



MANAGEMENT of Natura 2000 habitats * Coastal dunes with *Juniperus* spp. 2250

*Directive 92/43/EEC on the conservation of natural habitats and
of wild fauna and flora*

The European Commission (DG ENV B2) commissioned the Management of Natura 2000 habitats. 2250
*Coastal dunes with *Juniperus* spp.

This document was completed in March 2008 by Stefano Picchi, Comunità Ambiente

Comments, data or general information were generously provided by:

Barbara Calaciura, Comunità Ambiente, Italy
Daniela Zaghi, Comunità Ambiente, Italy
Oliviero Spinelli, Comunità Ambiente, Italy
Roberto Fiorentin, Veneto Agricoltura, Italy
José Carlos Muñoz-Reinoso, Universidad de Sevilla, Spain
John Houston, Liverpool Hope University, United Kingdom
Antonio Perfetti, Parco della Maremma, Italy
Antonio Sánchez Codoñer, Ayuntamiento de Valencia, Spain
Ana Guimarães, (ATECMA, Portugal)
Mats O.G. Eriksson (MK NATUR- OCH MILJÖKONSULT HB, Sweden)
Marc Thauront (Ecosphère, France)

Coordination: Concha Olmeda, ATECMA & Daniela Zaghi, Comunità Ambiente

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2250 | *Coastal dunes with *Juniperus* spp.



22 - Sea dunes of the Mediterranean coast

Eunis Classification:

B1.63 Dune [*Juniperus*] thickets

* Priority habitat

Coastal dunes with Juniperus oxycedrus macrocarpa in Policoro, Italy.
Photo: S.Picchi

Summary

Coastal dunes with junipers occur on the coasts of Southern and Western Europe. This rare and beautiful habitat features sparse junipers that are prostrate or erect depending on wind action and the adverse conditions typical of sand dunes.

Nowadays this habitat is under threat from factors such as urban development, tourism, forest fires, alien species, coastal erosion, grazing and browsing, habitat fragmentation, polluted sea spray and nutrient deposition. When in good condition, the habitat is part of a succession of other habitats situated seaward. The good ecological quality of juniper dunes therefore depends on the presence of habitats of embryonic shifting dunes and so-called white dunes, which help to stabilise the sand, thereby creating a more stable substratum inland that is suitable for juniper formations. From a management point of view, therefore, this habitat should be regarded as one part of dune systems that need to be managed as a whole.

Where habitat status is good and not under any threat, non intervention is the best choice. However, recurring management is often necessary owing to its unfavourable conservation status in many sites. The main recurring management measures consist of eradication of invasive plants, fire prevention, shrub clearance and controlled grazing. Alien trees or shrubs should only be removed if they are damaging the habitat. Removing plant roots can have negative impacts on the habitat. The vegetation should be removed from the site as soon as possible after felling/cutting or be left in piles in order to minimise the fertilisation effect. Fire prevention is a response to one of the most damaging threats to habitat, and costs less than extinguishing fires and recovering habitat. It should include surveillance, making and maintaining firebreaks and preventive actions in neighbouring areas, as well as public awareness actions.

In Central and Northern Europe shrub clearance and controlled grazing are crucial since the habitat's natural successional trend is always towards climax woodland. Recovery interventions on degraded dunes with junipers take time since juniper cultivation is difficult due to its low germination rates and slow sapling growth. When rapid re-colonisation is needed, it is better to use other species associated with juniper habitat so as to create better conditions for natural propagation. Only where natural regeneration is not possible should planting be considered. As failure to take into consideration the importance and rarity of coastal juniper dunes jeopardises the habitat, it is also important to raise awareness among local people.

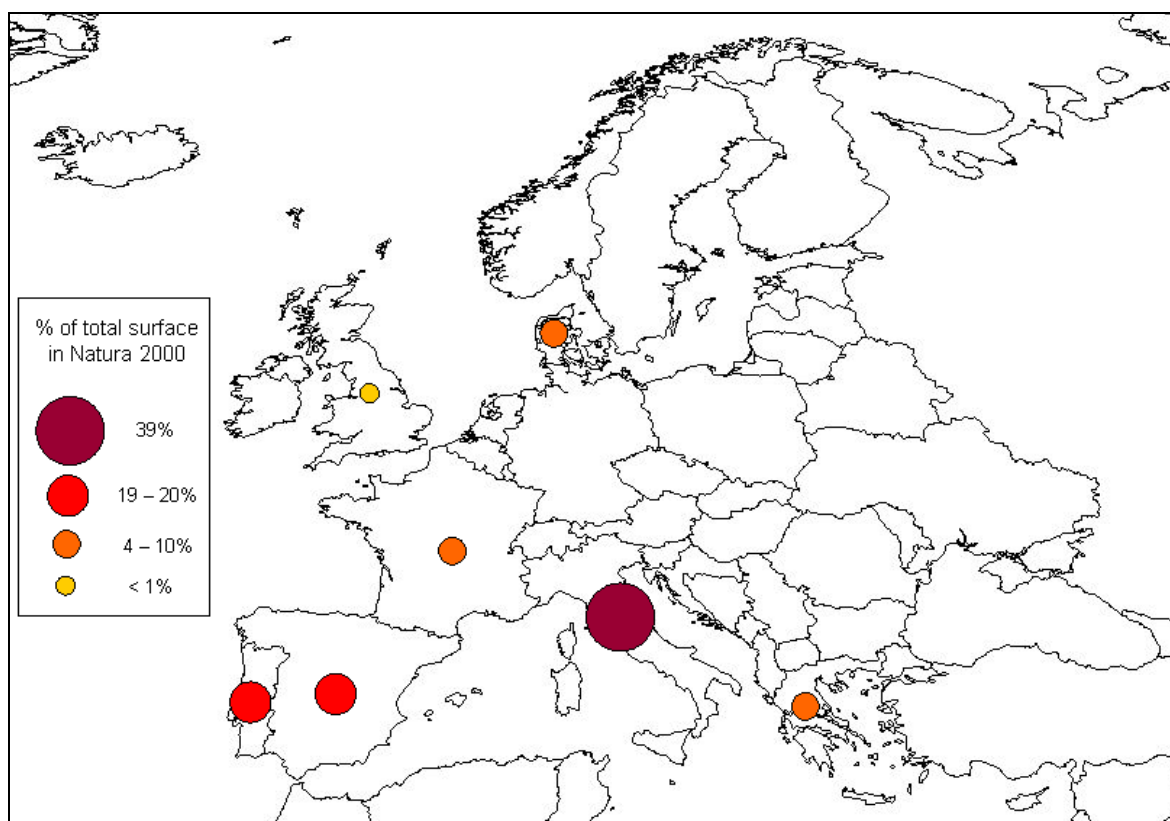
1. Description of habitat and related species

This habitat type comprises juniper scrub on coastal sand dunes in a variety of situations. Junipers are coniferous plants, shrubs or small trees, native to Mediterranean coasts, growing into a pyramid shape, with branches growing from its base. There are both prostrate and erect forms of juniper, but neither usually grows over 6 metres high.

Distribution

Coastal dunes with *Juniperus spp.* (juniper) are widespread on the coasts of Europe, but not very common. The habitat is distributed along the sandy coasts of Southern and Western Europe, on Mediterranean and Atlantic coasts. Italy hosts the main area of this habitat at EU level followed by Spain and France. This habitat is rare in the United Kingdom, where it is present only in Scotland. The distribution is very discontinuous, with large portions of habitat surviving mainly in protected areas.

Coastal dunes with *Juniperus spp.* in Natura 2000 sites



Percentage distribution of the total surface of coastal dunes with *Juniperus spp.* in Natura 2000

The following data have been extracted from the Natura 2000 Network database, elaborated by the European Commission with data updated on December 2006. The surface was estimated on the basis of the habitat cover indicated for each protected site and should be considered only as indicative of the habitat surface included in Natura 2000.

Biogeographical region	N° of sites	Estimated surface in Natura 2000 (ha)	% of total surface In Natura 2000
Mediterranean	148	22,413	88.61
Continental	22	2,740	10.83
Atlantic	4	143	0.56
Countries	N° of sites	Estimated surface in Natura 2000 (ha)	% of total surface In Natura 2000
Italy	87	9,769	38.61
Portugal	8	4,874	19.27
Spain	26	4,884	19.31
Denmark	15	2,459	9.72
France	21	2,213	8.75
Greece	15	1,077	4.26
United Kingdom	2	20	0.08
TOTAL	174	25,296	100

Main habitat features, ecology and variability

Juniper stands usually cover small areas and are closely associated with other Annex I habitat types, including dune grasslands and coastal heaths. They range from discrete stands to more scattered and occasional specimens, which occur within the fixed dune habitat type.

The characteristic species of the habitat is mainly *Juniperus communis* in thermo-Atlantic coastal dunes of Central/Northern Europe (Britain, Denmark), while in Southern Europe other juniper species predominate:

- *Juniperus oxycedrus ssp. macrocarpa* and *Juniperus phoenicea* in Portugal, Spain, France, Italy, Greece, Albania and Bulgaria.
- *Juniperus phoenicea ssp. turbinata* (= *J. lycia*, *J. phoenicea ssp. lycia*) and *J. navicularis* (= *J. transtagana*, *J. oxycedrus ssp. transtagana*) in Portugal and Spain (ICN 2007, EEA 2007, JNCC 2007a).

Other species normally found in the habitat include: *Ammophila arenaria* (marram), *Asparagus acutifolius* (wild asparagus), *Pistacia lentiscus* (mastic tree), *Myrtus communis* (myrtle), *Smilax aspera* (common smilax) and *Phillyrea angustifolia*.

Sand dune systems are very rich in invertebrates, especially Coleoptera, butterflies, moths and burrowing bees and wasps. The beetle *Icosium tomentosum* is strictly dependent on the juniper for its lifecycle. Also, the sandhill rustic moth (*Luperina nickerlii*) is reliant on these habitats. In Northern Europe, especially Denmark, rabbits (*Oryctolagus cuniculus*) are important in the habitat, with moderate rabbit burrowing and grazing guaranteeing open and diverse vegetation.

Juniper seeds are normally dispersed by birds although mammals, such as foxes, badgers, rabbits and wild boars, can also play a significant role in some southern areas (Muñoz-Reinoso 2003). Germination rate is generally low.

Ecological requirements

Juniper formations on dune systems are subject to factors such as salt spray, sand mobility, relatively infertile soils and lower water availability. The ecological conditions influence the formation of the habitat substrate, sand dunes, and the formation of juniper vegetation. The formation of sand dunes depends on active factors (winds, waves, tides, fluvial deposits) and passive ones (topography, geology). Normally sand dunes develop where coasts are surrounded by plains or small hills, and are formed by sediments of marine or fluvial origin and with granule sizes ranging from 0.03 to 2 mm diameter. The onshore winds blow dry sand from the beach landwards and deposit it above the high water mark, where it is trapped by specialized dune-building grasses which grow through successive layers of deposited sand. Plants are also important in coastal dune formation as they act as a partial obstacle holding back the sand.

Embryonic and mobile dunes occur mainly on the seaward side of a dune system (UK Biodiversity Group 1999). Semi-fixed dunes with juniper formations usually occur further inland where the rate of sand deposition is less, but the surface is still mostly bare sand. Fixed dune systems occur further inland where sand deposition is no longer significant. Many plant species grow there, helping to stabilise the dune surface and creating a thin layer of soil. Sand grain dimension decreases gradually from the beach to the dunes where, in 2250 habitat, it is usually about 0,02 mm in diameter. As this community grows on shifting sand, the ecosystem is, as for all near-shore areas, relatively young. Various studies of the soil characteristics of fixed coastal dune heathland indicate that, in general, the soil is less than 300 years old. This should be taken into consideration when assessing stability conditions (Pihl *et al.* 2001).

Coastal juniper dunes on the Mediterranean coast are subject to strong seasonality, with warm and wet winters and hot and dry summers. Vegetation is exposed to high stress in summer caused by drought, high evaporation and high irradiance (amount of radiant flux per unit area falling on a surface) at high temperature (Castillo *et al.* 2002). In the Atlantic and the Continental biogeographical regions, conditions are less extreme since winters are mild and summers cool.

Main subtypes identified

According to the Interpretation Manual of European Habitats, the subtype *Juniperus communis* formations of calcareous dunes includes *J. communis* communities from the calcareous dunes of Jutland (Denmark) and *J. phoenicea* ssp. *lycia* communities in Rièges woods, in the Camargue (France).

On the Mediterranean and Atlantic coasts of the Iberian peninsula, this habitat type is associated with dune scrub of *Corema album* (*Rubio-Coremion albi*) and substitution *Halimium halimifolium* dune scrub (*Stauracantha-Halimietalia*) (EC 2007, ICN 2007).

In Denmark, the habitat is associated with fixed dune heaths involving predominant vegetation consisting of *Calluna vulgaris*, *Empetrum nigrum* and *Deschampsia flexuosa*. It has also been found on grey dunes (type 2130) and green dunes. At a few localities, species associated with acidic fens and calcareous fens are present (Pihl *et al.* 2001).

Species that depend on the habitat

Even if not exclusive to this habitat, the rare and declining bird *Lanius collurio* (red-backed shrike), included on Annex I of the Birds Directive, is found in dune scrub. It depends on easy availability of larger insects and small invertebrates in the habitat that is in good condition. This makes the red-backed shrike a good indicator of wildlife diversity (Esselink *et al.* 2003).

Related habitats

When in good condition, this habitat is part of a succession of other habitats situated seaward. The good ecological quality of juniper dunes therefore depends on the presence of the habitats of 2110 embryonic shifting dunes and 2120 shifting dunes along the shoreline, with *Ammophila arenaria*, which helps to stabilise the sand, thereby creating inland a more stable substratum suitable for juniper formations. The two habitats mentioned constitute the initial stages of dune construction, comprising ripples or raised sand surfaces on the upper beach or by a seaward fringe at the foot of the tall dunes where Habitat 2250 is normally located. Management of these habitats affects the development of the juniper dune habitat behind (e.g. mechanical clearance of beach debris).

In several situations, the habitat includes small areas not covered by shrubs which host vegetation typical of priority Habitat 2130 *Fixed coastal dunes with herbaceous vegetation (grey dunes) (Fiorentin 2006).

According to the French "Cahier d'habitats", coastal dunes with juniper are in contact with Habitat 2230 Malcolmietalia dune grasslands and with priority *2270 Wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (Bensetti *et al.* 2004) as understorey.

The habitat is sometimes associated with Habitat 2160 Dunes with *Hippophae rhamnoides*, except for Portugal and Spain, where this habitat is not present. On the Adriatic coast, in northern Italy, junipers form an endemic association *Junipero-Hippophaetum fluviatilis* Gehu et Scopp. In Portugal, this habitat frequently occurs in mosaic with sclerophyllous* (*Cistaceae*) dune scrub (2260) rich in endemic species, dominated by *Stauracanthus* sp. pl. (*Stauracantho-Halimietalia commutati*) (ICN 2007).

Ecological services and benefits of the habitat

Coastal dunes with *Juniperus spp.* are highly valuable in landscape terms and are often recreational areas. The habitat is important for retaining sand and stabilizing the sand dunes, for soil formation and creating biodiversity areas (ICN 2007). Juniper dunes are also recreational areas and wildlife refuges since fruiting individuals are an important food source for vertebrates such as badgers, foxes, wild boars and rabbits (Muñoz-Reinoso 2003).

Natural coastal ecosystems have proved to be crucial to increasing coastal resilience and protecting the coast during hurricanes. Coastal habitats are the most effective defence in this kind of natural disaster. However, coastal ecosystems and habitats need space and time to recover fully in order to be able efficiently to protect settlements inland (EEA 2006).

Trends

Over the last hundred years, coastal dunes with *Juniperus spp.* woodland have been seriously disturbed by logging, urban development, pine plantations and farming. Coastal juniper woodland is also a vulnerable ecosystem due to its ecological position withstanding the effects of wind, drought, salt, erosion and pH. Nowadays, junipers appear in isolated stands of different sizes. Large populations still survive in natural or semi-natural situations within protected or military areas (Muñoz-Reinoso, 2003). The habitat can also be found as understory associated with pine plantations, the result of past land management practices (ICN 2007, Muñoz-Reinoso 2003, 2004).

Many large reforestation (e.g. with *Pinus spp.* and *Eucalyptus spp.*) have reduced the area of natural dune landscapes. Since the eighteenth century, on the Atlantic coast, e.g. in France and in Denmark, governments implemented large-scale projects to stabilise dunes by planting conifers to halt the landward movement of shifting dunes (Wilkie 2002). While successful in stabilizing the sands, this treatment resulted in a decline in the maritime juniper population.

Pine plantations were also carried out in Mediterranean countries such as Italy and Spain, being one of the main causes of coastal juniper woodland regression (Muñoz-Reinoso 2004, Fiorentin 2006). The development of infrastructure associated with the growth of the tourist industry has also devastated many areas and has had a major impact on much of the coastal landscape. According to recent data, coastal habitats in Europe have continued to shrink, with a 10% increase since 1990 in the area covered by concrete or asphalt (EEA 2006).

In the United Kingdom, where this habitat is present only in northern Scotland, it is regarded as stable over the last 50 years (JNCC 2007b).

Threats

Urban development

The main cause of habitat disappearance and fragmentation has been urban development in coastal areas over the last forty years, in particular where increasing tourism has induced local communities to take advantage of the sea to generate a new source of income. Large natural areas have been built over, the dunes and their habitats have been removed or natural dune habitats have been “squeezed” into restricted areas (EEA 2006) where dune landward mobility is impossible, causing the habitat to disappear.

In 1997, Corsica’s regional agency for coastal protection estimated that 28% of the juniper population had been lost due to urban development. Furthermore, although not common, quarrying sand for the

building industry poses a severe threat to juniper dunes, as in Corsica (Paradis *et al.* 1997) and Sicily, where a LIFE project was carried out to restore the Vendicari dunes (Pisano 2006).

Tourist pressure

Today, the existing portions of dune habitat are subjected, in particular in the Mediterranean region during summer, to intense trampling and habitat degradation due to uncontrolled access of tourists on foot and in cars, including four-wheel-drive vehicles and motorcycles. Moderate pressure by pedestrians may cause little damage and may even help to counteract the effects of ceasing grazing. However, excessive pedestrian use, as on routes between car parks and beaches, and vehicular use in particular, have caused unacceptable erosion at many dune sites, aggravating wind erosion (ICN 2007, UK Biodiversity Group 1999). Furthermore, excessive and ongoing trampling prevents typical dune vegetation from regenerating.

Moreover, allowing tourists to camp on juniper dunes often leads to junipers being cut and trampled, as well as an increasing the risk of forest fires, as documented for Corsica (Paradis *et al.* 1997, Bensettiti *et al.* 2004).

Mechanized beach cleaning to eliminate the piles of dead leaves of *Posidonia oceanica* can damage the juniper roots and eventually kill them (Paradis & Piazza 1996) and the vegetation that stabilises the sand on shifting dunes (Fiorentin 2006, MATT 2004).

Forest fires

Forest fires in the Mediterranean region are often an important threat to this habitat (MATT 2004, Bensettiti *et al.* 2004) since juniper adaptation and resistance to fire is very low. Moreover, a relatively long germination period and poor germination rates contribute to slow post-fire re-establishment, based principally on seed propagation. With an average of 50,000 fires and 600,000 ha burnt annually, forest fires in the Mediterranean basin account for a significant part of all fires globally.

Despite the efforts made, particularly in the Southern European countries, the phenomenon is far from being under control and even appears to be increasing significantly, with a general trend towards larger areas being burnt, more severe fires and longer fire seasons (MMAMRM in prep., Alexandrian *et al.* 1998). This increase is due to several factors, including land being abandoned, with resulting larger amounts of biomass in woodlands. The human population is concentrated in urban areas, which accentuates the countryside/urban interface and, as a consequence, fire risks (Pinaudeau 2005). Also, climatic change leads to more extreme droughts in most regions (MMAMRM in prep.).

Alien plant species

Another important threat is the spread of alien species, partly due to past conifer plantations on the dunes. Coastal *Pinus pinea* plantations tend to mitigate the effect of harsh maritime physical environmental factors, causing the disappearance of endemic juniper woodland vegetation, promoting the establishment of landward species, which change the structure and composition of the plant communities.

Pine plantations involve important changes in plant composition due to sand stabilization and the reduction in salt spray deposition under the pine tree canopy. Thus, species adapted to a moving substrate disappear, and the community is invaded by species less tolerant of coastal stress, creating conditions in which the junipers are less competitive. Moreover, deposition of pine needles prevents seedlings from getting established and kills mature junipers. Juniper populations surviving as understory show a lack of natural regeneration (Muñoz-Reinoso 2003, 2004). In Denmark, the habitat has been damaged by artificial plantations of *Pinus mugo* (mountain pine).

The presence of exotic species is also due to the natural spread of the following non-native plants: *Yucca gloriosa* (moundlily yucca), *Robinia pseudacacia* (black locust), *Elaeagnus angustifolia*, *Pyracantha coccinea*

(Scarlet firethorn), *Pinus pinea* (Italian stone pine), *Tamarix gallica* (French tamarisk), *Amorpha fruticosa* (desert false indigo) (Fiorentin 2006).

Coastal erosion

Coastal erosion is another important threat that reduces the distance between the coastal dunes with *Juniperus spp.* and the sea, causing them to degrade and disappear (Paradis *et al.* 1997) in particular on the Mediterranean coast. Erosion of frontal dunes often manifests itself as a distinct scarp line that is easily identified if the dune/beach system is examined in cross-section.

Coastal erosion is a natural process that is nowadays aggravated by several manmade factors, including a reduced supply of sediments from rivers, with a consequent decrease in sand deposition rate on the coasts due to the barriers along their courses (EEA 2006).

Sand deposition can also be altered by the installation of harbour groynes (a rigid structure built out from the shore which interrupts the flow of water and sediment), breakwaters or a revetment along the coast, which changes coastal sea-flows and sediment deposition. Also, subsidence due to water/gas abstraction from underground leads to coastal erosion and loss of habitat.

Grazing and browsing

In the absence of human interference, most stable dunes, with the exception of those experiencing severe exposure, as in the Mediterranean region, develop into scrub and woodland. As evidenced in the second report by the United Kingdom under Article 17 on the implementation of the Habitats Directive (2007), the preponderance of grassland and heath vegetation on British dunes is due to a long history of grazing by livestock. Continued grazing is normally necessary to maintain the typical fixed dune communities, but over-grazing, particularly when combined with provision of imported feedstuffs, can have damaging effects.

A more widespread problem is undergrazing, leading to invasion by coarse grasses and scrub, though rabbits are locally effective in maintaining a short turf (JNCC 2007a and b).

Habitat fragmentation

Fragmentation and isolation of juniper populations due to urban development could reduce seed dispersal since access to dispersing mammal species (foxes, badgers and wild boars) is restricted by infrastructures such as roads.

Since maritime juniper (*Juniperus oxycedrus* subsp. *macrocarpa*) is a dioic plant, habitat fragmentation in small populations with scattered individuals can cause deficient pollination and, together with other factors, may be responsible for a lack of seed regeneration, as pointed out in a study conducted on the south-western coast of Spain (Muñoz-Reinoso 2003, Muñoz-Reinoso *et al.* 2005).

Polluted sea spray and nutrient deposition

The presence of detergents or silt in sea spray can cause "crusting" of the beach and a decrease in sand deposition on the dunes, with a consequent increase in erosion and habitat loss (Ruffo 2002).

Another indirect effect of eutrophication (over-enrichment with nutrients) is the increase in atmospheric nutrient deposition, which can threaten the habitat's typical plant species. This aspect is still poorly studied; however, in Denmark, the National Environmental Research Institute puts the critical load for decalcified fixed dunes with *Empetrum nigrum* (habitat type 2140) at between 10 and 15 kg nitrogen ha⁻¹ year⁻¹ (Tybirk & Jørgensen 1999). As the present annual deposition in coastal dunes with *Juniperus spp.* is likely to be at approximately the same level, there is a risk that the long-term stability of this natural habitat type may be threatened by this source of environmental change. The growing nutrient load is

presumed to inhibit juniper regeneration, as this species can only sprout in mineral soil and is sensitive to competition from dense vegetation when in the early phases of growth (Pihl *et al.* 2001).

Climate change effects

Global changes in climate may affect coastal juniper dunes through changes in minimum winter temperatures, modifying the distribution of several plant species and frequent storms, with the resulting damage to the seaward side of the dune slacks. Changes in dune structure and ecosystems are often cyclical, with periods of loss (erosion) balanced by periods of gain (sand deposition) so these tendencies will be obvious only in the long term (Corre 1991).

Changes in storm frequency and intensity and the expected increase in sea level attributed to climate change could increase dune erosion due to more extensive coastal inundation and higher storm-surge flooding (EEA 2006).

Warmer and sunnier weather will probably lead to an increase in domestic tourism (Viner & Agnew 1999). If the issue of higher visitor numbers to sea dunes is not properly addressed in advance, increasing pressure might have an adverse effect on them.

An increase in temperature would probably affect species composition, but there are not enough studies on this subject. Also, the predicted higher rates of evaporation would have negative effects on juniper vegetation. Young juniper seedlings are vulnerable to summer drought and this climatic factor might have implications for juniper as regards any future global warming (Ward 2004).

However, defining future climate threats on habitats and species is very unreliable due to the uncertainty associated with: future greenhouse gas emissions, the consequent changes in climatic features (e.g. temperature, precipitation CO₂ concentrations), habitat and species responses to these changes (for instance, location, phenology, community structure) and the role of other socio-economic drivers of environmental change (JNCC 2007b).

2. Conservation management

General recommendations

From a management point of view, coastal dunes with *Juniperus spp.* should be considered as part of dune systems that need to be managed as a whole following a holistic approach (Fiorentin 2006). This is due to the interdependence of the dune succession stages from the sea inland. For instance, coastal erosion that may affect/destroy embryonic dunes or shifting dunes located before dunes with juniper thickets can have a deleterious effect on habitat. Sand and salt spray transported by the wind settles at the foot of the dunes and on the juniper formations and may jeopardise plant survival or the entire habitat. In most of cases, therefore, to manage the habitat, direct intervention is also needed in the other habitats situated seaward (Bensettiti *et al.* 2004).

Restoring the dune with juniper formations should be preceded by field surveys to study habitat status, location and coverage inside the dune ecological system, as well as floristic and phytosociological¹ characteristics. The study should also examine the general status of the dune system and, therefore, the status of related habitats seaward and the presence of possible threats such as erosion, uncontrolled access on the dunes, etc. If habitat status is good, with no threats, non-intervention is the best choice (Bensettiti *et al.* 2004).

Public understanding of dune processes, coastal changes and the need for management is still generally poor. As habitat restoration schemes often require a dramatic landscape change (e.g. felling pines) and sometimes the use of large heavy machinery, care should be taken to avoid conflict between members of local communities and dune managers. Conflict resolution diverts scarce resources away from conservation management (Rooney 2003).

Active management

The main measures for active recurring habitat management are:

- Eradication or control of invasive plants
- Fire prevention
- Shrub clearance and controlled grazing

Eradication or control of invasive plants

One of the main threats to the habitat is the natural and artificial spread of alien plants or plants that are not part of the habitat. Active recurring management should include their removal. Habitat proximity to built-up areas or artificial pine forest leads to constant invasion by garden plants, such as the moundlily yucca, scarlet firethorn and Italian stone pine, which have to be controlled.

The general criterion to be followed is that alien trees or shrubs on dune juniper thickets should be removed only if they are damaging the habitat and if they are invasive because the removal of plants and their roots can have negative impacts on substrate and surrounding natural vegetation (Fiorentin 2006).

As evidenced for dune heaths, when removing trees and other vegetation from dunes, it is important to minimise the level of nutrients left behind by the vegetation that has been removed. It is advisable to move it away from the site as soon as possible after felling/cutting. If this is not possible, vegetation should be stored in piles to minimise the fertilisation effect of dead leaves and needles (Skov-og Naturstyrelsen 2003).

Removing pines may allow the original environmental conditions to be restored, e.g. moderate sand mobility, salt spray deposition and wind flow. That may favour stress-tolerant species such as juniper, and

¹ Phytosociology: study of the organization, association and development of plant communities.

although negative effects on junipers are not likely, their acclimatization to 'new' conditions needs to be monitored. Appropriate management of pine plantations would also allow juniper populations within them to survive, as at La Breña Natural Park in Spain. There, the management of pine trees and understory for pine-seed production has allowed the junipers to regenerate through seeds, with sound recruitment (Muñoz-Reinoso 2003). Pines can be removed by cutting at the base since regrowth is rare.

In Enebrales de Punta Umbría Natural Landscape (Huelva, Spain) some pine tree (*Pinus pinea*) clearance were done in 2004 using two different treatments: 1) removing the pines closest to the maritime junipers –*Juniperus oxycedrus macrocarpa* (intermediate) and 2) removing all pine trees, as well as the largest Phoenician junipers (clearings). Salt spray deposition and Juniper cones and seeds production were estimated in the treated areas, and were compared to those in areas that had not been cleared (under pine dense canopy). Juniper growth and cone and seed production increased in the treated areas (intermediate and clearings). Cone production, number of seeds/cone, pollen density and twigs growth were significantly higher within the clearings (Muñoz-Reinoso 2007).

Manual removal of self-sown young conifers is necessary every year for at least 3 years after the initial clearance of plantations and dense overgrowth. Subsequently, clearance should be done manually every 3 years until the seed bank in the soil is exhausted (Skov-og Naturstyrelsen 2003).

Removing other species may be necessary, in particular as regards invasive species. Most invasive trees and shrubs have a great reproductive capacity after cutting. Cutting invasive alien shrubs and trees should be carried out only if strictly needed in order to avoid encouraging the growth of strong suckers. This option should be followed only if conditions in subsequent years are right for the regular removal of suckers.

Cuttings should be done before fruiting. Just after cutting, it might be necessary to use an appropriate herbicide swabbed on the remaining section of the trunk to prevent sucker growth between the cambium and the sapwood where holes have been drilled to aid penetration. When the plant is too near protected species, it is better to place the herbicide in small holes drilled in the trunk, which are then closed with mastic.

As herbicide use is a controversial issue, it is advisable to check beforehand whether it is legally permitted in the working area and whether its use is acceptable to local stakeholders. Trees or shrubs of local species should be placed where non-native trees have been removed. Well documented experiments have been carried out at dune sites in the Venetian Lagoon within the framework of a LIFE Nature project (Fiorentin 2006).

Fire prevention

Fire prevention is very important as fire is one of the most damaging threats to coastal dunes with *Juniperus spp* (MATT 2004). Fire prevention includes all activities and measures directed at reducing the occurrence of fires. The main aim of prevention is to eliminate the causes of forest fires. Prevention not only allows safeguarding the habitat but it is also less expensive than fire extinction (Ioannou & Papageorgiou 2007). Fire prevention should include the actions set out below.

Surveillance: The main objectives of surveillance are fire detection, warning and intervention, public information, law enforcement and fire suppression. In some countries most fire services use light vehicles equipped with lightweight fighting equipment, but some employ small rapid- intervention fire engines. Surveillance should be carried out using observation points covering large areas so as to minimize costs. They should focus on the most sensitive areas and where fire risk is highest. Fire breaks can be used by wardens' vehicles to cover large areas. Recently, satellite-based systems are permitting early warning of fire ignition over extensive areas. Plane-based systems are more common to cover specific areas in critical periods.

Making and maintaining firebreaks. Firebreaks are useful to isolate fire-prone areas in compartments, which stop fires from spreading. Considering the rarity and limited size of the coastal dunes with juniper, firebreaks should be made outside those areas, where cutting shrubs and trees does not damage rare habitats, but where fire risk is significant (e.g. unmanaged pine plantations rich in combustible material). One suggestion is to construct fire breaks along gentle ridges where heavy vehicles and fire engines can

move when there is a fire. Well designed breaks also permit effective firefighting operations if they can be used as roads by fire brigades. Regular maintenance of firebreaks is important to prevent the regrowth of shrubs and deposition of dead biomass and should be carried out in spring and early summer to eliminate as much new vegetation as possible. This can be done mechanically or by grazing sheep and cattle (Etienne & Rigolot 2005). However, it is important to bear in mind that making and maintaining firebreaks is expensive since usually it can only be done using manual methods (Arrigo & Quesada-Fernandez 2005).

Preventive actions on neighbouring areas: vegetation should be treated regularly in the areas bordering coastal dunes with juniper so as to reduce the risk of ignition and the spread of forest fires to juniper thickets. Treatments include: pruning, clearance and removal of both herbaceous and woody vegetation along roadsides, planting of fire-resistant species, prescribed burnings and controlled grazing.

Public awareness to prevent accidental fires: the great majority of fires are due to negligence and arson. Almost all Mediterranean countries have adopted measures to increase public awareness of forest fires. All mass media channels are engaged to reach the general public through television campaigns, posters and radio advertisements.

Shrub clearance and controlled grazing

In Central and Northern Europe, the habitat is difficult to maintain in the long term since the natural successional trend will always be towards climax woodland. Clearing scrub may therefore be essential to halt succession, and in order to support juniper regeneration, it is crucial to maintain grazing (Pihl *et al.* 2001; UK Biodiversity Group 1999).

In some dune heath areas, extensive grazing (particularly by sheep and possibly cattle) is recommended as a means of maintaining the open vegetation type dominated by herbaceous plants after the self-sown conifers have been removed. Grazing has a long tradition in dunes and other (semi-) natural habitats and is seen as one of the most promising management tools to remove biomass and create a heterogeneous vegetation. However, using it as a tool to manage nature requires a different approach to that of the past.

Grazing used to be carried out in flocks during the day, the animals being kept in stables or pens at night. A shepherd could channel the flock to grazing areas and many nutrients were removed from the area in the faeces left in the stables. Nowadays, livestock often spend night and day inside a fenced area with no regulation, and fewer nutrients are removed as a result. Although the effects of this kind of grazing might be more 'natural' compared to grazing with a shepherd, it is questionable whether nature management goals can be achieved in this way. Although the effects on vegetation are well known and in many cases positive, little is known about the effects of grazing on wildlife species (Skov-og Naturstyrelsen 2003).

Other relevant measures

Recovery interventions

Recovery interventions on degraded dunes with juniper thickets may involve planting relevant species.

Cultivating junipers in plant nurseries is not easy because of their low germination rates and slow growth during the early stages. When rapid recolonisation is needed, it is better to use species associated with juniper in the habitat of EU interest, such as *Pistacia lentiscus* (mastic tree) and *Phyllirea* sp. Other well known techniques involve the use of psammophilous (sand-loving) plant species in order to favour natural re-colonisation of juniper formations (MATT 2004).

All plants used in dune restoration must be native species. The best way to guarantee the origin of the plants and a successful reintroduction is to collect the propagation materials from residual habitats in the area and cultivate them in a nursery for reintroduction to the wild.

The juniper seeds should be planted in deep pots so as to permit sound root growth and to facilitate the placement of saplings in the dunes. Seeds should be collected from local plants on site, but a sufficient amount of seed should be left on the site (at least 50%) so as to permit natural *in situ* reproduction.

The juniper must be at least 30 cm high before being planted, and can be protected with plastic shelters. In Andalusia, where a programme to recover this habitat is underway (see below) the best results to get the plants established are achieved when about 1/3 of the aerial part of the plant is buried (Muñoz-Reinoso, pers. comm.).

An Italian Life Nature project (LIFE03NAT/IT/000141) has created a juniper arboretum using local seeds so as to collect propagation material rapidly and economically. Young junipers should be planted in rows at a distance of 2.5 meters, with row spacing of 4 meters (Fiorentin 2006).

Aftercare is important in order to guarantee complete planting success. It generally involves:

- annual inspection of shelters and fences to check maintenance needs.
- weed clearance from within shelters.
- removing and replacing dead plants (beating up).
- after the first three years it should be possible to reduce annual beating to biennial inspections
- removing shelters after five years and, if appropriate, reusing rather than disposing of them (McBride, 2005).

In Corsica, several projects carried out since 1987 have involved the planting on dunes of about 15,000 *Juniperus oxycedrus macrocarpa* and *Juniperus phoenicea* and the drafting of a management plan for the habitat, including suggestions based on ten years' planting experience (Paradis *et al.* 1997). For a higher success rate, young junipers should be planted in autumn, after the first rains. Small young plants should be planted in the most exposed areas since they are better able to survive (e.g. seafront of dunes), but they need to be protected with shelters: The biggest and oldest specimens (1 meter/5 years) should be planted more landward, where protection from other species is greater. Plants of *Juniperus oxycedrus macrocarpa* should be placed more seaward in relation to *Juniperus phoenicea*, which is less resistant to the harsher conditions.

The Regional Ministry of the Environment of Andalusia is developing a conservation programme whose main purpose is to revert the current regression of maritime juniper (*Juniperus oxycedrus* subsp. *macrocarpa*) as it is considered an endangered species in Andalusia (Redondo & Saavedra, unpublished). Several preparatory actions were implemented between 1999 and 2001, which included an inventory of maritime juniper populations, assessment of the ecological and biological status of the species in Andalusia, identification of the main factors threatening maritime juniper conservation, development of a new methodology for plant production and identification of proper sites for species reintroduction. The main factors controlling species distribution were identified as being high risk of forest fire, genetic isolation of small existing populations, habitat transformation due to urban development and pine tree plantations and the spread of invasive species such as *Carpobrotus edulis*.

The risk of genetic isolation in the current Andalusian population is being addressed through the planting of *Juniperus* trees using seedlings produced in regional nurseries. Plantations are made both in small populations and in potential habitats where the maritime juniper does not currently occur. Different planting conditions, such as polygons vs. random irregular distribution, planting depth, use of cylindrical protectors of plastic grid and the need for irrigation are considered.

This programme also includes pine trees clearance, including pruning and removal of individuals selected according to proximity to juniper trees, and the removal of *Carpobrotus edulis* by hand to reduce their competitive predominance and the environmental changes caused by them. Finally, different *in situ* experiments are being carried out in order to select the optimum conditions for juniper reintroduction and management. An optimum method, based on green-house plant production from seeds collected from wild populations has been achieved.

An interesting experience on habitat recreation has been implemented on the coast near Valencia within a LIFE project (LIFE04NAT/ES/000044, Sanchez *et al.* 2007). As the dune ecosystem had been totally destroyed, the potential vegetation at the site was studied with a predictive system based on GIS tools and photo-interpretation, which made it possible to generate models that can be used to regenerate habitats that have disappeared. The habitat restoration included planting about one thousand maritime juniper produced in a local plant nursery.

There is also a project aimed at restoring an ancient dune system in El Partido (Doñana National Park, south-western Spain), where a few remnants of native juniper woodland (*Juniperus oxycedrus* ssp. *macrocarpa* and *J. phoenicea* ssp. *turbinata*) survive in dunes close to the coastal fringe (García-Novo *et al.* 2007). Given that the distance (almost 10 km) of the national park from the sources of seeds of dune shrub species and the scarcity of remnants of mature vegetation meant there was no adequate seed supply to the area, making succession to more mature stages of dune vegetation virtually impossible, it was decided to undertake ecological restoration of dune vegetation by planting a series of species typical of this habitat (see table 1).

The species were planted in a way that enhances the visual perception of the dune and its constituent parts. The plantation was done also taking into the various parts of the dune (dry, intermediate and humid) by placing drier species in the upper parts (*Juniperus phoenicea* ssp. *turbinata*) and *Juniperus oxycedrus* ssp. *macrocarpa* and the rest along the dune slopes and delineating its perimeter. Small patches of *Lavandula stoechas*, *Halimium halimifolium* and *Rosmarinus officinalis* were placed along the intermediate part of the dune. Besides the difference in species shape, their flowering colour helps visitors to interpret the parts of the dune during the various flowering seasons.

Table 1: List of dune species used in the restoration project in El Partido (Doñana, Spain).

Dune species	Distance to water table
<i>Juniperus oxycedrus</i> ssp. <i>macrocarpa</i>	Low
<i>Juniperus phoenicea</i> ssp. <i>turbinata</i>	High
<i>Halimium halimifolium</i>	Intermediate
<i>Cistus libanotis</i>	High
<i>Lavandula stoechas</i>	Intermediate
<i>Rosmarinus officinalis</i>	Intermediate
<i>Thymus mastichina</i> ssp. <i>donyanae</i>	High-intermediate
<i>Retama monosperma</i>	Intermediate

Plant production

Active recurring management of juniper dune habitat should include reproduction of the main representative species to replace the alien plants removed and for recovery interventions in general. The creation of a plant nursery for this purpose is a long-term action also aimed at conserving *ex situ* the species' genetic characteristics.

Planting should only be considered where natural regeneration is impossible. Sowing is generally slower in comparison with vegetative propagation, taking up to three or four years, whilst plants grown from cuttings can be ready within two years. However, recent experiences in Northern Italy on common juniper indicate that seeds treated so as to break their dormancy can germinate from the first spring and grow to 25 cm by the end of the first year (Fiorentin *et al.* 2006).

Sowing provides greater genetic diversity. Conversely, the genetic diversity of cuttings is dependent upon the number and range of donor bushes and, although quicker, root development may be poorer. This kind of replication is necessary when the genetic characteristics of a local population have to be replicated exactly. In general, the genetic and health advantages of sowing means it ought to be the preferred propagation method. For larger projects, a combination of plants from cuttings and seeds is probably the best strategy as this enables early planting and tangible results, whilst improving the future genetic diversity of the plants (McBride 2005). The low germination rate of juniper seeds is a constraint, and suitable seed treatment is required to obtain as many plants as possible from the seeds collected. One of the possible procedures consists of two periods of cold stratification at 90 days for 3.5°C separated by 60-90 days at 20°C diurnally. This results in successful germination of 70-75% of the seeds over 20-30 days. Some authors (Piotto and Di Noi 2001, Fiorentin *et al.* 2006) recommend that seeds be removed from the fruit and soaked in 1% citric acid solution for 4 days before being stored in well aerated conditions at 4°C for 30 weeks to break their dormancy. If seeds are in the open air in compost and kept free of rodents, a few will germinate in the first year, most in the second year and several more over the next two to three years (Ward 2004).

Raising the awareness of local people and tourists about the importance of the habitat

A lack of consideration of the importance and rarity of coastal juniper dunes is not good for the habitat so it is important to raise awareness amongst local people and visitors, particularly by:

- raising public awareness of coastal threats and values
- involving the public in promotion and management activities
- providing targeted awareness-raising opportunities, including guided walks, talks, seminars and educational events, linking with existing initiatives
- providing education opportunities with schools and higher education establishments
- providing appropriate signposting, interpretation, leaflets, etc., in consultation with local communities.
- educational displays at backshore car parks or along footpaths should be used to explain management schemes and encourage public interest and support for management objectives (SNH 2000).

Monitoring and limiting coastal erosion

Coastal erosion and the consequent risk of habitat degradation should be constantly monitored, in particular on the Mediterranean coast, where this phenomenon is increasing and is damaging coastal habitats.

Monitoring must be driven by the need to provide appropriate data for shoreline management. It is important to understand local coastal dynamics, short-term fluctuations and long-term trends in dune-beach system in order to understand the present and predict future developments. Monitoring allows significant change to be identified so that a reasoned response can be devised and implemented, e.g. if dune erosion may lead to damage to an important backshore asset such as juniper priority habitats.

In terms of evaluating dune evolution a combination of techniques is necessary to locate the erosion or accretion areas, quantify the extent of damage, determine the likely causes and evaluate the rate of change. The survey methods can be in the field (with topographic/GPS systems), by plane (using aerial photography) or involve detailed and regularly available satellite images. In any case, measurements should give the bearing and distance to identifiable features from each datum. These features will be some or all of the following:

- seaward limit of yellow dunes
- seaward limit of foredunes
- scarp slope or any identifiable part of the seaward face of the dune system
- boundary between different types of dune/beach system (i.e. the transition between dune, shingle upper beach, sand lower foreshore, muddy offshore zone, etc.)
- signs of dune retreat or areas of wind blown erosion (blow-outs)
- signs of trampling by livestock or people

Having identified the various geomorphological zones, any change to their extent between successive surveys should be mapped. The horizontal rates of change of the various boundaries can be calculated and put into context. Simple spreadsheet software or survey analysis packages will allow changes to be stored and presented effectively. Initially surveys should be undertaken bi-monthly, with additional surveys following severe storms.

Regular surveys should be completed at the same point in the tidal cycle, e.g. during spring tides, and post-storm surveys should be completed as close to the event as possible. After the first year (say, six to ten surveys) the frequency can drop to quarterly, plus post storm (say, four to eight surveys).

After several years the surveys will have revealed the potential extent of short-term change, and the frequency can drop once more to early spring and early autumn, plus extreme storms. The timing of these ongoing surveys should be consistent in terms of the month and the tidal state, perhaps ideally the March equinox tide (erosion expected) and the first Spring tide in September (accretion expected). At this frequency the long-term trends can be monitored, and can be analysed with a well founded knowledge of short-term variation.

Having mapped out the erosion areas, some preliminary evaluation should be made as to the likely causes of erosion. Wind data can be purchased from the nearest anemometer station and any periods of high winds from the main onshore wave generating directions highlighted. Records from the nearest tide gauge station should be examined for any periods of higher than normal water levels. This simple data review should reveal the recent periods of likely dune erosion.

If the records fail to identify any such events, other reasons for erosion should be considered. Natural reasons for dune toe erosion should be obvious from the site inspection. For example, the undercutting of the dune foot by meandering tidal channels within an estuary should be evident.

If erosion has been caused by man, and is of a short-term nature, this too should be obvious from the site inspection. Longer term erosional trends may be caused by structures interfering with the natural supply of sand to the dune area. Such structures could be groynes located some distance from the site or possible underwater obstructions to sand movement. Evaluating the causes of erosion may therefore entail discussions with adjacent landowners, local authorities, harbour authorities, etc. (SNH 2000).

Special requirements driven by relevant species

The reasons for the decline of *Lanius collurio* (red-backed shrike) are poorly understood and details of the species habitat requirements are not yet known. At the moment there are no clear guidelines on how to conserve this bird. Red-backed shrike needs a variety of habitats and that the habitat is maintained with open and species-rich vegetation stages.

In the Netherlands and other parts of north western Europe, acidification and eutrophication (due to increased nitrogen deposition), drainage and changes in land use cause accelerated vegetation succession in coastal dunes. This results in encroachment by tall grasses and bushes.

The lack of plants variety has negative consequences for the resident fauna. Many insect species, especially larger ones, decrease in numbers. As a consequence, bird species that depend on these insects as a food source, such as red-backed shrike, have disappeared from the Dutch coastal dunes (Esselink *et al.* 2003). Particular attention should therefore be paid to removing non-native trees and shrubs as suggested above.

Cost estimates and potential sources of EU financing

Cost estimates

Costs may vary a lot depending on the type of action to be undertaken and surface areas to cover. Some particular examples from previous experiences (mainly LIFE-Nature projects) are provided below for different actions.

Clearing planted pine trees and eradication or control of invasive plants

- During the LIFE project "Coastal habitats conservation in Cadiz" (LIFE03 NAT/ES/000054) some eradication actions were developed at Pinar de Roche, such as pine tree clearance (4.8 ha, €12,109), and eucalyptus cutting and stump removal (6.73 ha, €1,875).
- Within the same LIFE project (LIFE03 NAT/ES/000054), *Carpobrotus edulis* was removed manually at Punta de Trafalgar (1.74 ha, €2,397).
- In addition to mechanical and manual removal of invasive plants, some herbicides could also be applied directly on the invasive plants when the surface affected is large, in order to totally remove the invasive plants and avoid resprouting (Ley *et al.* 2007). The most used herbicides, due to their low toxicity, are those made of "Glifosato" and the recommended dose is 160 ml per 100 m².

Fire prevention

- The LIFE project "Coastal habitats conservation in Cadiz" (LIFE03 NAT/ES/000054) also created perimetral firebreaks to protect the areas under regeneration from fire (3,200 m, €2,015).

Shrub clearance and controlled grazing

- Shrub removal at Pinar de Roche (LIFE03 NAT/ES/000054): 4,48 ha, €1,764.

Recovery interventions – plant production

- The LIFE project “Recovery of coastal sand dunes with *Juniperus* spp. in Valencia” (LIFE04 NAT/ES/000044) involved the cultivation and planting of about 1,000 junipers on a surface area of 55 ha. The action, which lasted about 30 months and required 12 workers, included seed collection and cultivation (*Juniperus oxycedrus* subsp. *macrocarpa*) in a local nursery, preparation of the area to be restored and planting. Total estimated cost for the action was €674,305 (€12.260/ha).
- As part of the LIFE project “Coastal habitats conservation in Cadiz” (LIFE03 NAT/ES/000054), land was prepared for juniper cultivation in two areas. At Pinar de Roche, 85 ha were prepared (€25,190) for subsequent planting of maritime juniper and a few other different species (€39,916), whereas at Punta de Trafalgar 11,9 ha were prepared (€5,035) for the planting (€15,640).

Potential sources of EU financing

The majority of the marine and coastal habitats are not explicitly included in the major grant schemes operating in Europe (UK Biodiversity Group 2000). However, in the past, several restoration actions and active management of juniper dunes have been carried out with co-financing of the LIFE Nature instrument (Picchi *et al.* 2006; Houston 2005) and the community initiative Interreg (Regione Lazio 2005).

The majority of the Community’s co-financing for Natura 2000 in the period 2007-2013 will be delivered through different existing Community funds aiming to enhance rural, regional, and marine development in the EU. The integrated use of these resources will make it possible to finance various active recurring management actions for areas with habitats in the Habitats Directive that are included in the Natura 2000 network.

The programming of EU funds envisages that each Member State and/or region identifies the issues that are of most concern locally, and prioritizes EU funds in order to address those issues. This means that specific funding opportunities for Natura 2000 in 2007-2013 are determined by the national and regional programmes that have been prepared by the Member States on the basis of the EU Regulations that set out the main characteristics of each fund. The reference authority to be contacted for additional information is the European Commission in the case of LIFE+ and FP7 funds, or the national and the local authorities for the other funds mentioned.

The analysis of opportunities presented in the tables below is based on the guidance handbook “Financing Natura 2000”, issued by the European Commission (Torkler 2007), which is based on the text of the EU Regulations for each individual fund. The activities have been selected from the 25 on the list in Annex 3 to the Commission’s Communication on Financing Natura 2000 (COM(2004)431 final), excluding the ones not relevant for this study and the activities not covered by European funds (e.g. surveillance).

It should be noted that the activities mentioned often need to be integrated into a broader development context (projects, programmes) and refer to specific areas.

The funds taken into consideration are:

- The Structural Funds (European Social Fund -ESF and European Regional Development Fund -ERDF)
- The Cohesion Fund (CF)
- The European Agricultural Fund for Rural Development (EAFRD)
- The European Fisheries Fund (EFF)
- The Financial Instrument for the Environment (LIFE+)
- The 7th Research Framework Programme (FP7)

Types of activities	EU Funding opportunities with references to EU Regulations
Management planning	
1. Preparation of management plans, strategies and schemes (Elaboration and/or update of management and action plans, land use plans etc.)	EAFRD art. 52 (b)(iii): it could finance Natura 2000 management plans of coastal sites associated to rural areas, and high nature value areas in the context of conservation and upgrading of the rural heritage. The art. 63, Leader, could finance development of site management plans as an objective of local development strategy encouraging the sustainable management of environmentally sensitive habitats such as coastal dunes. LIFE+ art. 3 and Annex I, LIFE+ Nature and Biodiversity component: it could finance site and species management and site planning, including the improvement of the ecological coherence of the Natura 2000 network, in particular in marine and coastal areas. ERDF art. 4-6 could finance development of management plans, but only where management of the Natura 2000 site is crucial for risk management.
2. Establishment of management bodies (Start-up funding, feasibility studies, management plans etc.)	ERDF art. 4-6, could finance establishment of regional/trans-boundary management bodies to promote sustainable use of biodiversity and nature protection in coastal areas.
3. Consultation – public meetings, liaison with landowners (Including costs incurred for the organisation of meetings and workshops, the publication of consultation outcomes, financial support of stakeholders, etc.)	EAFRD art. 52 (b)(iii): could support regional networking, sharing of positive experiences to communicate economic benefits of Natura 2000 sites in the context of initiatives to conserve and upgrade the rural heritage, and within, private-public partnership for sustainable rural development (Leader, art.63). FP7 art. 2(2)f: Transnational Cooperation, theme Environment, could finance consultation and networking as part of a research projects including stakeholders involvement. ERDF art. 4-6: could finance networking and consultations on various socio-economic aspects of Natura 2000 sites on local/regional/ transnational level. ESF art.3 (2). Could finance networking between public and private bodies, departments, public administrations and public services etc. in relation to management of coastal Natura 2000 sites, in objective Convergence regions.
4. Review of management plans, strategies and schemes	EAFRD art. 63: Leader, could finance revision of present management schemes to achieve a more sustainable rural development. LIFE+ art. 3 and Annex I: Nature and biodiversity component could finance site planning, including the improvement of the ecological coherence of the Natura 2000 network, the development and implementation of species and habitats conservation action plans. FP7 art. 2(2)f: Transnational Cooperation, theme Environment, could finance plans review as part of a research projects aimed at determining plans efficacy. ERDF art. 4-6: could finance revision of management plans, in the framework of risk management, and in transnational cooperation initiatives to favor ecotourism in areas needing socio-economic diversification.
5. Maintenance of facilities for public access to and use of the sites, interpretation works, observatories and kiosks etc. (Including costs related to guides, maps, related personnel.)	EAFRD art. 52, Art. 63, Leader could finance maintenance, restoration and upgrading of facilities for public access to Natura 2000 sites in the context of the conservation and upgrading of rural heritage and private-public partnership for sustainable rural development strategies. EFF, art. 41(1) could finance maintenance or improvement of public access facilities for use at coastal sites, to facilitate development of eco-tourism with the objective of restructuring and redirecting economic activities. ERDF art. 4-6, could finance development of infrastructure to improve access linked to biodiversity and Natura 2000 contributing to sustainable economic development and diversification of rural areas.

Types of activities	EU Funding opportunities with references to EU Regulations
Ongoing habitat management and monitoring	
<p>6. Conservation management measures – maintenance and improvement of habitats’ favourable conservation status (Including restoration work, provision of wildlife passages, management of specific habitats, preparation of management plans.)</p>	<p>EAFRD art. 63: Leader could finance management of local habitats to facilitate objectives of the local rural development plan. Art. 36 (b)(i) could finance first afforestation of agricultural land to finance habitat recovering on dunes transformed in cultivations in the past. EFF art 41(1)(f) could finance restoration of coastal habitats so as to protect the environment in fisheries areas to maintain its attractiveness. LIFE+ art. 3 and Annex I, Nature and biodiversity component, could finance pilot conservations projects for site and species management, implementation of species and habitats conservation action plans, in particular in coastal areas. FP7 art. 2(2)f, Transnational Cooperation, theme Environment, could finance coasts conservation management measures as part of a research projects on management options of natural habitats. ERDF art. 4-6, could finance adaptation/improvement of transportation infrastructure to mitigate effect to Natura 2000 coastal sites e.g. to reduce habitat fragmentation, and the protection of coastal areas from erosion, pollutants.</p>
<p>7. Conservation management measures in relation to invasive alien species (IAS) (Including restoration work, infrastructure, management of specific species, preparation of management plans).</p>	<p>EAFRD art. 36 (b)(v) could finance removal of invasive plant species that degrade native plants and forest structure in the context of forest-environment payments. EFF art. 26(1)(c) could finance retraining of fishermen as rangers in habitat restoration to work on Natura 2000 coastal sites, including invasive species management. EFF art 41(1)(f) could finance restoration of coastal habitats e.g. restoration of coastal matorrals through removal of invasive plants within initiatives to protect the environment in fisheries areas to maintain its attractiveness. LIFE+ art. 3 and Annex I, Nature and biodiversity component, could finance removal of invasive alien species or elaboration of demonstrative methodologies as part of larger nature conservation projects. ERDF art. 4-6: various opportunities could be used to fund a one-off eradication or control programme for an IAS with significant negative economic/social/environmental effects. FP7 art. 2(2)f: Transnational Cooperation, theme Environment, could finance control of alien species as part of a research projects on biodiversity threats.</p>
<p>8. Implementation of management schemes and agreements with owners and managers of land or water for following certain prescriptions</p>	<p>See activity 6 above.</p>
<p>9. Monitoring and surveying (Refers mainly to one-off costs related to monitoring and surveying activities, eg development of monitoring plans, methods and equipment; training of personnel.)</p>	<p>EAFRD art. 52 (d) could finance base studies aimed at elaborating the local development strategies. Art. 63, Leader, could finance monitoring activities in the framework of rural development projects. LIFE+ art. 3 and Annex I, Nature and biodiversity component, could finance projects aimed at designing and implementing policy approaches and instruments for monitoring and assessing nature and biodiversity and the factors, pressures and responses that impact on them in natural areas. FP7 art. 2(2)f, Transnational Cooperation, theme Environment, could finance biodiversity surveying as part of research projects on new methods to monitor biodiversity. ERDF art. 4-6: could finance habitat monitoring plans or infrastructures, in the framework of environmental risk management programmes, or in a transnational cooperation initiatives to monitor coastal zones. CF art. 2(2): could finance monitoring plans on Natura 2000 coastal sites as part of larger projects on regional sustainable development in “Convergence” regions.</p>

<p>10. Risk management (fire prevention and control, flooding etc) . Includes the preparation of wardening and fire-control plans, development of relevant infrastructures, and the acquisition of equipment.</p>	<p>FP7 art. 2(2)f: Transnational Cooperation, theme Environment, could finance research projects on new methods to manage risks in Natura 2000 sites. ERDF art. 4-6: could finance plans or infrastructures to avoid risks such as fires, invasive species, in the framework of environmental risk management programmes, at local/regional/transnational level. LIFE+ art. 3 and Annex I: Nature and Biodiversity component: see point above. Information and Communication component: could finance training activities of agents involved in forest fire prevention initiatives.</p>
<p>11. Provision of information and publicity material (Includes establishing communication networks, production of newsletters and awareness and information materials, setting-up and maintenance of internet pages, etc.)</p>	<p>EAFRD art. 52.: could finance promotion of coastal Natura 2000 sites within environmental awareness actions on rural heritage associated with the development of high natural value sites. art. 63: Leader, could finance information material on the environmental values of the rural areas e.g. on neighboring coastal Natura 2000 sites within private-public partnership for sustainable rural development. EFF, art. 41(1): could finance production of informative material on coastal Natura 2000 sites in the framework of redirecting fishing activities, facilitating development of coastal eco-tourism. LIFE+ art. 3 and Annex I: Nature and biodiversity component, could finance public awareness activities e.g. in the context of projects for coastal site and species management. ERDF art. 4-6: could finance elaboration and spread of informative material, in the framework of programmes to enhance ecotourism, at local/regional/transnational level. ESF art 3(2): could finance elaboration of information for training programmes to strengthen institutional capacity and the efficiency of public administrations.</p>
<p>12. Training and education Including production of handbooks, seminars, workshops, communication materials.</p>	<p>EAFRD art. 20, 52.: could finance training and networking necessary for realisation of the local development strategy (e.g. regional promotion in relation to Natura 2000), to enhance ecotourism e.g. through promotion of coastal Natura 2000 sites. EFF, art. 41(1): could finance training to fishermen to develop coastal eco-tourism on coastal Natura 2000 sites in the framework of projects to redirect fishing activities. LIFE+ art. 3 and Annex I: Information and Communication component could finance training activities of agents involved in forest fire prevention initiatives. ESF art 3(2): could finance training activities on good management of Natura 2000 coastal sites in the context of training programmes for public administrations to strengthen institutional capacity and the efficiency.</p>
<p>13. Facilities to encourage visitor use and appreciation of Natura 2000 sites</p>	<p>See activity 5 above.</p>

For further information on EU financial possibilities and synergies between funding programs during this period, a Guidance Handbook on the funding of the Natura 2000 network has been produced (Torkler 2007). A web tool (based on that handbook) to easily determine the possible funding for Natura 2000 sites is available in: <http://financing-natura2000.mocccu.com/pub/index.html>. There is also a more general handbook on the EU financing of Environmental projects (Lang *et al.* 2005), which is available at: http://ec.europa.eu/environment/funding/intro_en.htm.

Furthermore an IT-tool is available on the EC web site: http://ec.europa.eu/environment/nature/natura2000/financing/index_en.htm.

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