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The restoration of El Partido stream watershed (Doñana Natural Park) A multiscale, interdisciplinary approach

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ABSTRACT

1800 ha of El Partido stream watershed, SW Spain, have been purchased by the Spanish Ministry of Environment to enlarge Doñana National Park. Prior to incorporation, a functional restoration will be carried out. El Partido stream is building a depositional sandy delta on Doñana Marsh (now ca. 400 ha) with little or no vegetation.

Restoration Project envisages:

- Building a hydraulic scheme favoring sand deposition upriver avoiding its transfer to the Marsh.
- Restoring natural ecosystems previously existing in the area.

The restoration project was divided into phases. First phase (342 ha) was based on self-organization of plant communities (self-design) during succession. Existing remnants of woody vegetation covering about 7.66 ha (2.2%) will be restored, adding about a three-fold surface (26.8 ha, 7.8%) of new plantations. Also, 545 new vegetation patches, initially covering 20.53 ha (about 6% of the area) will be planted, following composition and structure of the natural shrubbery. Each patch combines 5–10 perennial species: a core of a few trees, an inner area with some fruit–bearing scrub and the outer fringe with flower–bearing scrub. River banks will also be vegetated.

Patch vegetation will attract insects and vertebrates (mostly birds), the latter eventually performing as dispersers of seeds, thus expanding the shrubbery. Finally, the restored area will provide the menaced Imperial eagle and Iberian lynx an appropriate hunting ground.

1. Introduction

Riparian systems are among the richest biodiversity systems of the biosphere. At the same time, they rank among the most transformed and often the most degraded ecological systems throughout the world (Petts, 1994). Their restoration is one of the key processes to combat the present trend of biodiversity loss on the European scene (EASAC, 2005).

Doñana National and Natural Parks (SW Spain) represent the main protected area in the country (1079 km^2) with an almost completely vertebrate fauna. Doñana includes a large wetland (La Marisma, 25,000 ha), wide dune fields with active

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wandering dunes and inland fixed dunes with depressions where aquifer upwelling feeds temporary ponds.

Doñana has been declared a Ramsar site, UNESCO MAB Biosphere Reserve, World Heritage Site, and Natura 2000 site. The core area is protected as a National Park (54,252 ha) surrounded by the Natural Park. Descriptions of the parks may be found in Duque (1977), García Novo (1997), García Novo and Marín Cabrera (2006).

The Doñana area originated from the evolution of the Guadalquivir River estuary that opened on the Gulf of Cadiz in the Atlantic Ocean. Inland sand transport produced sand mantles with rolling morphology in alternating episodes of dune activity. At present, active dune fields are limited to the coastal strip, and sand substrates with old dune morphology dominate landscapes to the W and N. Sandy formations are the recharge area of the regional aquifer 27: Almonte-Marismas. Water availability plays a key role in Doñana ecosystems both on the continental marshes and the sand mantles where aquifer discharges support a wide collection of aquatic habitats.

The Spanish Ministry of the Environment launched the Doñana 2005 Project in 1998 with the final goal to restore the Park's hydrology (Saura Martínez et al., 2001) as a basis for conservation. It comprises six key interventions addressing specific problems: controlling aquifer overexploitation, building the sewage treatment plant of El Rocío village, reshaping drainage channels entering the Park, recovering degraded areas and purchasing abandoned agricultural lands to restore them, and providing menaced Imperial eagle and Iberian lynx populations with a suitable hunting ground.

The hydraulic modification of El Partido stream to abate transport of sediments into the Marsh, along with the ecological restoration of its watershed, is the most complex intervention of the Doñana 2005 Project. It has been undertaken by watershed authority (Confederación Hidrográfica del Guadalquivir) belonging to the Spanish Ministry of Environment, with an estimated budget of M€7.85. Preliminary surveys and experimental studies in permanent plots began in 2003 and the works were carried out during 2005–2006. Monitoring and adaptive management are planned until 2010. This paper presents the environmental problems posed by the functioning of the stream, the technical solutions that have been put forward, and the ecological restoration of the area.

2. Study area

El Partido watershed presents a Mediterranean–type climate (average rainfall 660 mm/year) with a concentration of 80% precipitation from October to March. Intense rainfalls that can exceed 60 mm/day induce a torrential regime in El Partido stream with peak discharges rising to 300 m^3/s.

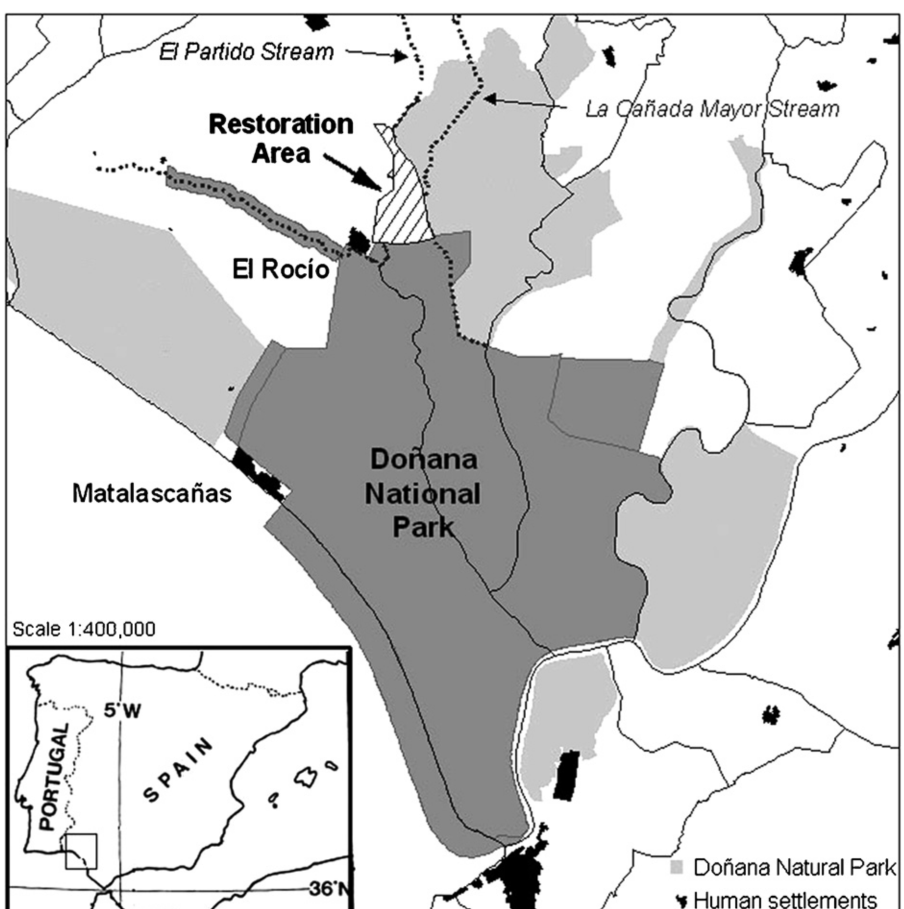

Fig. 1 – Location of restoration area.

The stream watershed covers 308 km^2 and the course is 21 km long with a maximum slope of 1% (Mintegui et al., 2003). For its last 6 km, the stream crosses the Natural Park of Doñana, finally discharging into Doñana Marsh inside the National Park (see Fig. 1).

Prior to human intervention, in the lower section of the watershed, waters were flowing through a network of braided channels spreading over a 1 km–wide depression with an estimated surface of 3700 ha. At the time, the low current speed limited sand transport (Mintegui et al., 2003).

Early in the 1980's, 8 km of the lower course of the stream were canalized and the surrounding watershed area was leveled, tilled and converted into arable land. The hydraulic effects of collecting braided channels into a single straight course favored strong erosion of embankments and riverbed with a sediment load (largely sands) estimated at 15 g/l during high water periods (Mintegui et al., 2003). Ensuing effects were the accretion of a large depositional delta reaching up to 380 ha by 2003 on the Doñana Marsh. Sandy sediments of delta present little or no vegetation. 1800 ha of El Partido watershed were bought by the Spanish Ministry of Environment in 2004.

The ecological restoration of the area is being carried out with the following aims: (1) prevent further silting up of the Marsh avoiding sand transport during flood events and (2) create functional ecosystems for target species (Iberian lynx, Imperial eagle and their preys, namely rabbits).

3. The hydraulic project and the ecological survey

Analysis of the area to devise an adequate restoration plan and the sequence of interventions to promote self-organization of ecosystems are presented in this paper.

3.1. *Hydraulic project*

Hydrogeology of the region has been the subject of several research programs. The early ones (1960's) were oriented to the exploitation of the local aquifer for irrigation. Almonte-Marismas aquifer shows the superimposition of sandy and gravel levels separated by less permeable substrates (silt, clay, iron-cemented sandstones). Aquifer levels exhibit different turnover rates (Llamas, 1990; Trick and Custodio, 2004). Discharge areas widely differ in chemical composition of waters, thus inducing contrasting biological communities (García Novo et al., 1996).

The hydraulic project behind restoration was developed by Mintegui Aguirre (2003). It was based on the diversion of El Partido stream waters to the floodplain, when debit exceeded a threshold, during flood events, thus recreating the former braided channel layout. As speed and turbulence substantially drop because of the deviated flow, solid-load sand will sediment and, consequently, water reaching the Marsh will carry little sand. The diverted flow will flood an estimated area of 1500 ha on the northern section of the old alluvial plain. The project involved construction of a weir across El Partido channel and the construction of 4.2 km of new earthen dikes to divert water flow.

3.2. *Ecological history*

Documents dating back from the 13th century, forest descriptions, and ancient cartography assisted in documenting evolution of the Doñana region through the last centuries (Granados Corona et al., 1987; García Novo, 1990; Sousa and García Murillo, 2003; García Novo and Marín Cabrera, 2006). Availability of aerial pictures from 1946 onwards, improved the interpretation of ecosystem and landscape changes and the mapping of previous vegetation types.

Regional ecology is known in some detail and vegetation types and succession stages have been identified (Allier et al., 1974; García Novo and Merino, 1997). Variations in depth of piezometric surfaces induce long-term changes of vegetation in depressions (Muñoz Reinoso and García Novo, 2005; Zunzunegui et al., 1998). Spatial variation in vegetation composition, plant communities, and plant traits have been shown to follow water availability gradients induced by upwelling in sandy substrates (Zunzunegui et al., 1998, 2004).

At the beginning of the 20th century, El Partido watershed presented a mosaic of semi-natural vegetation, interspersed with cultivated plots and pastures. Fragments of meso-xerophilous woods of *Quercus suber*, *Q. rotundifolia* and *Olea europaea* var. *sylvestris* survived, along with Mediterranean shrubs, such as *Arbutus unedo*, *Myrtus communis*, *Phillyrea angustifolia*, the dominant presence being *Pistacia lentiscus*. Remnants of riparian vegetation were composed of *Fraxinus angustifolia*, *Salix atrocinerea*, *Populus alba*, *Tamarix africana* with ferns: *Pteridium aquilinum*, *Thelypteris palustris* and several vines: wild *Vitis vinifera*, *Rubus ulmifolius*, and *Lonicera peryclimenum*.

This vegetation mosaic was shaped by channel migration of El Partido stream and aquifer upwelling on depressions. Land use patterns followed land tenure of two large Estates, to the South (Coto de Doñana) and to the East (Coto del Rey), which were managed for game and husbandry with no cultivation for centuries (Granados Corona et al., 1989). To the North and West, where the area belonged to Almonte Town Council, land was open to range with treeless cultivated plots along El Partido banks.

Agriculture interventions on the area in the 1970's included leveling of the surface and suppression of perennial vegetation. El Partido stream was confined into a channel lined with earthen dikes. Orchards of wild pear (*Pyrus bourgaeana*), under 0.1 ha surface, were planted to graft pear trees. Cereal fields of wheat and barley were cultivated in a long rotation regime. Pine woodlands were planted on the old estates retaining some oaks and tamarisks.

Present–day landscapes are dominated by abandoned cereal fields, which were cultivated until 2002/2003. Post-cultural grasslands, with ruderal forbs and tall grasses cover the abandoned fields. Some relics of the former vegetation, such as isolated cork oaks, pines, kermes oaks, pear trees, and scattered *Chamaerops humilis*, *P. lentiscus* and *Crataegus monogyna*, survived on the fields. Shrubs dominate succession series of woodlands often exhibiting dense isolated clusters with two to five species, measuring 2–16 m across and 1.5–8 m in height. A tree sometimes overtops the cluster and small flower scrub 0.7–1.5 m high (*Cistus salvifolius*, *Cistus monspeliensis*, *Halimium halimifolium*, *Stauracanthus genistoides*) frequently appears and develops as an outer fringe. In some favorable areas, shrub patches grow bigger (up to 23 m across) and denser, often coalescing into closed shrubbery. As trees expanded during succession, patches dwindled, turning into sparse underbrush on wooded surfaces.

River banks preserve ash, poplar and willow trees. Elms (*Ulmus minor*) have been lost, probably due to logging and a strong expansion of *T. africana*. Some invasive species are actively spreading, such as reeds, *Aster squamatus*, *Conyza canadensis*, *Cotula coronopifolia*, *Xanthium strumarium*, *Iris germanica*, *Oxalis pes-caprae*, *Datura stramonium*, *Nicotiana glauca*. Planted eucalyptus (*E. camaldulensis*), along old tracks, are the largest trees of the area, but they fail to reproduce.

The distance to sources of seed from trees or scrub species, and the scarcity of mature vegetation remnants, prevent an adequate seed supply to the area, making succession more difficult. Other than along river banks, no tree seedlings or tree sprouts from roots can reach the area. Horses, cows, and sheep only disperse herb species and, if any, they destroy emerging tree and shrub seedlings.

Large scrubs bear fleshy fruits (wild olives, pears, berries, dates) eagerly consumed by birds and mammals. Acorns, pinions and wild olives from associated trees add to trophic resources. Studies on this vegetation have shown how birds select fruits and how they actively disperse seeds (Jordano and Herrera, 1981; Jordano, 1987).

Table 1 – Restoration project summary

Restoration area	
Land surface bought by state	1800 ha
Earthen dikes length (phase I)	4.2 km
Earthen dikes volume (phase I)	36,500 m^3
Watershed restoration area	1500 ha
Length of riparian forest restoration (phase I)	2.8 km
Area of riparian forest restoration (phase I)	45.35 ha
Preserved vegetation	
Number of vegetation remnants nuclei to be restored	158
Initial nuclei of remnant vegetation	7.66 ha
Restoration treatments (phase I) ha (%)	
Riparian vegetation	45.35 (13.3)
Reconstruction of remnant vegetation nuclei	26.68 (7.8)
Revegetation patches (545)	20.53 (6.0)
Abandoned cropland	205 (60.0)
Grassland	22.8 (6.7)
Earthen dikes	14 (4.1)
Total	342.15 ha
Revegetation (number of plants)	
Patches	58,800
Nuclei of remnant vegetation	76,800
Stock provision (ca. 60% total)	80,000
Total	215,600

4. The ecological restoration project

The ecological restoration of El Partido watershed focused on the following objectives:

- identifying reference vegetation types for restoration in Doñana Parks;
- developing a Concept Plant to abate the impacts of traditional agricultural uses and recent hydraulic works;
- recovering what was left of natural vegetation and landscapes;
- steering the area into a self-organization process of vegetation, giving support to endangered vertebrate species.

The whole restoration program was divided into two phases. The first one (342 ha) includes the restoration of core area and of hydraulic works (see Table 1). The second phase includes ancillary interventions in river banks and woodlands, and will not be dealt with in this paper.

4.1. *Vegetation survey*

A detailed survey of vegetation of the area and monitoring of soil water table and soil moisture was carried out for 1–2 years prior to the intervention. Growth of scrub species was monitored in an Experimental Plot during two annual cycles.

Reference plant communities for restoration have been identified in mature scrubland and forests of the Natural and National Park. El Partido watershed vegetation has been characterized by floristic inventories, quantitative studies of horizontal and vertical structure and soil analysis (texture, pH, profile). Water table depth fluctuations were monitored (monthly) in a network of shallow piezometers. Bird monitoring started in 2005, a year before the beginning of restoration works.

4.2. *Concept Plan*

Successive Concept Plan blueprints regarding the ecological restoration were drawn. Each one was tested at the onset for interference with hydraulic design, construction feasibility and cost. Secondly, future landscape evolution, conservation policies and the access of visitors were considered. In a third stage, the impacts of some contingencies were analyzed: cattle intrusion from neighboring areas, longstanding drought, repeated flooding events, wildfires and spread of invasive species. Accepted changes were incorporated into the final blueprint providing feasible solutions to goals (Ehrenfeld, 2000).

The Concept Plan (see Fig. 3) was discussed in some detail with National and Natural Park administrators and was presented to the Scientific Board of Doñana 2005 Restoration Plan. The sequence of interventions to promote self-organization of ecosystems (self-design; Mitsch, 2000) is presented in this section, following the next three issues: recovery of vegetation remnants, abatement of environmental impacts and induction of succession (see Fig. 2).

4.3. *Recovery of perennial vegetation*

What was left of mature vegetation, trees, or scrubs was incorporated into the restoration. It offered a network of valuable nuclei of structured vegetation, sources of seeds for succession, and productive sites that maintain animal populations. Vegetation remnants were individually identified, measured and GPS mapped, soils were sampled and pictures taken in a standard way (distance and elevation). Individual site recov-

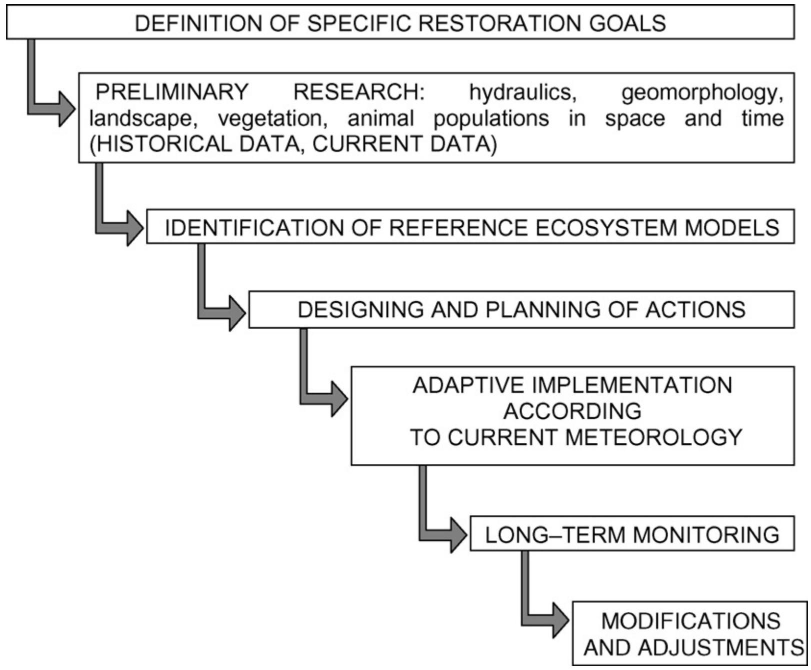

Fig. 2 – Flowchart of the ecological restoration project.

ery plans were drawn with specific plantations to consolidate existing vegetation.

Some of the remnants, small fragments of semi-natural woodlands (pines, corks, ashes), were large enough to trace their changes from early (1946, 1955) aerial pictures. In those cases, reconstruction aimed at restoring larger sections of the 1950's lost vegetation. Isolated trees (large cork oaks, pines) were surrounded by a few trees of the same species, creating a thicket. Wild pear orchards with noticeable rows have been completed, missing trees added following original patterns, but plantation will not go beyond original boundaries. The case for eucalyptus was much debated, because the Park set plans to suppress this introduced species. However, they presently are the tallest trees in the area and large birds (storks, eagles, and other birds of prey) use them for nesting. Eucalyptus were planted in a historical and will be preserved, highlighting the old tracks across the landscape.

4.4. *Abatement of environmental impacts*

Abandoned cereal fields now exhibit a cover of ruderal species largely dominated by annual grasses and forbs. Repeated plowing reduced perennials and there is a scarcity of woody plants, and bulb or rhizome species of *Asphodelus*, *Narcissus*, *Leucojum*, *Ornithogalum*, *Urginea*, *Muscari*, *Gladiolus*, *Iris*, *Arum*, *Scirpus*, *Juncus* and others. The populations of several interesting species have been identified and will be preserved: *Lupinus luteus*, which produces a large number of seeds, attracting granivorous birds; the menaced *Onopordon dissectums* or the rare *Glaucium corniculatum*. In each case, the site was signaled for monitoring and no intervention or alteration during works will be carried out.

The earthen dikes belonging to the hydraulic design were realigned to avoid damage to vegetation remnants or protected plant populations. When construction ends, the topsoil horizon, with a rich soil bank, will be used as mulch to cover dike surfaces avoiding the use of commercial mixtures. Along the base of dikes, a row of large scrub and trees will be planted in alternate segments for landscaping purposes. The growth of vegetation will screen out the geometric shape of the dikes.

4.5. *Induction of succession*

A restoration plan based on complete reconstruction of reference vegetation was feasible at a high cost. Instead it was decided to take advantage of succession, by facilitating the process in the area, which will end up with a vegetation cover and landscape similar to the reference areas in the Park. Following Gallego Fernández and García Novo (submitted for publication), the selected low–cost alternative is trading time for budget. Low cost implies a lengthy development of restored ecosystems through longstanding self-organization processes.

A few perennials resisted cultivation practices, sprouting after plowing, such as *Asparagus* or *Clematis* species. *Asparagus* and *Clematis* individuals as well as isolated tree seedlings have been sheltered planting a few specimens of *Quercus coccifera* or *Phillyrea angustifolia* close to them. Fruit and flower scrub species were planted around existing trees following individual plans that were drawn for each site. On average, restored surfaces cover a three-fold surface of the remnant vegetation surface. Vines (*Smilax*, *Rubus*, *Vitis*) were planted at the base of existing trees.

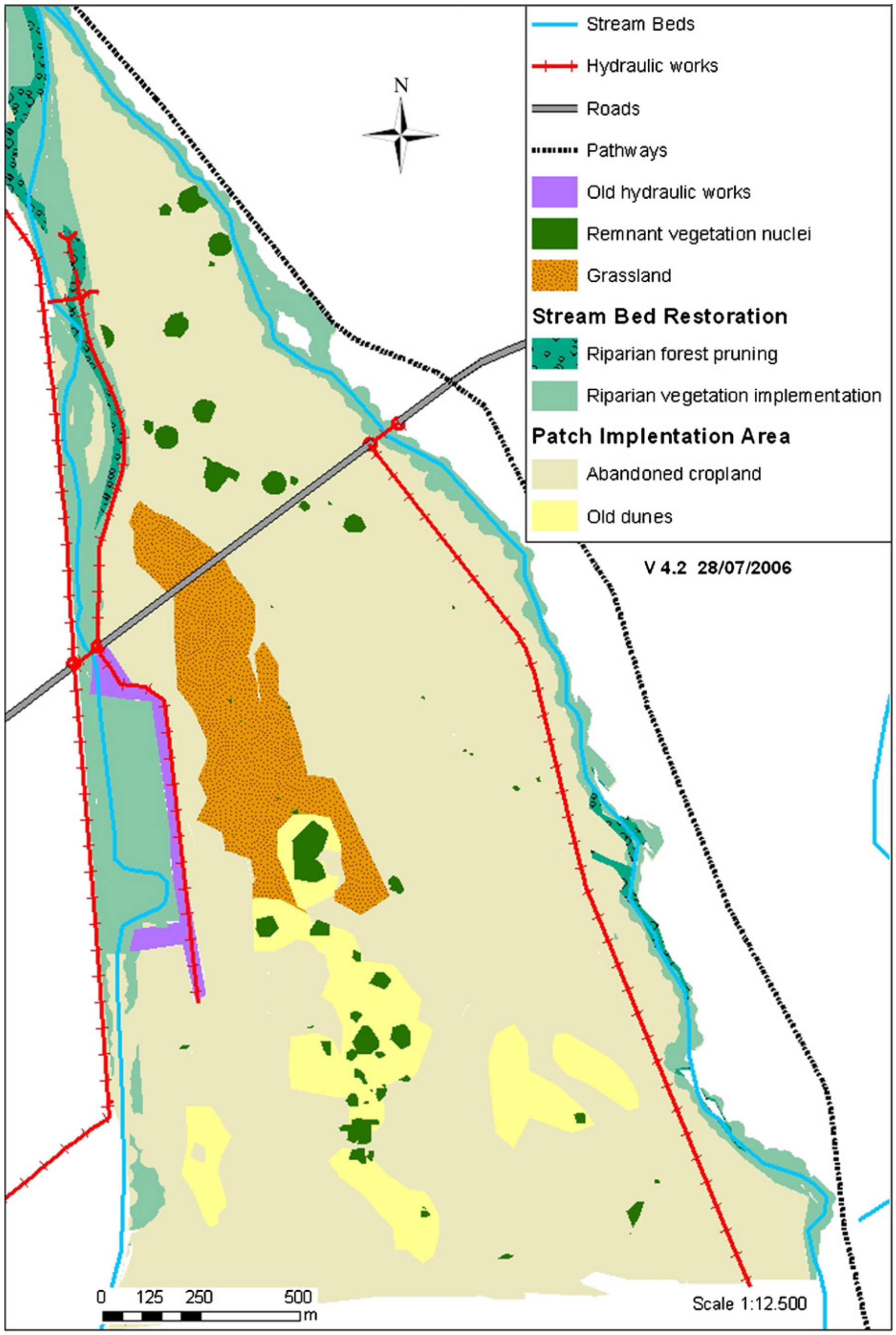

Fig. 3 – Concept Plan for ecological restoration.

To complete the ecological restoration, structured patches of shrub were planted, following reference vegetation composition and pattern. Each planted patch combines three plant types; trees for the inner core; large scrub of fruit–producing (sprouters) species for the main area; an outer fringe of smaller shrub (seeders) species, producing large flowers but no edible fruits. Within the patch, scrubs will be planted every 1.5 m in rows 2.6 m apart, combining sectors of different species in the same patch using 5–10 species according to patch size. Table 2 includes list of species.

When completed, 545 patches will be planted over the restoration area in rows at 40–50 m intervals. Vegetation clumps will appear to the observer as randomly distributed. Plant composition of patches changes according to water table depth and soil type.

Patch density in the area after restoration will be 1–2 patches/ha with an initial ground cover of 6%. Shrubs will be planted in two sizes: small (1–2 years plants, 20–60 cm according to species) and medium (2–4 years plants, 30–80 cm). Trees are 5–8 years old and range 1.5–2 m in height.

Table 2 – List of species to be planted in patches

Tree (core)	Fruit shrub (mains)	Flower shrub (fringe)	Hygrophyte vegetation
Ceratonia siliqua	*Arbutus unedo*	*Cistus ladanifer*	*Arundo donax*
Olea europaea	*Chamaerops humilis*	*Cistus salvifolius*	*Fraxinus angustifolia*
Pinus pinea	*Crataegus monogyna*	*Cistus monspeliensis*	*Nerium oleander*
Pyrus bourgaeana	*Myrtus communis*	*Genista hirsuta*	*Populus alba*
Quercus ilex ballota	*Phillyrea angustifolia*	*Halimium halimifolium*	*Salix alba*
Quercus suber	*Phillyrea latifolia*	*Lavandula stoechas*	*Salix atrocinerea*
Ulmus minor	*Pistacia lentiscus*	*Phlomis purpurea*	*Salix purpurea*
	Quercus coccifera	*Retama monosperma*	*Spartium junceum*
	Rhamnus alaternus	*Rosmarinus officinalis*	*Tamarix gallica*
	Rhamnus oleoides	*Thymus mastichina*	
	Rubus ulmifolius	*Vitis vinifera*	

Core, mains and fringe refer to the structure of planted patches (see text).

To avoid introduction of foreign genetic stock, seeds, fruits, and twigs from local populations of woody species have been collected for multiplication purposes in a nursery. Exchange resins are not being used as dressing in plantations.

4.6. *Outcome of plantations*

According to previous results in the Experimental Plot, flower production after plantation will attract insects to the outer fringe scrub. Insect and fruit availability will lure birds. After 3–5 years, it is expected that the next generation of scrub plants having germinated from patch seeds, will contribute to scrub expansion creating new nuclei. At the same time, vegetative growth will turn isolated crowns into a continuous vegetated structure over the patch. At this point, scrub will grant protection to rabbits, and new dens are expected to spread over the restored area. In a medium–term stage of succession (after 10 years), planted trees will develop a higher crown allowing birds to find adequate perch and nesting sites, also contributing with fruits and leaves to herbivores and decomposers. After their successful establishment, patches themselves will perform as seed sources for the rest of the restoration area. A similar plantation model has been applied with success in Mediterranean vegetation restoration elsewhere (Sartori et al., 2001).

Later succession stages to woodlands will be delayed by high mortality of tree seedlings due to herbivore pressure (rabbit, hare, rodents, wild boar, deer, and roe deer among others), and competition for light with dense scrub plants. The long-term outcome (after perhaps 50 years) is expected to approach the reference vegetation of large patches of shrub, often coalescent into a thick layer, with scattered tree crowns at higher levels. Among patches, a diverse herb layer will retain a ground cover of depressions in the 30–50% bracket. This vegetation mosaic will be optimal for conservation of menaced species and for maintenance of the highest diversity of plants, vertebrates and invertebrate species.

At every succession step, the natural landscape will gain in vertical structure, diversity of elements, colors, shapes, and visual quality. Landscape image simulations confirm that, even if ground cover by scrub patch is scarce at the beginning (6%), it strongly contributes to a change in perception, creating a scrub layer above grasslands. Reconstructed remnants (another 10%) add to this effect creating dense point structures.

4.7. *Adaptive management*

The sequence of interventions described above will be completed in a year. But plantation success depends heavily on precipitation regimes in the ensuing years. A dry period will probably cause losses as high as 60%. Heavy flooding may be deleterious for plantations in depressions and on river banks. Wildfires can easily destroy vegetation if they occur in summer.

A wet spring will make the grassland grow over 70 cm suffocating scrub plants. The outgrowth of grasses will be checked (as needed) by harrowing among rows of plantations that were planted 2 m apart for this purpose. The Park keeps a careful control on wildfires with a network of watchtowers and on duty fire brigades.

In view of these foreseeable setbacks, it is assumed that yearly plantation losses could rise to 30%. Plant material has been prepared in a 60% excess of immediate needs, so that losses can be replaced during the first 2 years. If losses do not occur, extant plant material will be used to set up new patches.

5. Discussion

As pointed out above, shrub and trees have no means for dispersion into the area under restoration. Their dispersion is limited to river beds and boundaries with neighboring woodlands. Therefore, leaving the area to colonize naturally would be an exceedingly lengthy process and most vertebrates of the Park would remain excluded from it.

One of the requirements to be met in El Partido restoration is to provide the right habitat for Iberian lynx and Imperial eagle, the most menaced vertebrates in the Park. This implies creating an adequate habitat for rabbits, their main prey and a landscape structure where hunting is facilitated. Preliminary surveys in the area (Moreno et al., 2004), have evidenced that rabbit den density was highest at the boundary between woodlands and pasturelands and close to riverbeds. The wild pear orchards described above were the most appropriate environments of the area for rabbits, supporting a high number of dens that were exploited by wild boars, foxes, badges and others. Vegetation patches, once they have developed into dense vegetation clumps, will provide both protection and trophic resources to many vertebrates in the area.

There are two key points in the restoration described above: plant cover and plant size. For immediate effects on vertebrate populations, a large plant cover was advisable in the 25–40% range, inducing larger vertebrates from the adjoining Parks to enter the area. The project, however, designed a plant cover under 20% with plantations representing a mere 13.8%. Summing up vegetation remnants, woody vegetation after restoration accounts for 16% of the surface. This saves, at least, half the budget, but will extend the process of plant cover by 20–30 years. The irregular Mediterranean climate may confront restoration with either an extreme drought or high flooding, with heavy effects on plantations. It was decided to concentrate efforts on a smaller restored surface replacing plant loses as needed. Surviving young shrub plants will eventually develop a suitable root system to withstand future adverse conditions.

Using large shrub plants instead of small ones for plantations gives better landscaping effects from the onset and also shortens patch vegetation development. It has two drawbacks, however: larger plants are more expensive and take longer to produce from local genetic stock. What is more important, young plants adapt more easily than older ones to the harsh environmental conditions of the site.

6. Conclusions

The ecological restoration of El Partido stream watershed is an attempt to restate hydrological and ecological functions in a degraded agricultural area bringing it to a level where integration into Doñana National Park becomes feasible. Objectives will be achieved through regulatory actions capable of reorienting natural processes in the future. Water flow and infiltration, sediment deposition, plant growth, and animal dispersion of seeds, will be combined into an accelerated succession process bringing the restored area back to its former functional state. Monitoring and adaptive management will ensure the process, steering the area towards the restoration objectives.

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