

The conservation of sand dunes in the Atlantic Biogeographical Region: the contribution of the LIFE programme

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Abstract

Since 1992 the EU LIFE programme has supported a series of dune conservation projects within the Atlantic Biogeographical Region. LIFE co-financing has been used to safeguard threatened sites through land purchase, to support the development of the Natura 2000 network, to undertake practical management and to interpret the functions and values of dunes to a wide audience. The additional resources from LIFE have been targeted at specific sites, at national programmes and, through wider networking initiatives, at the community of practitioners. LIFE projects have contributed to the development of European and National policies by acting as case studies and milestones. Dissemination of information is aided by practitioners networks such as the European Union for Coastal Conservation and through the series of conferences and workshops held within the framework of the projects. A further step may be to use the completion of the Natura 2000 network as a catalyst for encouraging a more coordinated approach to networking and for raising some of the key issues affecting dune systems at the European level.

Keywords: Dunes; LIFE programme; Atlantic Biogeographical Region; Project results; Networking.

Introduction

Sand dune habitats of the Atlantic Biogeographical Region

An inventory of the sand dunes of Europe was compiled in 1991 on behalf of the European Union for Coastal Conservation (Doody, 1991). This important piece of work is now updated (*cf.* Doody, 2005). The Atlantic Biogeographical Region with its large dune systems along the Aquitaine Coast of the Bay of Biscay, the Dutch mainland, the Wadden Islands, the machair of Ireland and Scotland and the Danish west coast is the major European region in terms of the scale and number of its dune systems.

Sand dunes are well represented in the EU Habitats Directive (Table I) with 10 habitats listed under 'Sea Dunes of the Atlantic, North Sea and Baltic coasts'. Other dune habitats can be added including coastal dunes with *Juniperus* spp. (found only in UK and Denmark in the Atlantic Region) and there is a considerable range of habitats (Table II)

and associated Annex II and Annex IV species (Table III) associated with European coastal dunes.

Table I. Sea dunes of the Atlantic, North Sea and Baltic coasts

Code	Description	BE	DE	DK	ES	FR	IE	NL	PT	UK
2110	Embryonic shifting dunes	X	X	X	X	X	X	X	X	X
2120	Shifting dunes along the shoreline with <i>Ammophila arenaria</i> (white dunes)	X	X	X	X	X	X	X	X	X
2130*	Fixed coastal dunes with herbaceous vegetation (grey dunes)	X	X	X	X	X	X	X	X	X
2140*	Decalcified fixed dunes with <i>Empetrum nigrum</i>		X	X			X	X		X
2150*	Atlantic decalcified fixed dunes (<i>Calluno-Ulicetae</i>)	X	X			X	X	X	X	X
2160	Dunes with <i>Hippophae rhamnoides</i>	X	X	X		X	X	X		X
2170	Dunes with <i>Salix repens</i> ssp. <i>argentea</i> (<i>Salicion arenariae</i>)	X	X	X		X	X	X	X	X
2180	Wooded dunes of the Atlantic, Continental and Boreal Region	X	X	X		X		X		
2190	Humid dune slacks	X	X	X		X	X	X	X	X
21A0*	Machairs (*in Ireland)						X			X

Six sub-types are identified under the priority habitat 2130 fixed coastal dunes, representing a series of types from the Straits of Gibraltar to the Baltic Sea.

Table II. Additional habitats associated with dune coasts

Code	Description	BE	DE	DK	ES	FR	IE	NL	PT	UK
1110	Sandbanks which are slightly covered by sea water all the time	X	X	X	X	X	X	X	X	X
1140	Mudflats and sandflats not covered by seawater at low tide	X	X	X	X	X	X	X	X	X
1150*	Coastal lagoons		X	X	X	X	X			X
1210	Annual vegetation of drift lines		X	X	X	X	X		X	X
1220	Perennial vegetation of stony banks		X	X		X	X			X
1330	Atlantic salt meadows (<i>Glaucopuccinellietalia maritima</i>) –also some 1310 and 1320	X	X	X	X	X	X	X	X	X
2250*	Coastal dunes with <i>Juniperus</i> spp.			X						X
2260	<i>Cisto-Lavenduletalia</i> dune sclerophyllous scrubs				X	X				
2270*	Wooded dunes with <i>Pinus pinea</i> and/or <i>Pinus pinaster</i>					X			X	
2310	Dry sand heaths with <i>Calluna</i> and <i>Genista</i>	X	X	X				X		
2320	Dry sand heaths with <i>Calluna</i> and <i>Empetrum nigrum</i>		X	X				X		
2330	Inland dunes with open <i>Corynephorus</i> and <i>Agrostis</i> grasslands	X	X	X		X		X		X
3110	Oligotrophic waters containing very few minerals of sandy plains (<i>Littorelletalia uniflorae</i>)	X	X	X	X	X	X	X		X
4030	European dry heaths	X	X	X	X	X	X	X	X	X
7230	Alkaline fens	X	X	X	X	X	X	X		X

Table III. Some Annex II and Annex IV species associated with sand dunes in the UK

Great crested newt	<i>Triturus cristatus</i>
Narrow-mouthed whorl snail	<i>Vertigo angustior</i>
Slender Naiad	<i>Najas flexilis</i>
Fen Orchid	<i>Liparis loeselii</i>
Shore Dock	<i>Rumex rupestris</i>
Petalwort	<i>Petallophylum ralfsii</i>
Natterjack Toad	<i>Bufo calamita</i>
Sand Lizard	<i>Lacerta agilis</i>

Current uses and threats to European dune systems

Coastal communities have generally utilised the sandy soils in association with the sea and seashore and the backlands (polders, peatlands, etc). However, historical records throughout north-west Europe show that large scale destabilisation and sand drift (the so-called wandering dunes) also occurred. Whole communities could be driven out by advancing waves of mobile dunes. Factors triggering dune de-stabilisation probably included climatic deterioration, increasing populations and over-use, de-forestation, and general lack of management, often despite local and national laws. Powerful natural cycles may also be at work as dune coasts adjust to a changing coastline.

By the early twentieth century the stabilisation of sandy 'wastelands' was advocated by coastal authorities and as technology improved large scale projects, such as the dune building programmes along the Aquitaine coast, could be completed.

Most dune systems are subject to ongoing low intensity management. The open areas of fixed dunes and dune heaths are often, but not always, plagio-climax communities kept open by grazing, cultivation, scrub cutting and fires.

The present day use and management of dune systems also varies from the local community-based approaches on the machairs of Ireland and Scotland to more centralised control through Forestry Services and nature agencies throughout much of northern Europe.

Uses of dunes fall into a number of broad categories and generally several types of land use are to be found within one 'system':

- The continuation of low-intensity agricultural activities including grazing, cultivation and rabbit-cropping. There are no easy-to-hand figures of the extent of dune area which is being maintained through such traditional and re-introduced practices. In a healthy situation a dune system will tolerate some marram cutting, sand extraction for agricultural use (especially within the same system), cultivation and trampling by livestock. Most traditional activities will be able to continue within Natura 2000 sites and may even be promoted. The machair coasts are essentially agricultural zones.

- The use of the dune area primarily as a recreational site where the needs of tourism infrastructure impacts on the naturalness of the site. Such uses are often linked also to beach-based recreation and the beach and dunes must be treated as one unit for overall management planning.
- The use of the dune area primarily as a nature reserve where access and management are tailored to the needs of species and habitats. Keeping the open landscape is often a priority with a focus on scrub control and the conservation of grazing management.
- The use of the dune area as a sea defence.
- The use of the dune area for land uses such as forestry, water abstraction, sand extraction, military use, golf courses and other leisure activities. In all these uses nature can still survive well although natural processes (*e.g.* blowouts) are often restricted.

Current threats to dune systems include the catastrophic damage caused by development, and the more insidious cumulative damage caused by fragmentation, over-stabilisation, afforestation, the edge effects of development, uncontrolled recreational uses, water loss, nutrient deposition, lack of ecological understanding and general lack of awareness and respect by local communities and tourists.

Projects funded under LIFE

LIFE projects (through the strands of LIFE-Environment and LIFE-Nature) have helped to support conservation by translating new ideas about dune management into practice and demonstration. The two elements of the LIFE programme have proved complementary in helping to link broad management issues (forestry, beach management, erosion etc) to the specific nature conservation priorities of Natura 2000. Ecological knowledge and experience has also been exchanged through a LIFE-Nature Co-op project.

Some of the actions undertaken by these projects include:

- Working with local communities to raise awareness of the need for sustainable management
- Reducing the impact of recreation pressure through the introduction of visitor management
- Stabilisation of sand-drift where infrastructure and development is at risk whilst also supporting less-intensive techniques where time and space allow (the dynamic approach)
- The re-building of shifting dunes damaged by tourist pressure
- Changing attitudes within well-established sectors such as forestry to allow a new balance with nature to be achieved
- Taking nature conservation messages to new partners such as golf courses and military sites
- The purchase of sites at risk and the development of land acquisition policies
- The restoration of dune areas following the removal of development infrastructure
- The establishment of management and monitoring systems at the Natura 2000 site level

- Investigations into the difficulties of monitoring habitat quality in such naturally dynamic areas
- Long-term predictions of habitat losses and gains as a result of sea-level rise and climatic change
- Studies into insidious threats such as nutrient deposition
- Production of brochures and publications at local, national and international level
- Encouraging the development of European networks through workshops, conferences and publications.
- Working in parallel with other EU funding sources (*e.g.* INTERREG) and national funding opportunities to develop long-term management programmes.

A concurrent theme within LIFE projects is the motivation of the people involved in assembling and running the projects. Often they are breaking out from 'institutional' working practices to develop new ideas and engage new stakeholders.

An analysis of the work of several LIFE projects

A search of the LIFE database for the keywords 'dunes' or 'sand dunes' gives nearly 100 projects. Not all of these are directly associated with dune management and the range of projects in the Mediterranean and Baltic Seas are not included in this review. For the Atlantic Biogeographical Region 16 projects have been selected as particularly relevant for dune conservation (Table IV). Whilst no projects have been funded to date in Germany and the Netherlands the contribution to knowledge and networking from these countries has helped with the understanding of dune habitats and conservation concerns. Dutch interest in wider networking led to the establishment of the European Union for Dune Conservation (now EUCC) in 1987.

The contribution of the LIFE fund to the 16 projects selected is about 11.4 million Euro with a total project expenditure of 22. million Euro (an average of 50%).

Projects in France

The Office National de Forêts has co-ordinated two LIFE-Environment projects on coastal dunes. The first 'Biodiversity and dune protection' marked a turning point in the forestry sector's understanding of their responsibilities towards forest production, coastal defence, recreation management and nature conservation. The aim was to find management solutions which conserved the biodiversity of the dunes at six sites. The results were drawn together through the publication of 'Biodiversité et protection dunaire' (Favennec and Barrière, 1997).

Project actions included the development of a restoration plan to reduce recreation damage and repair dunes (Mimizan and Messanges), dune stabilisation to protect property whilst maintaining the landscape value of the dunes (Cap-Ferret), gaining understanding of coastal processes through the production of eco-dynamic maps (La Coubre and Oléron), preparation of a management plan to conserve the biodiversity of a complex dune system (Merlimont), restoration and diversification of a dying dune woodland (Vendée) and conservation management of forests (Landes de Lessay).

Table IV. Selected LIFE projects

Project reference	Project title	Total €	EU €	Beneficiary
92ENV/F/000021	Protecting dunes from erosion	1,600,000	600,000	Conservatoire de l'Espace Littoral et des Rivages Lacustres
92ENV/F/000024	Biodiversity and dune protection	2,865,000	1,386,946	Office National des Forêts
94NAT/DK/000492	Re-establishing lichen and coastal heaths in the Anholt desert, Denmark	490,000	245,000	Arhus County
95ENV/P/000119	Recovery, conservation and management of species and natural habitats in the coastal area of central Portugal	695,306	281,558	University of Coimbra
95ENV/P/000254	Campaign for the dunes' preservation in Vila Nova de Gaia	607,124	290,849	Câmara Municipal de Vila Nova de Gaia
95ENV/F/000676	Rehabilitation and sustainable management of four French dunes	913,134	456,567	Office National des Forêts
95NAT/UK/000818	A conservation strategy for the sand dunes of the Sefton Coast, North West England	1,013,400	506,700	Sefton Metropolitan Borough Council
95NAT/UK/000821	Integrating monitoring with management planning	786,000	393,000	Countryside Council for Wales
96ENV/UK/000404	Implementing alternative strategies in Irish beach and dune management	1,312,007	630,403	University of Ulster
96NAT/B/003032	Integral Coastal Conservation Initiative	2,551,854	1,137,106	AMINAL
96NAT/DK/003000	Protection of grey dunes and other habitats on Hulsig Hede	1,004,575	502,287	Nordjyllands Amt/County
99NAT/UK/006081	Living with the Sea	2,234,433	1,117,217	English Nature
02NAT/B/008591	Fossil Estuary of the Yzer Dunes restoration area	1,309,522	654,761	Ministerie Vlaamse Gemeenschap AMINAL
02NAT/DK/008584	Restoration of dune habitats along the Danish West Coast	4,675,796	2,805,478	Danish Forest and Nature Agency

Project reference	Project title	Total €	EU €	Beneficiary
03NAT/CP/NL/000006	Dissemination of ecological knowledge and practical experiences for sound planning and management in raised bogs and sea dunes	152,000	98,000	University of Nijmegen
04NAT/ES/000031	Dune regeneration on Laida beach (Urdaibai)	522,568	261,284	Patronato de la Reserva de la Biosfera de Urdaibai
TOTAL		22,732,719	11,367,156	

Concurrent with this project was a project led by the Conservatoire du Littoral to protect the dunes at Sangatte in the Nord-Pas-de-Calais region through dune restoration and the control of public access.

The second ONF LIFE-Environment project ‘The rehabilitation and sustainable management of four French dunes’ continued to develop management which considered the principles of dynamic coastal geomorphology (and beach-dune interaction) and biodiversity (by focusing on four Natura 2000 sites). The second project was important in taking the ideas from being revolutionary to normal practice within ONF. The key actions were a plan for the conservation of priority grey dune habitat at the Quiberon-Plouharnel dunes in Brittany, enhancement of the biodiversity of the maritime pine and oak woods at the Combots d’Ansoine dunes at the mouth of the Gironde Estuary, an overall management plan for the dunes at Seignosse-le-Penon and recreation management to reduce damage to the dunes at Tarnos and to protect the habitat of rare plants.

Project results are presented in a special volume of ‘Les Dossiers Forestiers’ (Knowledge and sustainable management of Atlantic coast dunes) (ONF 1996) and so has become formalised within ONF. The project recommendations aim to combine conservation with rational tourist use of the ONF forests and dunes. The projects have also had other spin-offs such as recognition of the importance of lichens, fungi and insects in the dune ecosystem and more understanding of the value of grey dunes.

Projects in Portugal

The first ONF project developed links between the situation on the Atlantic coast of France and the Portuguese coast. These links were explicitly developed in the second ONF project and a joint video produced.

A specific LIFE-Environment project in Portugal (‘campaign for the dunes’ preservation in Vila Nova de Gaia’) was focused on raising public awareness of the value and fragility of the narrow dune systems along the Portuguese coast. The project carried out actions based on an 18km section of coast around Gaia but also targeted the population along 200km of coastline. The awareness-raising actions were aimed at decision-makers, travel agents, students, residents and visitors. The project pump-priming has helped to encourage other restoration projects along the Portuguese coast.

A similar project in 1995 involved the recovery, conservation and management of species and natural habitats in the coastal area of central Portugal. The actions were aimed at protecting dunes through access control, the recovery of dune scrub, the restoration of woodlands following fires and interpretive and educational activities.

Projects in Spain

In 2004 a restoration project was approved for dune regeneration on Laida beach at the mouth of the rivers Guernika and Mundaka. Here, intensive recreational pressure has damaged the natural shifting dune habitat making natural recovery impossible. The project will rebuild the dune formations using sand trapping fencing and will replant the area with natural vegetation. Public awareness and control of recreation pressures will assist recovery.

Projects in Belgium

Two LIFE-Nature projects run by the Ministry of the Flemish Community have made a major impact on the protection, management and understanding of the dune systems of the Belgian coast and represent a policy-shift away from almost total exploitation for tourism development. The first of these, the Integral Coastal Conservation Initiative (ICCI) helped to secure the conservation of dune sites as a component of the Belgian coast. The remaining dunes sites are fragmented and isolated but nevertheless contain valuable habitats and species.

The project concerned legal protection for the dunes and coastal zone, land purchase, habitat management and restoration, management planning and scientific monitoring. The link between policy, science and management has been particularly well developed and sets the scene for future management work. Project actions included the restoration of dune heath, scrub removal, introduction of grazing, the re-flooding of inland meadows and the removal of military infrastructure.

The second project is entitled Fossil Estuary of the Yzer Dunes Restoration Action. This continues the work of the first project on this site and aims to restore the natural dynamics of the priority fixed dune habitat so that wind, water and grazing activities can maintain a healthy habitat. Actions include the restoration of a dune stream (a rare feature), scrub and tree clearance and the demolition of infrastructure. The project will also use the Westhoek dune system as an example of good dune management.

Projects in the United Kingdom

The sand dunes of the Sefton Coast in north-west England is one of the largest dune systems in the UK. The area is under numerous ownerships and has been fragmented by past development, road and rail infrastructure and afforestation. The opportunity was taken through a LIFE-Nature project to develop an overall management strategy for the Sefton Coast candidate Special Area of Conservation. This helped to strengthen the existing level of conservation management, to engage new partners, to purchase private

land, to develop habitat and species strategies and to disseminate information to local people about the conservation value of the site.

The additional support through the LIFE fund allowed the development of a GIS database for the cSAC. The project encouraged a whole site approach to management rather than a system based solely on land ownership and this has encouraged the more extensive application of conservation techniques and the sharing of resources.

Large sand systems are usually a complex matrix of habitat types where the boundaries are often indistinct and this leads to challenges for monitoring. The monitoring of cSACs in Wales was addressed by the LIFE-Nature project 'Integrating monitoring with management planning: a demonstration of good practice on Natura 2000 sites in Wales'. The detailed work concluded that since it was so difficult to establish accurate and repeatable monitoring programmes for dune sites the best option was to revert to more simplistic measures, *e.g.* height of vegetation as an indicator of 'quality'. The study looked at five dune types (2110, 2120, 2130, 2170 and 2190) and made recommendations for sampling techniques and for the setting of conservation objectives for maintenance and restoration management.

The Living with the Sea project was established with the support of the UK Government to consider the issue of conserving dynamic coastal habitats, and especially Natura 2000 sites, in the face of coastal change. The project developed the concept of Coastal Habitat Management Plans (CHaMPs) to predict the 'gains and losses' of habitats on a given section of coast over a 50-100 year period. Although the predicted losses of dune coasts was considerably less than the predicted loss of saltmarsh there is nevertheless general concern that dune coasts are subject to greater erosion than accretion. The CHaMPs approach helps to set dune systems in a wider coastal context and to habitats such as sand and mud flats, saltmarshes and lagoons.

A fourth UK beach and dune project was led by the University of Coleraine in Northern Ireland and, as a cross-boundary project, is considered with Ireland below.

Projects in Ireland

The Republic of Ireland benefited from the support of the LIFE-Nature fund to assist with the preparation of a national inventory of Natura 2000 sites including information on the current distribution and condition of the Irish dune systems.

A LIFE-Environment project was launched in 1997 to work with a number of local communities in Northern Ireland (UK) and the Republic of Ireland to develop management strategies for beach and dune systems. Beaches traditionally provided both sand and sea-weed to improve the fertility of the cultivated machair. But lack of understanding can lead to exploitation and the loss of beaches. Dunes can be damaged by the burning and harvesting of marram grass (*Ammophila arenaria*) and the collection of sand can lead to erosion. As with many LIFE projects the processes of consensus building and participation were integral to success. Final dissemination was through the publication of a good practice guide to rural beach management (McKenna *et al.*, 2000).

Projects in Denmark

A number of LIFE-Nature projects have been undertaken in Denmark, beginning with site specific projects on Anholt and Hulsig Hede and leading to the extensive project 'Restoration of dune habitats along the Danish west coast' covering 11 coastal Natura 2000 sites.

The project on Anholt aimed to re-establish the lichen and coastal heaths on the island. The actions involved the clearance of mountain pine *Pinus mugo* across some 400 ha of the 1200 ha site. The project was also an opportunity to develop techniques to be used on other restoration projects and to establish monitoring schemes.

A second project aimed at the protection of grey dunes and other habitats on Hulsig Hede (Hulsig Heath) in north Jutland. The mobile nature of the dune systems in north Jutland with remaining examples of the wandering dunes has made for a rich environment which also supports significant numbers of Annex I bird species. The project focused on the large scale removal of conifers from a 1680 ha site and the preparation of a long term strategy.

Following the lead from these local authority-led projects a larger and more ambitious project was drawn together by the Danish Forest and Nature Agency in 2001. The project focuses on the conservation of 11 Natura 2000 sites covering over 24,000ha, selected mainly for the priority habitats fixed grey dunes and decalcified dunes with *Empetrum nigrum*. In this project some 4000ha will be cleared of non-native conifers and a further 2000ha will be restored through burning, grazing and cutting.

Restoration actions and dune management

Dune repair/restoration techniques – learning to live a bit more with nature

In the ONF projects a number of techniques for dune restoration were developed and implemented. Such techniques include the re-profiling of dune faces, the planting of dune grasses and sowing of other species (e.g. *Helichrysum stoechas*) and fencing to restrict access and allow recovery. Pathways and information boards were erected to explain the work to the visitors. Similar work has been completed by the Portuguese project in Vila Nova de Gaia and will be the main action in the Spanish project at Urdaibai. Such actions are necessary where the damage to the dunes has reached a state where increased mobility threatens infrastructure and becomes a nuisance. A purist approach could argue that nature can be left to reform the dune landscape but with continued recreational use and nearby development the constraints to nature are already imposed. The situation along the narrow dunes at Vila Nova de Gaia gives a stark choice; no dunes or managed dunes. Total naturalness is no longer an option along many developed coasts.

One of the challenges for the stabilisation work on some of the French sites was how to maintain biodiversity value. Studies were undertaken to assess the changes in the vegetation communities as a result of stabilisation work. In much of the widespread

historical sand stabilisation work undertaken throughout north-west Europe preservation of biodiversity value was never an aim; today the need to respect and conserve natural values and landscapes is a key concern in such works.

An important feature of almost all LIFE projects is that the additional resources allow more time for communication and networking. Thus LIFE projects can help to progress conservation thinking on a wide front. The natural interest in sharing experience between sectors has been enhanced through practical projects such as those in France which have developed new approaches to dune management.

In England the national approach to develop Shoreline Management Plans did not, at first, give adequate attention to the requirements of the Habitats Directive. This weakness has been addressed through the Living with the Sea project which has targeted coastal engineers and conservation managers and encouraged new and long-term (50-100 year) thinking about the direction of coastal change and the appropriate responses for environmental, economic and social needs.

In the 1980s the idea of a 'dynamic approach' to soft coast management was being championed. The idea has now been widely applied and the LIFE projects, with their focus on communication and dissemination, have made a significant contribution to awareness raising.

Dune forestry – a new balance

Plantations of conifers are associated with sand dunes in all countries within the Atlantic Biogeographical Region, with the largest areas in France and Denmark. The underlying reasons for these plantations differ from region to region and include stabilisation as a priority (the sandy 'wastes' of Denmark being stabilised with *Pinus mugo*), commercial forestry and by-products (e.g. resin from *Pinus pinaster* in Les Landes), shelter for game (e.g. some of the plantings in the Netherlands) and attempts at commercial forestry (UK and Ireland). Whilst forestry was the single purpose land use in many areas there was little consideration given for the natural values of the dunes. This unbalanced view is now changing throughout north-west Europe and whilst good arguments can be put forward for the removal of trees the plans do not always go down well with local opinion which often now values the recreation and shelter functions of the woodlands. Also, the woodlands themselves often support an interesting wildlife including, in the United Kingdom, the endangered Red Squirrel (*Sciurus vulgaris*).

In all countries where forestry plays a major role in the coastal zone (France and Denmark especially) there is a sector-wide recognition that a more appropriate balance must be found between forestry (for timber and amenity) and natural habitats. Most at risk have been the fixed dune habitats (grey dunes and heaths) and several thousand hectares have now been restored.

LIFE projects have been able to put into practice restoration on a large scale and continually help to improve techniques and knowledge. Costs and effort are carefully recorded and this information can assist with estimating the cost of national restoration

programmes. It is important, however, that networking between projects and national agencies continues so that the collective knowledge is available.

Habitat management: mowing, grazing and turf cutting

Until the 1980s the control of sand movement in dunes was generally managed in a 'traditional' manner according to national legislation or policy. Generally this meant stabilisation of areas of mobile sand, marram planting, scrub and tree planting and access restrictions. In the 1980s, however, ecologists began to argue against such fixed management views and promoted the need to control vegetation growth through mowing, grazing and rejuvenation of soils through turf-stripping and other techniques.

Initially such techniques were confined to the nature reserves but as the 'dynamic approach' became more widely accepted there were more opportunities given for the creation of blowouts and destabilisation to encourage natural processes. Again LIFE projects, for example on the Sefton Coast, have helped to develop these approaches and go beyond the nature reserves to private land, military sites and golf courses. On some sites it was possible to introduce grazing to control scrub and to keep the habitat open, on others scrub cutting programmes have been developed to ensure that scrub does not exceed a fixed percentage (e.g. 10%) of the site and on others bare sand areas have been created to encourage early stages of dune succession. Some of the most extensive schemes of this nature have been carried out in the Netherlands in recent years.

LIFE projects have helped to consolidate management practice and disseminate practical information to professional networks. Some projects, such as the ICCI project in Belgium have combined applied scientific study to establish monitoring systems and assess the impact of management actions. Seminars, such as the European Dune Symposium, held by the Sefton Coast LIFE Project, have combined science and management to promote best practice (Houston *et al.*, 2001).

Managing for species

It is often difficult to achieve the correct balance between management at the whole site, habitat and species level. Inevitably through rarity interest, also supported by the Habitats Directive and national legislation, some management will be carried out for individual species. Dune habitats are a good example of this dilemma where the conservation of charismatic rarities such as the Annex IV species, sand lizard (*Lacerta agilis*) and natterjack toad (*Bufo calamita*) often lead to the development of local and national strategies. Although such strategies focus and coordinate effort it is important that action for species is integrated within a more holistic overview of the dune site. Knowledge of the requirements of species, however, can often help to support the rationale for site management. An example would be the Annex II bryophyte *Petallophylum ralfsii* which is an indicator of young dune slacks. A decline in this species may be associated with over-stabilisation and a loss of dynamic dune forming processes. A similar message is given by the Annex II species *Liparis loeselii*, the fen orchid.

The importance of dunes for Annex I bird species requires some further study. In Denmark the link between dune management and species conservation is integral to the restoration projects but, to date, there has been no European overview of the link between dune management practice and population trends.

Working with private landowners

The Natura 2000 network is not a network of nature reserves and much of the land is in, and will remain in, private ownership. The same rule applies in many areas to the dunes and comprehensive management strategies must embrace the issue of private ownership. Much of the duneland in the Netherlands, for example, is owned by a series of private water companies, but the potential damage through water abstraction has been recognised and these sites are now models of sustainable multiple-use management. In Belgium only 1400ha of the total of 3600ha are in the ownership of public bodies; the remaining areas have been protected but due to land speculation and the hope of future development land prices have risen. Nevertheless it is important that funds such as LIFE-Nature can be used to ensure that sites can be acquired in perpetuity.

The Integral Coastal Conservation Initiative and the Sefton Coast project have worked with private golf course owners to encourage conservation management actions. In the Sefton example, the golf courses (seven in total) occupy an area of some 500ha within the 2000ha dune system (25%) and their management is integral to the management of the whole Natura 2000 site. In the Belgian case the better long term solution would be to relocate two courses (120ha) to the polderland for total restoration of the current sites.

Military sites are a common feature on many dune coasts and a number of these have been established for a considerable length of time. The disturbance on such sites from vehicle movements, exercises and explosives has often helped to conserve early stages of dune succession and the general lack of fertilizers and pesticides makes such sites rich in wildlife. Projects in the UK (Sefton Coast), Belgium and Denmark have worked closely with military site managers to introduce conservation practices of benefit to dune habitats and species.

When working with private landowners the additional resources provided through LIFE funding help to develop working partnerships, prepare plans and often to carry out the initial works. But the spin-off is that these areas, whether a military site or a golf course, become examples of best practice in their sector.

Monitoring

Several projects have attempted to establish monitoring protocols for dune condition, habitats and species. The French approach has been through the development of eco-dynamic maps and monitoring a number of parameters. The Welsh monitoring project included dunes and a detailed evaluation of the monitoring problems associated with four habitat types (strandline, embryo dunes, humid dune slacks and grey dunes) was carried out. Because of the potentially high complexity of monitoring in dune systems there is a view that simplified systems may be all that can be realistic.

Monitoring is a key element of the Danish dune projects and a comprehensive programme has been established.

Access, public awareness and communication

Whilst the present day pattern of land-use on many dune systems was set by the end of the nineteenth century (forestry plantations, etc.) the twentieth century saw the rise in coastal tourism, first centred around coastal resorts and then further afield as camping grounds and access routes developed. Few of these visitors have an understanding of the potential damage that trampling pressures can do to dunes or of the unique natural values of the habitats.

Projects in France (at Seignosse-le-Penon and Tarnos dunes), in Portugal and in the UK (Sefton Coast) have focused efforts on nature trails, information and educational activities. The Portuguese projects have made a special effort to develop broad educational materials aimed at changing attitudes and perceptions to dunes in general.

Even where dune areas are better protected and total destruction is not the main threat there can be very different views expressed by local people on how the sites should be managed. A particular issue arises when large scale woodland removal is proposed. Even where the woodlands are relatively young and obviously an alien feature there can be strong opposition to clearance.

LIFE projects have spent a considerable effort in setting out the case for dune conservation by introducing local people and visitors to the natural values of sites through guided walks, specific nature trails, leaflets, booklets and videos. Through such understanding the conservation dilemmas can be more reasonably discussed and, generally, consensus can be reached. This may mean, for some sites, accepting some form of compromise between ecological best practice and local opinion but, across a number of sites, or a region, the conservation objectives can usually be met.

Networking

LIFE projects represent only a small part of the conservation effort on sand dunes and in terms of total management effort are no more than contributions to an ongoing process. But, importantly, LIFE projects are seen as 'milestones' in the development of techniques and networking. The additional funding given to LIFE projects brings with it a responsibility to disseminate information to other interested bodies. The main LIFE projects in France, UK, Belgium and Denmark have thus been able to achieve results on sites, have an impact at the national level (*e.g.* a link to Habitat Action Plans in the UK, or development of ONF policy in France) and have also support from the European and international dune management community through conferences and publications.

LIFE funding is therefore already indirectly supporting networking, not just for dunes, but for other habitats and species across Europe. A more direct funding opportunity comes through the LIFE-Nature co-op programme and, through a project led by the

University of Nijmegen, dune managers will come together to share experience and prepare guidelines for decision making.

Conclusion: towards a Natura 2000 network

In 2004 the initial list of sites for the Atlantic Biogeographical Region was approved, marking the end of the first phase of the establishment of the Natura 2000 network. Although there is still much to be resolved in terms of the funding of the network the publication of sites presents an ideal opportunity for stimulating habitat networks. After all, Natura 2000 depends on the collective effort of Member States and site owners and managers to achieve the goal of 'favourable conservation status'. The current loose European dune network, supported as it has been by a series of LIFE projects, could perhaps use the opportunities presented by Natura 2000 to establish more formal networking.

But it must be remembered that Natura 2000 sites are only one element of a network. The experience of dune management in Europe over recent decades would advocate that every dune site, no matter how small, is important for biodiversity and for acting as a link in a chain of sites.

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