Protection Area under the EU Birds Directive in 1994. Apart from the coastal zones and the karst outcrops, the greater part of the reserve has a potential vegetation of mixed-oak forest (GESPLAN 2002). This forest is dominated by *Quercus robur* L., but also supports *Fraxinus excelsior* L. and *Castanea sativa* L. (Onaindia et al. 2004). During the 19th and 20th centuries, this forest was fragmented, and it currently occupies a small proportion of its potential area (Rodríguez-Loinaz et al. 2007). It

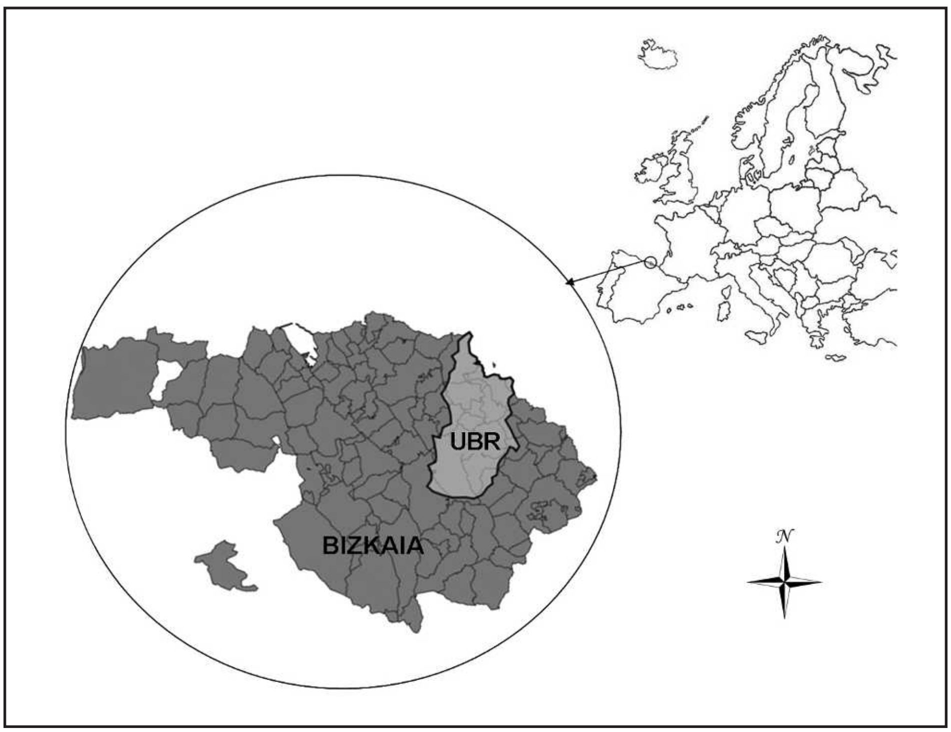

Figure 1: Location of the study area.

has been replaced by forest plantations of *Pinus radiata* and *Eucalyptus* sp. and by grasslands and crops.

Zoning and regulation of the UBR

The inclusion of Urdaibai in the International Biosphere Reserve Network was based on the recognition of a geographically singular enclave and the recommendation of protecting and preserving it. However, this did not imply the establishment of zoning or any concrete obligations for the administration or citizens. Those were imposed later, when a special legislation was established for the UBR.

The UBR has its own management plans. First, there is the "Urdaibai Protection and Regulation Law" (UPRL), which was approved in 1989. Its objective was the establishment of special legislation for the UBR to protect the integrity and promote recovery of all its ecosystems in terms of their natural, scientific, educational, cultural, recreational, and socio-economic interests. Second, the legislation objectives are developed by the Governance Plan for Use and Management (GPUM), which was approved in 1993. These two plans established UBR zones (Figure 2), designated authorized and prohibited uses in those zones, and generated urban development regulations.

In the special protection and protection zones, the principal aim is the conservation and regeneration of the natural forest and, thus, very few activities are allowed. In the forest and agrarian interest zones, a large number of uses, activities, and even new constructions are allowed. However, these zones have limitations in the use of herbicides, pesticides, and fertilizers, which are allowed only when they do not endanger the soil and water resources.

The development of the GPUM objectives has been very limited. Only one document with conservation objectives has been approved – the "Territorial Action Plan (TAP) for Cantabrian evergreen-oak forests and their protected zones." Other territorial action plans have been formulated, but have not yet been approved, including: the "TAP for the estuary special protection area" and the "TAP for the stream-banks protection area." Currently, the GPUM is being revised.

Source for the GIS database

In this study, a GIS database was produced to examine the composition, the spatial pattern, and the dynamics of the UBR landscape. For this purpose, maps of land use in 1991 and 2009 were generated from orthophotos at a scale of 1:10,000, provided by the cartography service of the County Council of Bizkaia. These maps were elaborated by manual digitalization and automatic scanning of the orthophotos, and were prepared and saved in GIS in vector format with the ARC/INFO program. In cases where the land use type was not clear, field visits were conducted to investigate the area concerned.

A total of 16 land uses were identified according to the classifications used in the environmental cartography system of the Autonomous Region of the Basque Country (GESPLAN 2002). These included (1) birch (*Betula* sp.), (2) coastal sands, (3) heath-gorse-ferns (heathlands), (4) reed beds, (5) coastal cliffs, (6) grasslands and crops, (7) Cantabrian evergreen-oak forest, (8) scrub, (9) broad-leaf plantations, (10) *P. radiata* and *Eucalyptus* sp. plantations, (11) riparian forests, (12) mixed-oak forest, (13) vegetation on exposed limestone, (14) population nuclei, (15) zones without vegetation, and (16) marshland vegetation.

The landscape changes were identified by overlaying the two maps and determining the zones that had experienced land use change and the direction of that change.

Landscape characterization

Once the database was created, the next step was to characterize the landscape in both years by calculating landscape indices at three levels: (1) patch, (2) land use, and (3) landscape. With the vLATE program (Lang and Tiede 2003), the following indices were calculated at the patch level: area (A), perimeter (P), and distance of a patch to the nearest patch of the same land use (NND).

Based on the indices at the patch level, the indices at the land use level were calculated with the formulation proposed in the FRAGSTATS program (Mc Garigal et al. 2002). For each land use type, the following indices were calculated: the number of patches (NP), total area (CA), average patch size (MPS), and average distance to the nearest patch of the same land use (MNND). The indices of dispersion (R) (Forman 1995) and fragmentation (F) (Gurutxaga 2003) were also calculated. The fragmentation index was calculated as follows:

$F = CA / (NP \times R)$

This index is inversely proportional to the degree of fragmentation. Thus, an increment in the F value is related to a reduction in the degree of fragmentation, and vice versa.

For the landscape as a whole, the calculated indices were: number of patches (NPL), average patch size (MPSL), richness (PR), and the Simpson indices of diversity (SIDI) and equitability (SIEI).

RESULTS

The UBR landscape structure after two decades of protection

In 2009, the total UBR area was 21,941 ha: 54% (11,853 ha) was covered by forest plantations of *P. radiata* and *Eucalyptus* sp.; 21.6% (4748 ha) by grasslands and crops; and 14.4% by other forest formations (Figure 3; Table 1). It should be noted that the mixed-oak forest, although the potential vegetation of a majority (80%) of the study area, was only present in 6.5% of the total area (1421 ha; Table 1). However, the number of patches showed that the mixed-oak forest was the most frequent land use type, with a total of 562 (35%) patches, though most were small in size (area < 2 ha). Mixed-oak was also the most fragmented habitat (F=1.12; Table 1). The next most frequent land use types were forest plantations of *P. radiata* and *Eucalyptus* sp. and grasslands and crops; each comprised nearly 17% of all patches.

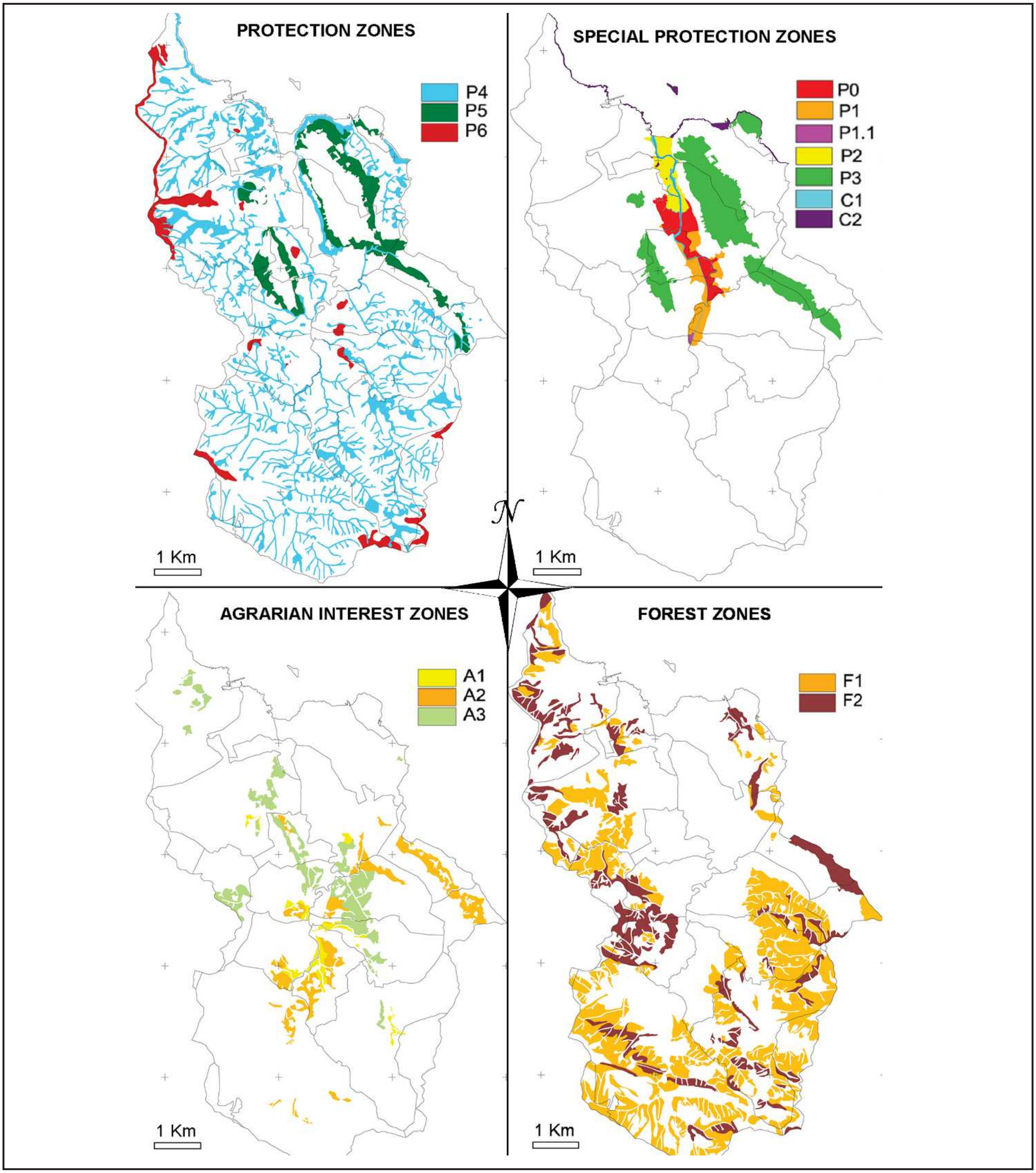

Figure 2: Zoning of the Urdaibai Biosphere Reserve established by the Governance Plan for Use and Management. P0, P1, P1.1, P2, C1: Special protection zones of the estuary. C2: Special protection zones of the coastline. P3: Special protection zones of the Cantabrian evergreen-oak forests. P4: Protection zones of the margins of streams and coastline. P5: Protection zones of the Cantabrian evergreen-oak forests. P6: Landscape protection zones. A1: Agrarian zones in fertile plains. A2: Agrarian zones in aquifer recharge zones. A3: Agrarian zones without specific limitations for the aquifer recharge. F1: Forest zones with high risk of erosion. F2: Forest zones with moderate risk of erosion.

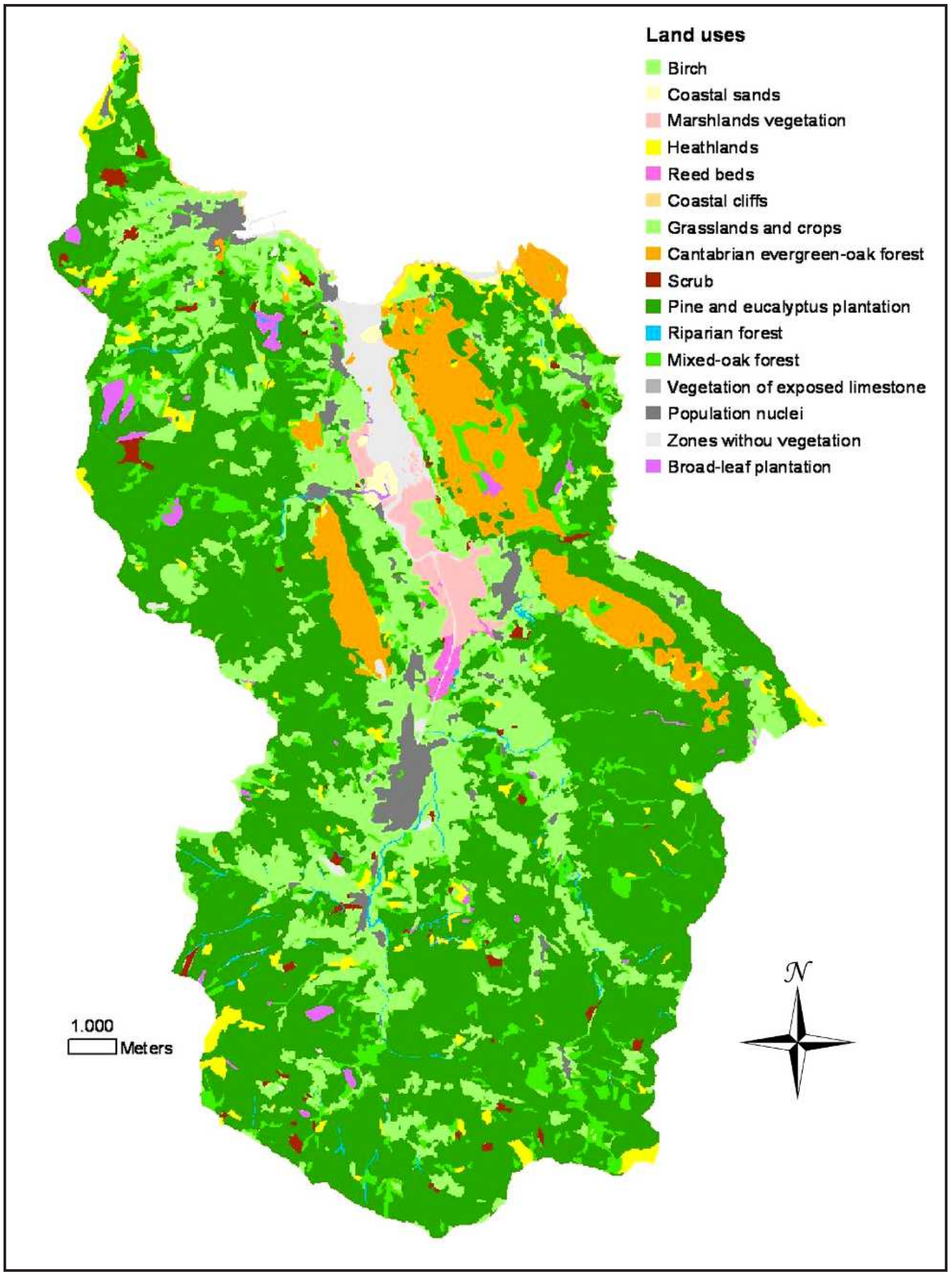

Figure 3: Map of land uses for the Urdaibai Biosphere Reserve in 2009.

The average patch size at the landscape level (MPSL) was 13.64 ha (Table 2). However, this parameter showed a very high standard deviation (41 ha), because some land use patches were of a considerable size, like the *P. radiata* and *Eucalyptus* sp. plantations (MPS: 45.1 ha) and the Cantabrian evergreen-oak forest (MPS: 52.6 ha); in contrast, other land uses formed very small patches, like the riparian forests (MPS: 1.9 ha) and the vegetation on exposed limestone (MPS: 0.6 ha).

The distribution of patch sizes, considering the landscape as a whole, showed a predominance of small-sized patches. Most (61%) of the landscape patches were smaller than 2 ha and only 9.4% were larger than 10 ha.

Changes in the landscape of the UBR between 1991 and 2009

The landscape structure of the Urdaibai Biosphere Reserve did not show significant changes in the time frame studied. Of the 21,941 ha of the reserve, only 2596 ha (11.8%) showed detectable land use changes. Of these 2596 ha, 950 ha were new plantations of *P. radiata* and *Eucalyptus* sp. that mostly replaced grasslands and crops (479 ha) and heathlands (241 ha). Conversely, 365 ha of the 2596 ha were new grasslands and crops that mostly (259 ha) replaced plantations of *P. radiata* and *Eucalyptus* sp., and 322 ha of the 2596 were new heathlands that mostly (272 ha) replaced plantations of *P. radiata* and *Eucalyptus* sp. (Figure 4).

The small changes in the landscape were reflected in small variations in the landscape indices (Table 2). There was an increase in the number of patches (289) in the time period studied. The majority of these patches were small in size. In fact, the MPS dropped from 16.38 to 13.64 ha. The landscape diversity indices (SIDI, SIEI) were virtually unaffected by the small changes.

Of the 16 land uses, 10 showed changes in patch number (Table 3). Among these, seven (heathlands, grassland and crops, scrub, broad-leaf plantations, mixed-oak forest, population nuclei, and zones without vegetation) underwent greater than 10% variation. The number of population nuclei had fallen (16.7%), and the number of patches of heathlands, grassland and crops, scrub, broad-leaf plantations, mixed-oak forest, and zones without vegetation had increased (148%, 13.6%, 16.4%, 510%, 26.9%, and 116%, respectively).

The majority of changes caused only small increments or reductions in the area occupied by the different land uses. Only three (broad-leaf plantation, mixed-oak forest, and population nuclei) underwent increments greater than 10% (90.7%, 17.9%, and 27.4%, respectively).

Finally, only three of the land uses (heathlands, broad-leaf plantations, and zones without vegetation) underwent significant increments in the degree of fragmentation (Table 3).

Table 1. Landscape indices for the 16 land use types in the Urdaibai Biosphere Reserve in 2009. CA= total area, %CA= % of the total area, NP= number of patches, F= fragmentation index, MPS= average patch size, MNND= average distance to the nearest patch of the same land use, R= patch dispersion. The most meaningful values are shown in bold type.

LAND USE	CA (ha)	%CA	NP	F	MPS (ha)	MNND (m)	R
Birch	8.5	0.04	4	10.6	2.1	1,739	0.20
Coastal sands	60.6	0.28	5	87.6	12.1	953	0.14
Heathlands	514.4	2.34	124	2.9	4.15	400	1.44
Reed beds	56.8	0.26	6	434.9	9.5	125	0.02
Coastal cliffs	65.8	0.30	7	128.5	9.4	360	0.07
Grasslands and crops	4,748	**21.6**	**276**	18.7	17.2	114.6	0.92
Cantabrian evergreen-oak forests	1,419	6.46	27	143.4	**52.6**	467.8	0.37
Scrub	180.2	0.82	64	2.1	2.8	724.5	1.35
Broad-leaf plantations	181.4	0.82	51	3.9	3.6	610.9	0.90
P. radiata y *Eucalyptus* sp. plantations	11,853	**54**	**263**	72.7	**45.1**	81.2	0.62
Riparian forests	111.6	0.52	52	3.4	**1.9**	412	0.62
Mixed-oak forests	1,421	**6.5**	**562**	**1.1**	2.5	138.5	2.26
Vegetation of exposed limestone	1.1	0.01	2	27.8	**0.6**	341	0.02
Population nuclei	558.3	2.54	55	13.7	10.1	462.6	0.74
Zones without vegetation	432	1.97	26	23.8	16.6	923.8	0.7
Marshland vegetation	324.4	1.48	62	324.4	5.2	65	0.04

DISCUSSION

UBR landscape structure

The landscape of the UBR is characterized by the presence of forest; around 70% of its area is forested. This is a much higher percentage than other temperate agricultural landscapes, both along the Cantabrian coast (Garcia et al. 2005) and in other parts world wide (Pan et al. 2001), where the average coverage is less than 30%. This fact can be explained by the changes in land use that have occurred over the past decades. Due to the crisis in traditional agriculture, a large change in the UBR landscape took place between 1957 and 1987. This led to the result, in 1987, of pine plantations that occupied over 50% of the reserve's total area (Atauri 1995). In that period, the area covered by pine plantations increased from 4500 ha to 11,000 ha. Conversely, the area covered by grasslands and crops decreased from 13,500 ha to 6000 ha and that of natural forests decreased from 3500 ha to 2500 ha (Atauri 1995). Currently, 54% of the UBR area is covered by *P. radiata* and *Eucalyptus* sp. plantations. This fact appears to contrast with the idea of a biosphere reserve, where the aim is the conservation and sustainable development of the natural environment. But, as explained previously, the zones with predominantly *P. radiata* and *Eucalyptus* sp. plantations were included in the reserve because their management can have a large effect on the zones of great value. Therefore, including these zones in the reserve facilitated the establishment of limitations in the management practices, etc., of these zones, with the aim of minimizing the potential negative effects that they might have on the areas of interest.

The expansion of plantations of fast growing species (mainly *P. radiata* and *Eucalyptus* sp.) has had a significant effect on the semi-natural forest that had previously been substituted by grasslands and crops in a large part of the territory. Thus, the mixed-oak forest, which is the potential vegetation of 80% of the reserve (GESPLAN 2002), has come to occupy only 6.5% of the total area, as has hap-

Table 2. Landscape level indices for the Urdaibai Biosphere Reserve in 1991 and 2009. TA= total area, NPL= number of patches, MPSL= average patch size, SIDI= Simpson's diversity index, PR= richness, SIEI= Simpson's equitability index.

YEAR	TA (ha)	NPL	MPSL (ha)	SIDI	PR	SIEI
1991	21,941.43	1,319	16.38	0.64	16	0.68
2009	21,941.43	1,608	13.64	0.65	16	0.69

Table 3. Number of patches (NP), total area (CA), and index of fragmentation (F) for the 16 land use types in the Urdaibai Biosphere Reserve in 1991 and 2009.

LAND USE	NP		CA (ha)		F	
	1991	2009	1991	2009	1991	2009
Birch	4	4	9.6	8.5	12.2	10.6
Coastal sands	5	5	55.4	60.6	78.2	87.6
Heathlands	50	124	554.1	514.4	16.1	2.9
Reed beds	6	6	58.1	56.8	443.8	434.9
Coastal cliffs	6	7	65.8	65.8	121.8	128.5
Grasslands and crops	243	276	5,159	4,748	28.7	18.7
Cantabrian evergreen-oak forests	26	27	1,376	1,419	144.9	143.4
Scrub	55	64	192.7	180.2	2.5	2.1
Broad-leaf plantations	10	51	95.1	181.4	84.2	3.9
P. radiata y *Eucalyptus* sp plantations	279	263	11,904	11,853	70.5	72.7
Riparian forests	50	52	108.4	111.6	3.3	3.4
Mixed-oak forests	443	562	1,205	1,421	1.2	1.1
Vegetation of exposed limestone	2	2	1.1	1.1	27.8	27.8
Population nuclei	66	55	438.2	558.3	8.1	13.7
Zones without vegetation	12	26	407.9	432	72.8	23.8
Marshlands vegetation	62	62	318.9	324.4	324.4	324.4

pened with other oak woodlands in other parts of the world (McCreary 2004). In this region, the mixed-oak forest has been replaced in the valleys by grasslands and crops, and on mountain slopes by the forest plantations. As a result, the mixed-oak forest is very fragmented. In contrast, the Cantabrian evergreen-oak forests have been preserved in large patches, because they are the potential vegetation of the karstic outcrops that form great, semi-bare, rocky patches (GESPLAN 2002). These areas are not suitable for the establishment of *P. radiata* plantations due to the very stony, poorly structured soil. In its natural habitat, *P. radiata* requires at least 35 cm of soil for establishment, and it requires more than 90 cm to reach 30 m in height (Gandullo et al. 1974).

The riparian forest is another semi-natural forest that has been seriously affected by land use changes. Despite the ecological importance of this forest (stabilization of the banks, ecological corridors, etc.) (Ferreira et al. 2005), the vast majority has been eliminated by urban areas, grasslands and crops, and forest plantations, where these systems grow to the very edges of the watercourses.

Effect of conservation law

The results of this study showed a small change in the UBR landscape over the study period (11.8% of the area; i.e., 2596 ha). The changes mainly included new *P. radiata* and *Eucalyptus* sp. plantations. Thus, the series of guidelines included in the GPUM of the UBR have not been very effective. They aimed to set baselines for minimizing the risks of environmental deterioration posed by these plantations and for promoting the recovery of natural ecosystems. The fulfilment of the guidelines would limit these plantations to about 6000 ha, mainly in forest zones. There are different reasons for the lack of efficacy. First, the application of guidelines has been difficult, mainly because the majority of the reserve (94%-95%) is privately owned, and the average property area is only 5 ha. Thus, there are approximately 4000 plantations; a third range between 2 ha and 5 ha, and only 70 are larger than 70 ha (Cantero and Garcia 2000). Second, there are administrative problems. The GPUM establishes some guidelines, but the TAPs must establish the definitive regulations. To date, only one of those plans has been approved. Furthermore, there is a lack of communication between the different policymakers. Since a change in Urdaibai's GPUM is approved, it must be immediately fulfilled, but incorporating that change into the local urban development plans may take months or years. The municipalities are based on these local plans to issue licenses and enforce regulations. Finally, Urdaibai is characterized by its administrative complexity. The different Administrations are based on different sector-specific plans that may overlap, fall outside, or even contradict the UPRL and the GPUM. The UPRL prescribes the need for information exchange, collaboration, coordination, and respect between the different Administrations; however, these prescriptions have not always been fulfilled. In some cases, issues between the legislation of the reserve (UPRL and GPUM) and the sectorial legislations (laws of coasts, waters, environment, roads, soil,

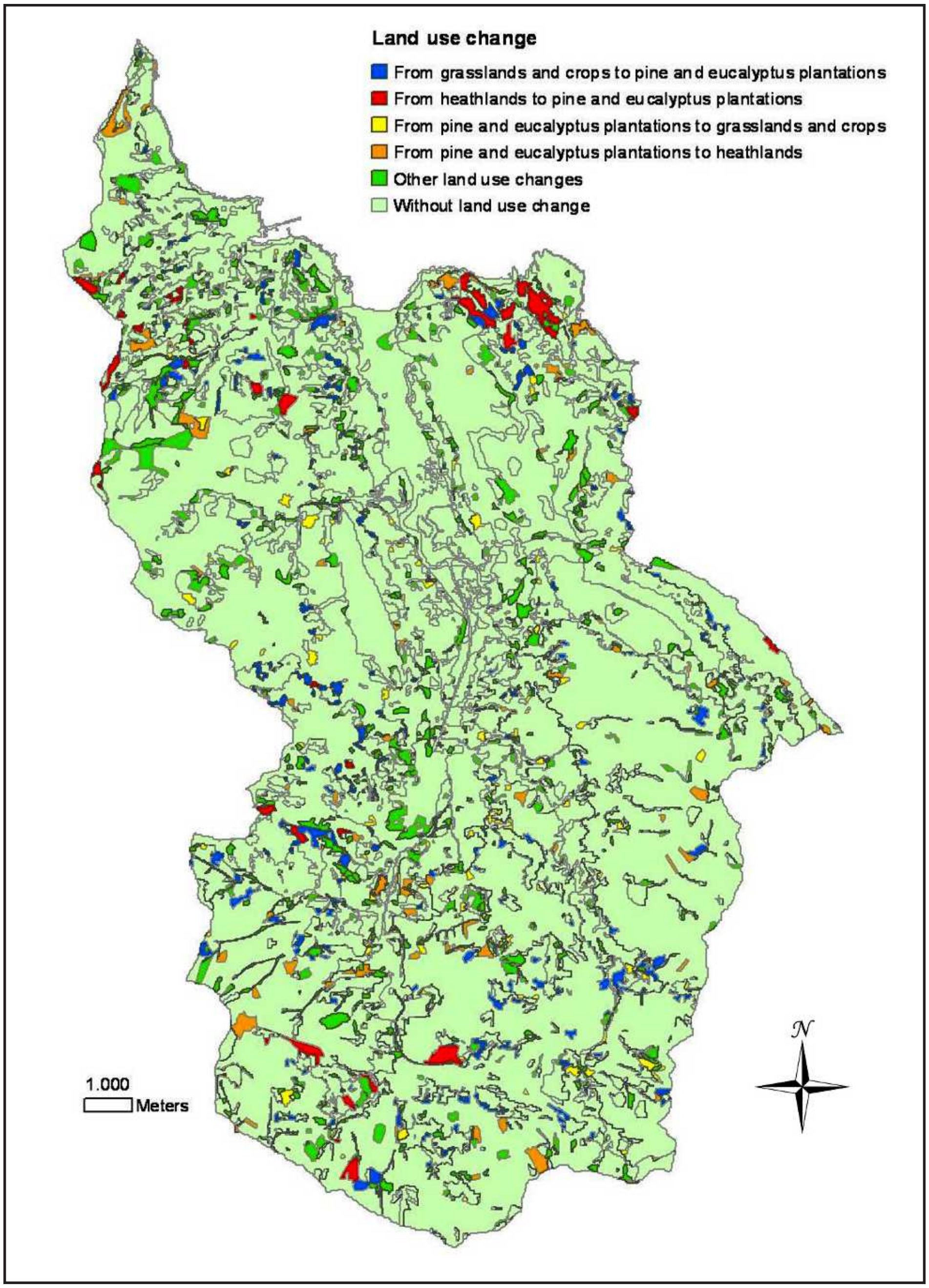

Figure 4: Changes in land use in the Urdaibai Biosphere Reserve between 1991 and 2009.

land management, evaluation of environmental impact, etc.) have not been resolved in favor of the former.

Although the measures taken do not seem to have been very effective, it is possible to appreciate the first signs, though quantitatively insignificant, of changes due to the policies for conservation and recovery of the natural environment. Among the changes detected, the most noteworthy is the positive evolution in the Cantabrian evergreen-oak forest cover. This forest sustained continued retreat until 1990, due to replacement by pines, a phenomenon that was accelerated in the 1980s (Atuari 1995). The Cantabrian evergreen-oak forest, located over the karstic outcrops, is one of the most highly valued natural ecosystems of the Reserve. Thus, the Protection and Regulation Law of the UBR classified the ensemble of five areas that comprised this natural system as areas of special protection. Later, the approval of the GPUM for Urdaibai supported these areas of special value with some peripheral protection zones to ensure the preservation and conservation of the environmental resources present in those areas. As a final step, an integrated overall TAP was developed for these forests and their protection zones. The aim was to create an active management plan of the area, based on deep knowledge of its bio-physical and social realities, which would conserve the area and help it recover. In the period studied, the retreat of this forest did not continue; furthermore, there was even an increment in its area. Thus, this trend of change can be recognized as the beginnings of positive effects brought about by the applied protection measures.

The coastal sands is another zone of special protection established by the GPUM that increased in area. This increment was mainly in Laida Beach, where a dune regeneration project was started in 1999 by the Urdaibai Biosphere Reserve Board. The Laida dunes existed until the 1950s, when they disappeared as the result of a huge ocean storm. In recent decades, this region has been subjected to massive human influences (dredging the river, pressure of swimmers, dike construction, and other civil works in the estuary) that have prevented natural processes from restoring the area to its original state.

The increase in broad-leaf plantations is also a positive trend, due to the ecological benefits they provide, in contrast to the plantations of fast-growing species. These plantations contribute to soil stabilization, the development of wildlife communities, and an increase in biological and landscape diversity (Basque Government 1993). This type of plantation has been recommended for all forestlands that have a high erosion risk; nevertheless, until recently their proliferation has been limited. They are mainly concentrated in public lands, because the subsidies provided are insufficient to develop these plantations, and, therefore, they represent a cost to the landowner.

The increase in the population nuclei of the reserve has been lower than that for the Autonomous Region of the Basque Country as a whole. The area of population nuclei in the reserve was increased by 27.4% in 2009 and in the Autonomous Region by 32% in 2005 (IKT 1995, 2005). This could be due to the limitations on new construction that the GPUM established. The creation of new population nuclei is forbidden and the existing ones can increase up to 40% only. The growth was concentrated principally around Gernika, the main urban nucleus of the Reserve. The concentrated growth in Gernika could be explained by the tendency in recent years of the active population to establish homes in well-connected areas where an active housing policy had been implemented (Murua et al. 2001).

Finally, two important natural systems, the riparian and mixed-oak forests, did not show any effects from the measures taken. The riparian forest has not shown any recovery, despite the ecological importance of this type of formation. The margins of streams were included as protected areas in the GPUM of the UBR. These areas consist of a 25-m wide strip of land running the length of the watercourse. The aim was to regenerate the natural forest (art. 93 of the GPUM). The main impediment to change in these areas was that the continuation of agricultural and grazing activities (like forest plantations, grasslands and crops, which were in place when the GPUM came into effect in 1993) is permitted (art. 118 of the GPUM). These activities are still permitted because the TAP for these zones has not been approved. As for the mixed-oak forest, the majority of new patches did not emerge due to the new measures. Most of the new patches were small, elongated areas on the edges of forest plantations. In the 1991 orthophotos, these sites were either identified as scrublands (20% of the new mixed-oak forest area) or were joined to *P. radiata* plantations (55% of the new mixed-oak forest area). By 2009, due to the growth of the trees, they could be seen clearly; therefore, the increment was due to natural succession, rather than the conservation measures.

In conclusion, despite the small changes in the UBR landscape structure in the period studied, it is possible to appreciate the first effects, although quantitatively insignificant, of implementing policies for conservation and recovery of the natural environment. There remains much to be done; the pine and eucalyptus plantations continue to thrive in all zones of water catchment – in special protection zones and in agrarian and protection zones. The work that lies ahead will be difficult, because 95% of the Reserve is privately owned. In addition, some administrative complexities may contribute to the difficulties.

Future management guidelines

Apart from solving the administrative problems mentioned above, proper territory management should include and implement some incentives for the conservation, recovery, and regeneration of the natural vegetation as observed in other locations (Higgins et al. 2007; Ernst and Wallace 2008). At present, new forms of management are being analyzed, namely the custody of the territory and the payment for environmental services. An agreement of custody of the territory is a voluntary procedure in which an owner and an entity of custody agree on the methods for preserving and managing a territory. The mechanisms for taking custody of the territory can vary from implementing awareness actions and education activities to voluntary agreements for managing the properties. These agreements can involve different levels of commitment, and they can imply different legal requirements. For example, they may involve a transfer of property management, the acquisition of legal rights, or the purchase of the property by the entity of custody. To date, only one non-profit-non-government organization, the Lurgaia Foundation, has carried out some actions for custody of the territory in Urdaibai; but, due to its limited resources, it only covers 16 ha, distributed among eight zones, where projects are being conducted to recover the riparian and mixed-oak forests.

In addition to the conservation of natural ecosystems, it is important to keep in mind that Urdaibai supports approximately 45,000 inhabitants that demand economic development. Thus, the Strategy of Sustainable Development of the UBR 2009-2012 has been developed. This strategy aims for sustainable tourism and ecological agriculture. In this sector, some transformations of relevancy are currently taking place. For example, the area dedicated to ecological agriculture has tripled between 2004 and 2006. In addition, the viability of implanting a brand image of quality tied to the UBR is being studied. Finally, methods are under consideration for stimulating the fishing sector.

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