6th European Conference on

ECOLOGICAL RESTORATION

10 September 2008 | Ghent (Belgium)

Excursion Map

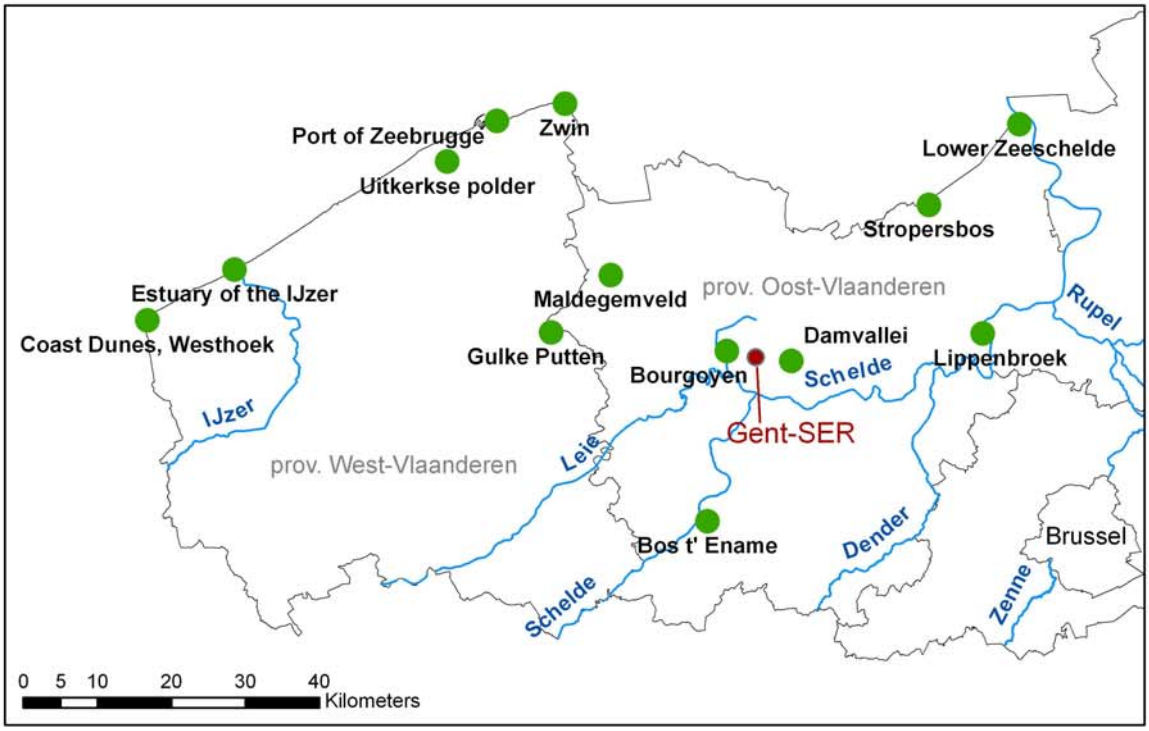
Coastal dunes Westhoek

Excursion Westhoek Nature Reserve

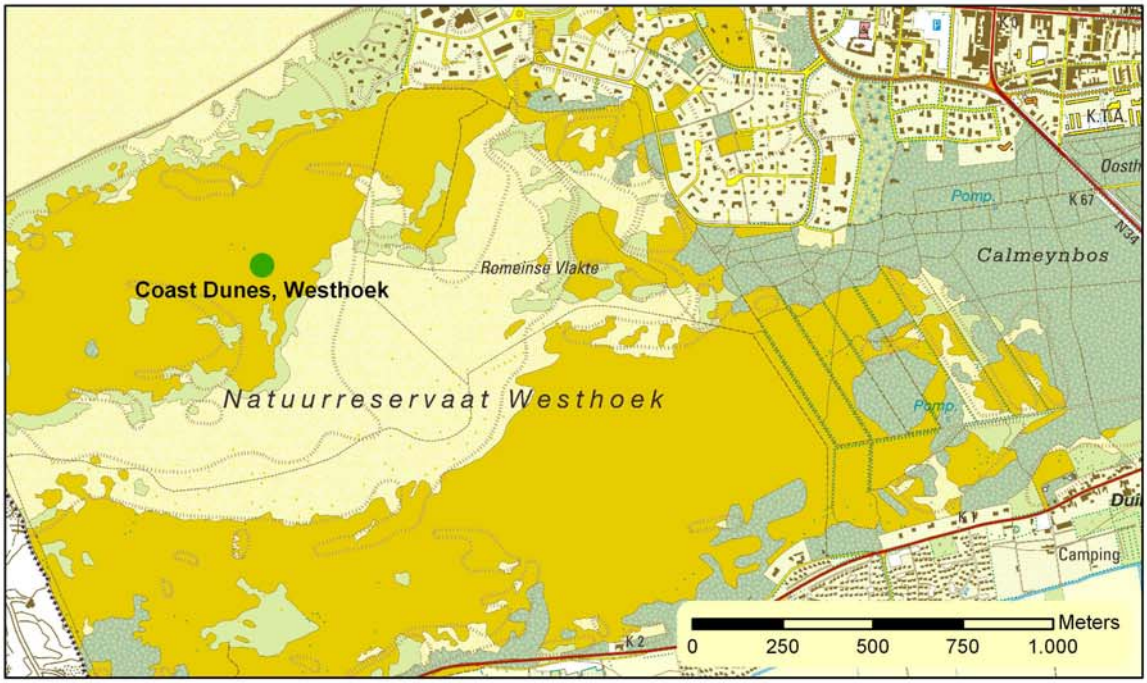
(De Panne, West-Flanders)

10 September, 2008

Location of excursions



Detail Westhoek



DE WESTHOEK NATURE RESERVE (DE PANNE, W. Vl.)

1. Short description of the area

1.1. name, municipality

De Westhoek, De Panne (prov. West-Vlaanderen)

1.2. biogeographical region

Flemish coastal dunes

1.3. management authority

Flemish Government, Agency for Nature and Forests (ANB)

1.4. protection status

Natura 2000: “Dunes incl. Yser estuary and Zwin”; physical planning map: ‘Nature zone of scientific value’; Flemish Ecological Network; Protected landscape; Flemish nature reserve (345 ha; public nature reserve since 1957), embedded in a much larger entity of protected dunes and forests in Belgium (Duinen en Bossen van De Panne) and France (Dunes du Perroquet); supported by LIFE-funding (ICCI, 1997-2000).

1.5. ecological characteristics

soil type

Holocene maritime sandy soils, very lime-rich to slightly decalcified; great variety in topography, hydrological conditions and vegetation types

ecological key processes

mobile sands, hydrology, spontaneous vegetation development

historical information

The reserve is situated in the formerly almost continuous belt of Flemish Dunes between Sangatte (France) and Cadzand (Netherlands). These dunes were formed during several phases of aeolian activity, starting some 5500 years ago. The current landscape of De Westhoek greatly originated during the last 5 centuries but partly covers older dunes (1000 up to c. 2500 BP). In these sediments archaeological artifacts from the Iron Age up to the Middle Ages were found. After a very active phase of dune formation between the 14th and 17th century, creating high inner dune ridges, parabolic dunes and large dune valleys, the area remained a greatly uninhabited ‘wastine’ until the first half of the 19th century when extensive parts of the dune slacks were transformed into arable lands. Less inhabited parts, as De Westhoek, were intensively grazed by rabbits and cattle, resulting at the beginning of the 20th century in a devastated and partly bare dune landscape with large mobile

dunes, dune valley grasslands, grey dunes and small patches of pioneer scrub. After World War I agricultural influences gradually disappeared (De Westhoek: free cattle grazing abandoned in 1940), while tourist development and urbanization expanded dramatically at the Belgian coast, causing severe fragmentation of the dunes. Protected as a landscape in 1935 and partially as a national nature reserve in 1957 (340 ha) the area of De Westhoek escaped complete urbanization, but still in the 1970's 80 ha of dunes were urbanized ('Westhoekverkaveling'), destroying the buffer zone of the reserve. Another adjacent 100 ha ('Krakeelduinen' and 'Calmeynbos') were developed as a drinking water extraction area in 1968 (at its height: 2.200.000 m^3/year), causing a significant lowering of the ground water table of the greater half of the reserve by the beginning of the 1990's. In the last decade the extraction has significantly diminished. In the 1960's a camping site was established between the reserve and the protected French dunes of 'Le Perroquet'. 10 years later, after some storms caused severe erosion of the foredunes, a concrete seawall was built between beach and foredunes. Internally, the abandon of agricultural practices, the regressing population of rabbits, the gradual stabilization of the mobile dunes and the fragmentation of the dune area resulted in a significant loss of biodiversity in the reserve. After an ambitious management plan was approved of in1996, restoration measures resulted in the reestablishment of lost species, the recovery of marginal populations and the return of large entities of moist to dry dune grasslands.

2. Management/restoration objectives, techniques and results (annex 1)

General objectives

In spite of its protected status since 1957, De Westhoek still changed a lot during the last decades. Fragmentation, fixation and the decrease of rabbits and agricultural use of the dunes stimulated vegetation development and encroachment of tall grasses, shrubs and trees. Combined with the lowering of the ground water table over a large area, these factors caused a severe decline of grassland and especially dune slack species. Until the late '70 no actions were undertaken as the changing dune ecosystem was considered to be 'autonomous' and able to preserve its values through natural cyclic processes. Afterwards some (very) small parts of the reserve were mown annually but overall, the open dune habitats kept decreasing at the expense of encroaching scrub until the end of the 1990's.

The management plan of 1996 aimed at restoring the historical biodiversity of the area as well as the preservation of the autonomous ecological key processes (dune mobility, natural vegetation succession, more natural seashore development, …). To achieve these goals a division in several management zones was established. In the western part of the reserve 2 zones were defined where direct actions for the conservation of species and habitats aimed at the restoration of historical biodiversity and landscape ('pattern management'). The central and eastern parts of the reserve remained a zone where only accompanying measures (removal of World War II debris, selective removal of alien species, extensive grazing, …) to the natural ecological key processes were undertaken ('process management'). Small areas were designed as buffer zone or sites for educational management (a specific mowing or cutting regime, the creation of a pond etc. along public paths to bring the variety of habitats closer to the visitors - without deliberately introducing species however!). The sea inlet area, closed off from direct maritime influence in 1977, was designed as a 'nature development' zone, where periodical inundation of some small dune slacks should be made possible through the artificial creation of gaps in the concrete dike.

Between 1997 and 2000, rather large scale restoration measures were taken including mechanized removal of about 16 ha of scrub. Another 9 ha of pioneering scrub and woodland in vulnerable zones was removed manually. A network of service tracks was established and two grazing zones were delineated, a third followed in 2002, an extension of the northern zone in 2008. Actually, about 180 ha is extensively grazed by Highland cattle, Shetland pony, Konik horse and donkey. In about 9 ha the vegetation is mown (with removal of litter) every (2) years or juvenile Hippophae plants are removed manually. The mown zones and hayfields include vulnerable locations with important relic populations. 29 ponds have been created or restored. In 2004 two (more or less artificial) sea inlets were created in the foredunes.

Parallel to habitat management and restoration, a comprehensive scheme of recreational and informative actions (creation of public paths, information panels & viewpoints, production of leaflets, organization of guided visits, …) ware taken, as a service to visitors but also to gain and preserve public support.

In order to evaluate the realization of the 1996 management plan and its results, but especially in order to cope with new developments as the rapid stabilization of the central mobile dune and the changing hydrological conditions a revision of management plan of the reserve is foreseen in 2009-2010.

3. Points of interest and discussion during the excursion (see annex 1)

1. Artificial stabilizing of the eastern part of the mobile dune (1950's; in preparation of the urbanisation of the adjacent area) resulted in high parabolic dune ridges and small dune valleys. From the end of the '60's up to the first half of the '90's adjacent drinking water extraction gradually lowered the ground water level with some 0,5-1m (more to the south up to 4 m!), while wind erosion continued to deepen local dune slacks. As water extraction decreased during the last decade (1992: 2.100.000 m³/year; 2007: 650.000 m³), some very low lying young slacks have become semi-permanently inundated dune lakes, with interesting seepage zones on the edges and a thriving population of *Bufo calamita*. In these young stages of dune formation, no direct accompanying or preparatory measures (scrub and sod cutting, …) were thought to be necessary to restore/create valuable wet dune habitats. However, regular cutting of reed beds and scrub may be needed in future to preserve the value of the newly developing wet habitats. Whether more to the south the nutrient rich scrub vegetation (greatly developed after 1960, see annex 3) of the older dune slacks, with deep humic soils, will need more then just an extensive grazing regime to regain the former species rich dune grasslands and marshes (*Gentianella uliginosa, Cladium mariscus*, *Helianthemum nummularium*, …), is open for discussion.

2. In the eastern half of the nature reserve, the objectives of the management plan of 1996 were the preservation of an autonomous dune ecosystem through 'process management': use of dune mobility, spontaneous vegetation succession, eventually extensive grazing, with a minimum of direct human interference. Spontaneous young dune scrub vegetation may be more important for biodiversity (species of *Rosa, Lonicera xylosteum*, birds, fungi, …) than formerly thought, but the invasion of alien plant species (*Prunus serotina, Mahonia aquifolia*, *Populus alba*, …) needs full attention. Selective removal of some alien species is foreseen. The recent hydrological changes and the decrease of pioneer dune slacks reopen however the discussion whether the management objectives in this part of the reserve should in future not focus more on 'pattern management': preservation of young stages of vegetation development through mowing etc., especially in the newly developed seepage zones.

3. As an exception to the 'process management' in the eastern part of the reserve, along public paths some patches of dune slack vegetation have been mown for at least 20 years ('educational management'). These areas developed spontaneously into some of the most species-rich young dune slack vegetations of the reserve, wherein the rarest plants can be seen and photographed from close by. Together with information panels at the entrances, information folders, viewpoints, guided excursions, etc., this helps to gain public interest for biodiversity and nature management in the reserve. Remarkably, since these colourful vegetations along paths have been created, theft of orchids or other striking plants has almost completely come to an end!

4. At the centre of the reserve lies a large dune system that was almost free of vegetation and very mobile until about a decade ago (locally called 'the Sahara'). For at least 150 years it was the most important 'motor' of the dynamic dune ecosystem, progressing 5 to 10 m per year and creating up to 5 ha of renewed dune slack per decade. Very recently it stabilized, probably due to a number of factors (geomorphology, climate, rabbit disease, eutrophication, …) and their combined and self-enforcing effects, resulting in abundant growth of marram grass. No measures to revive the system are yet undertaken, but the matter will be at study when the management plan is revised (2009-2010).

5. Until some 10 years ago large pioneer dune slacks were formed in the wake of the central mobile dune. Since the stabilisation of the wandering dune, formation of pioneer slacks has become rare and very restricted in surface area. Without radical changes or human interventions it is to be expected that natural pioneer slacks will be completely absent within one or a few decades. World War II relics (concrete roads, stony debris, …) represent an additional problem. Locally they have been successfully removed with good results, but small rubble always remains a problem (formation of 'desert pavement') for dune mobility.

6. In the wake of the central dune system a series of semi-parabolic dunes and associated slacks were formed. The slacks are characterized by a gradient in age, with pioneer situations to the southeast and (dry) slacks up to more then one and a halve century old to the northwest. After a short stage of in general not more then 10 years of pioneer vegetations with *Sagina nodosa, Blackstonia perfoliata*, …, and small populations of calcareous fen species (*Epipactis palustris, Parnassia palustris*, …) natural succession results in dense thickets of *Salix repens dunensis*, *Hippophae* and later on *Ligustrum vulgare*. Several management regimes are used to extend the life span of the fen vegetation. Since 1977 (only a few small patches) but especially since the 1990's large areas of recently formed dune slack are mown annually or once in two years (mostly September-October), with good (botanical) results, for instance large populations of orchids as *Dactylorhiza incarnata*. Mowing creates however a rather monotonous vegetation structure and is often not able to stop *Hippophae* from colonizing the slack. It is moreover a labour-intensive technique and the problems with processing the litter are far from resolved. Another technique is selective manual weeding of seedlings and juvenile plants of *Hippophae*. It keeps vegetation structure (an equilibrium between patches of short turf and dwarf scrub of *Salix dunensis*) intact, especially if accompanied by extensive grazing. Plant species profiting from this technique are for instance *Equisetum variegatum* and *Preissia quadrata*. It must however be done very consequently once or twice a year and from an early stage in vegetation development, which proves difficult to maintain. Extensive grazing in itself cannot stop or even slow down *Hippophae*-encroachment in young dune slacks if spring or summer inundations do not affect the vitality of the plants. In combination with mowing or weeding it however gives good results and may gradually take over the labour-intensive management techniques.

7. As spontaneous and diversified dune scrub is also an important and protected habitat (breeding birds, shrub and fringe species, …, also Annex II-species *Vertigo angustior*) the management plan aimes not only at the restoration of dune grasslands but also at the preservation of a significant share of thickets of different composition, age and landscape position in the reserves ecosystem. Grazing in itself does not transform vital thickets into dune slack vegetation but the creation of paths and patches of short turf where shrubs have died off is surely a diversifying element, especially when thickets tend to get dominated by *Calamagrostis epigeios* or *canescens*. The impact on ground breeding birds (*Nightingale*, …) may be less positive.

8. To restore grass- and marshland vegetation in the older dune slacks, completely overgrown with thickets, large scale scrub clearance was needed. From 1997 to 2000 15,5 ha of dune valley scrub was cleared with a heavy woodchopper mounted on a caterpillar tracked vehicle. Afterwards woody debris were cleared and burned (1997-1998) or scraped off together with the topsoil (2000). Experience learned that shallow sod-cutting was needed to have optimal results and to minimize regrowth of scrub. Special attention was however given to preserve micro-topography and well developed 'old' soils as well as their potential stock of viable seeds. These actions were supported by EU-funding (LIFE-project ICCI). Botanical and faunistical results were very positive, especially in the 2000-clearance (*Parnassia palustris, Botrychium lunaria, Anthyllis vulneraria, Lullula arborea,* …). The stock of persistent viable seeds in the topsoil

probably plays an important role in the colonization of the site by rare plants, but zoöchorous dispersion of seeds, especially of grassland plants, may be as important (*Helianthemum nummularium, Asperula cynanchica*, …).

9. Scrub clearance and dune slack and pool restoration produce a huge amount of organic debris and humic and mineral soil material. As in 2000 burning of the organic debris was no longer considered justified, debris and topsoil were very locally heaped up, creating an artificial dune. The nitrophilous vegetation serves as an extra food supply (*Urtica* roots, ...) for the grazing animals in winter. Except for the ashes of the burned woody debris in 1997/98, which were transported outside the reserve, all residual material was locally recycled, for instance to heighten or stabilise service tracks in the reserve.

10. The foredunes are made up of a zone of pioneer dunes and a dune ridge of 100 up to 200 m wide, adjacent to the beach. During an erosive phase in the 1960's and 70's some large wind channels were created in the closed foredune of De Westhoek forming temporary sea inlets during winter storms. In reaction a concrete seawall was built, disconnecting the high beach (also part of the reserve) from the foredunes. It resulted in a strong fixation of the foredune, which is currently even partly covered by *Hippophae* scrub. In 2004 two gaps were created to (artificially) restore the ecologically interesting contact zone between sea and land and the dynamic character of part of the foredune. The results are ambiguous. Vegetation development is positive: nice embryonic dunes have formed with *Cakile maritima*, *Atriplex glabriuscula*, *Euphorbia paralias*, *Calystegia soldanella* and *Eryngium maritimum*. Also viable populations of *Hipparchia semele* and *Cicindela maritima* are present, while *Great Ringed Plover* nested in 2006 and 2007. Salt marsh vegetations did not yet develop. On the other hand, the mouth of the sea inlets tends to fill up with sand and must be reopened mechanically every year.

11. The oldest parts of the northern dune slack belt are situated directly behind the foredunes. Originated out of moist dune slack vegetations (see above), they were formed in a period when moist and dry dune valley grasslands were commonplace in the Flemish dunes and (heavy) grazing by rabbits and farm cattle was a general feature. Due to their closeness to the sea some remnants escaped the scrub encroachment, accommodating the last relicts of intact calcareous dune grassland, with *Helianthemum nummularium, Thesium humifusum, Asperula cynanchica, Silene nutans*, *Cirsium acaule, Danthonia decumbens,* … In the 1990's their surface area was gradually enlarged by cautious manual scrub cutting. In total some 5 ha of vulnerable dune valley habitat + 3 ha of moss dunes in danger of afforestation were manually cleared. Also some ponds (former bomb pits with *Triturus cristatus*) were restored. The site is now the most important source of grassland species recolonizing the older dune slacks (see Annex 6: *Helianthemum nummularium*).

12. The large dune slack, with a life span ranging from 30 years (E) to c.120 years (W), that was traditionally known as 'Romeins kamp/Camp romain' and as the species richest wet dune slack of the site (with *Liparis loeselii* up till c.1960), was almost completely covered with scrub by 1997. Only a few very small relicts accommodating the last populations of *Gentianella uliginosa* and *Herminium monorchis* remained and were carefully mown since 1981. In 1998 6,5 ha was cleared from scrub, followed on only 1 ha of sod cutting (both manual and mechanized) and subsequently grazed. Sites where sods were cut often show better results as to the restoration of typical dune slack vegetation, even if differences tend to diminish over the years. No difference remains between manual and mechanized sod cutting. The most important relict populations are preserved in a mown exclosure. As the fence was placed right through a mown grassland relict, a comparison of 10 years of grazing vs. mowing is possible. A series of representative plots shows a constantly higher number of total plant species in

the grazed area but a generally lower number and covering of Red List species. A prudent conclusion might be that the preservation of most vulnerable dune slack species is possible with both mowing or grazing as a management technique, but that grazing might require larger areas to ensure survival of the populations.

13. In spring 2008 the 53 ha of the northern grazing area (konik horses and Highland cattle) were extended with 5 ha of formerly mown young dune slack and 22 ha recently stabilized dune. The goal was to diminish labour-intensive mowing, preserving patches of bare sand and blowouts in the rapidly closing dune vegetation and creating space for a more diversified social structure of the Konik herd. As was more or less expected, the first victims of the grazing regime were the orchids in the mown dune slacks (especially *Dactylorhiza* and *Gymnadenia conopsea*). Should the area remain temporarily enclosed in spring and early summer? Even if the reserve is only freely accessible on the marked paths, fencing off an area remains offensive to the public. During the works but also afterwards information panels explaining the action were put up by the view points. At study is also a connection between the northern and southern (en eventually eastern) grazing areas, thus creating a potentially 180 ha integrated grazing area. This will need new choices as to grazer type and public accessibility of the grazed areas.

14. Fixed marram dunes develop rapidly towards moss dunes with *Carlina vulgaris, Viola curtisii and Cerastium diffusum*. The semi open habitat patches are important for *Issoria lathonia*, *Bembix rostrata* and other invertebrate populations but risk to be immediately overgrown by *Hippophae* scrub. Grazing and trampling might lengthen the life of open patches with moss dune and bare sand, but may also harm invertebrates depending on undisturbed topsoil as *Bembix*. Should vulnerable moss dunes be excluded from the grazing areas?

15. The southern slacks and the adjacent dune ridges bordering the maritime plain make up the oldest part of the reserve. The slacks probably formed during the 16-18th century (small parts even during the 20th century), while the ridges were still largely bare in the 1960's. This zone was mainly covered by mixed scrub and grassland relicts on deep humic and partly decalcified soils. In 1997 6,5 ha of scrub was transformed into grassland vegetation, ponds were dug (at the sites where organic debris was burned) and Shetland ponies and Highland cattle were introduced. Several ponds are now characterized by an interesting submerse vegetation with *Groenlandia densa* and several *Chara* species, some with *Triturus cristatus*, others with *Bufo calamita*. Eutrophication by cattle is often a problem. The slightly decalcified 'old' dune slack vegetation is often more slowly and less successfully restored then the grassland vegetation in the northern dune valley belt. Soil and hydrological conditions and lack of relict populations or viable seeds may be a reason. Recurrent clearing of young scrub and rough grasses is necessary, partly because grazing pressure might have been too low in recent years.

16. Another zone (c. 3 ha) of 'old' dune slack remained a moderately fertilized farm meadow until 1965. As one of the few clearly 'cultivated' sites in the reserve, it was the first relatively large site chosen to be actively managed and it was yearly mown from 1977 up to 1997 (sometimes twice a year). Due to less optimal hydrological conditions (fluctuations) and an enriched humic soil, the resulting grasslands are not very rich in vulnerable species, although some seepage-influenced spots accommodate species as *Carex panacea*, *Juncus acutiflor*us and *Ophioglossum vulgatum*. Since 1997 it is part of the grazed area, except for an mown exclosure where management regimes are monitored. The grazed parts of the old meadow are now almost completely dominated by a species poor vegetation of *Iris pseudacorus*.

17. A historical wood fringe existed at the foot of the high inner dune ridge, as a protection of the adjacent arable land against blowing sand (see annex 3, topographic map 1860). Amongst the first traces of woodland plantations within the dunes is the nearby Calmeynbos (1902). In De Westhoek the only active plantations (mostly *Alnus glutinosa, Populus x canadensis & Populus x canescens*) are some small parcels of former arable land, reclaimed c.1850 and afforested between the World Wars. They have gained some forest characteristics as *Galanthus nivalis* and *Hyacinthoides non-scripta*, often remnants of former gardens. Natural pioneer woodland is mostly composed of *Populus tremula* and *Crataegus monogyna*, while elsewhere isolated stands of *Quercus robur*, *Fraxinus excelsior* and *Betula* specs. are closing. Management actions are limited to the selective removal of alien tree species as *Acer pseudoplatanus, Populus x canescens* etc.

4. References

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5. Annexes

5.1. Annex 1: Map of the nature reserve, with points of discussion during excursion (see pt. 3)

5.2. Annex 2: Leaflet of the nature reserve (ANB)

5.3. Annex 3: Landscape history of De Westhoek

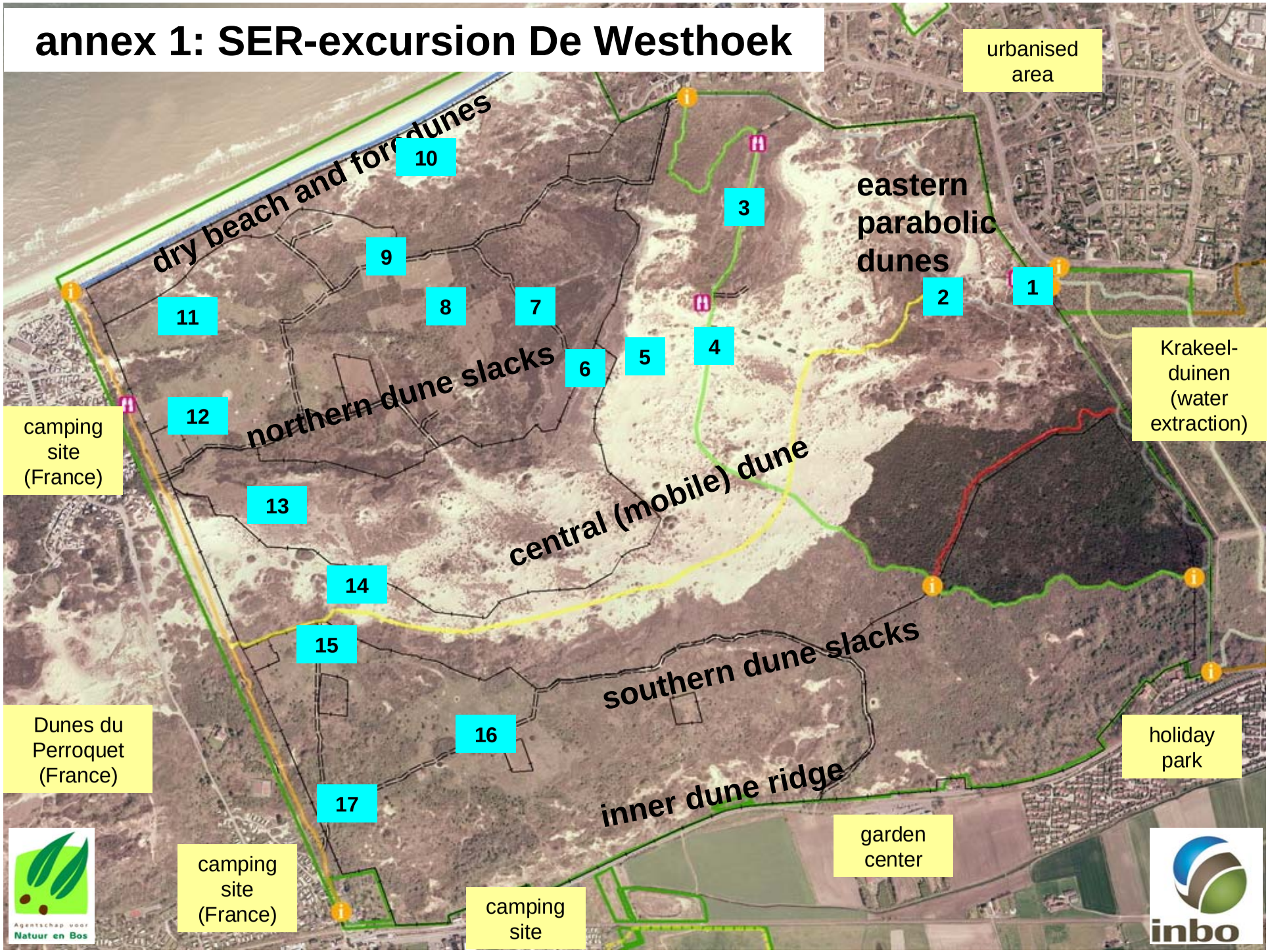
5.4. Annex 4: Hydrology of De Westhoek

5.5. Annex 5: Management options for De Westhoek

5.6. Annex 6: (Historical) distribution of *Helianthemum nummularium* in relation to management

5.7. Annex 7: Publication on dune slack restoration in Proceedings ‘Dunes and Estuaries 2005’

annex 1: SER-excursion De Westhoek



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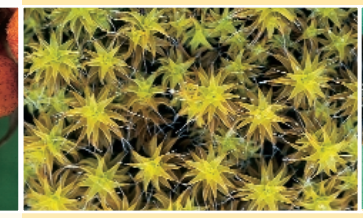
The Agency for Nature and Forests of the Flemish Community has among its responsibilities the preparation and implementation of Flemish nature policies and the management of the nature reserves owned by the Flemish Region. The Agency for Nature and Forests also provides financial support in the purchasing and managing of nature land by the acknowledged land-managing nature associations.

Caterpillars of the cinnabar



Star moss

Sea buckthorn

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The centre is situated in the middle of the Flemish nature reserve *Duinen en bossen van De Panne*, on the border of the *Calmeynbos* and the *Oostoekduinen*. The highly valuable dune areas of *De Westhoek*, *Houtsaegerduinen* and *Duinzoom Oostheek* are close by.

The visitors centre can be reached via the E40 motorway, exit Adinkerke – direction of De Panne; 250m before reaching the St. Pietersker, turn right. There is a stop of the coastal tramline at the St. Pietersker, which is at a five minutes' walk from the centre.

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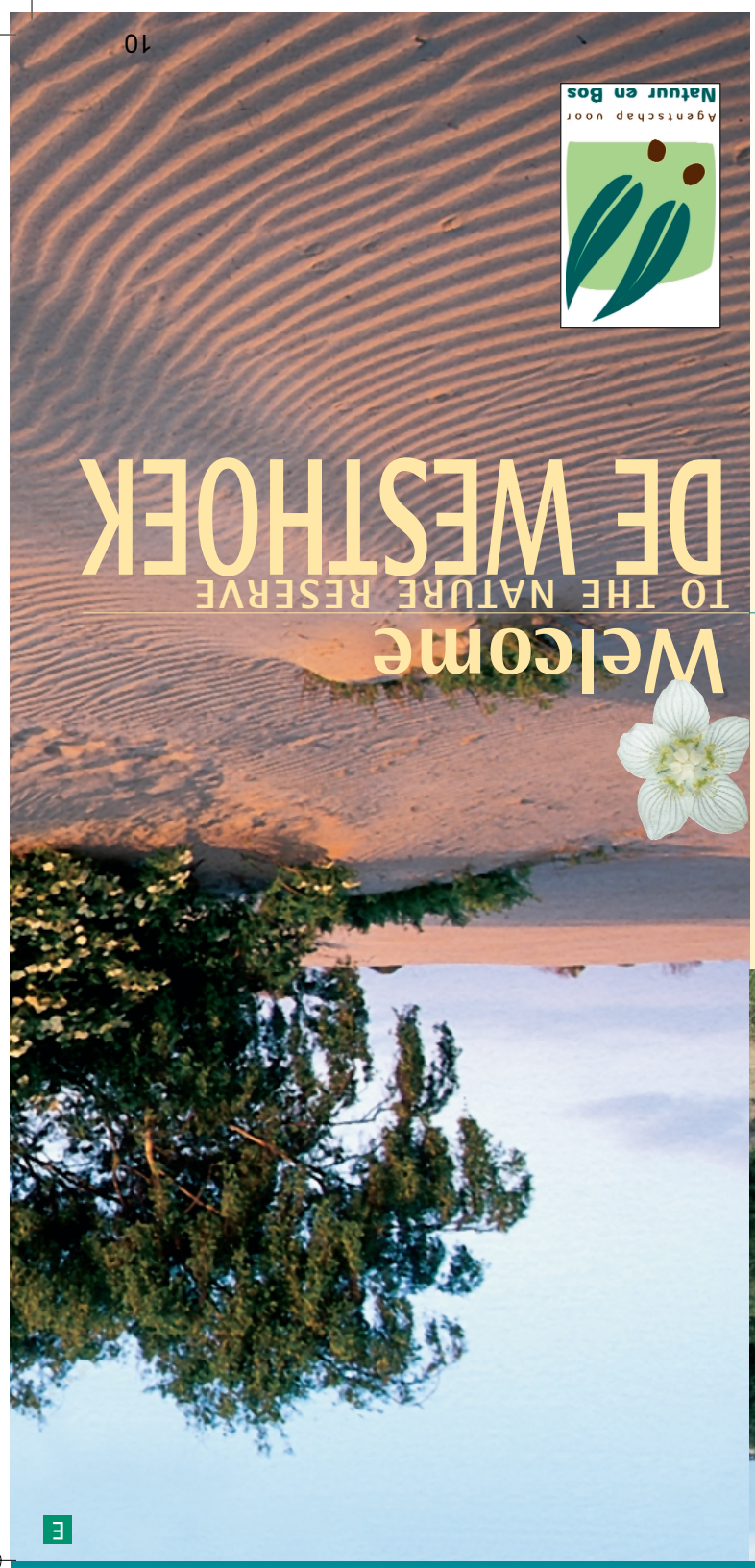
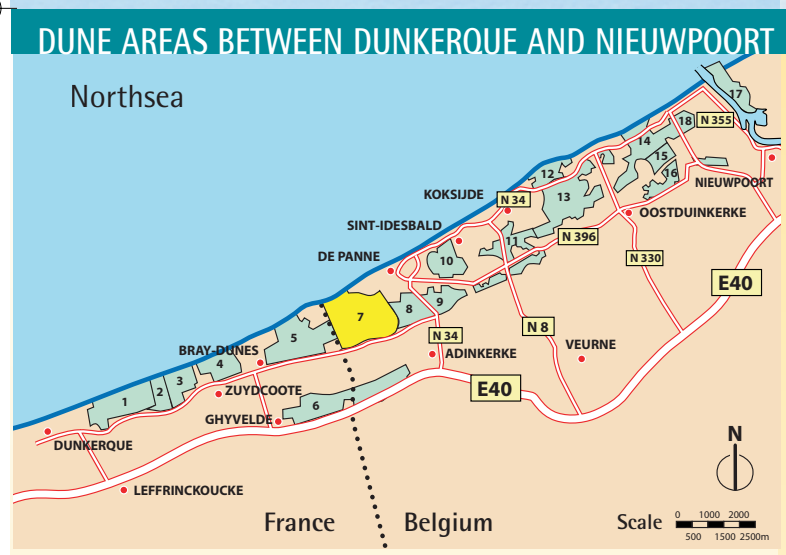
Concept & Productie Vanden Broele Grafische Groep



Welcome TO THE NATURE RESERVE DE WESTHOEK

Agentschap voor Natuur en Bos

MORE INFORMATION



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DUNE AREAS BETWEEN DUNKERQUE AND NIEUWPOORT

1 Dunes de Leffrinckoucke
2 Dune Dewulf
3 Dunes de l'Hôpital Maritime
4 Dune Marchand
5 Dunes du Perroquet
6 Dune fossile de Ghyvelde-Cabourduinen
7 Westhoek
8 Calmeynbos
9 Oosthoekduinen
10 Houtsaegherduinen
11 Noordduinen
12 Schipgatduinen
13 Hoge Blekker-Doornpanne
14 Ter Yde
15 Hannecartbos
16 Oostvoorduinen
17 IJzermonding
18 Simliduinen

SITUATION

The Flemish nature reserve *'De Westhoek'* (340 ha) is part of the largest closed range of dunes along the Flemish coast. Together with the neighbouring **Krakeelduinen**, the **Calmeynbos**, the **Oosthoek-duinen** and the French Dunes of **Le Perroquet** (225 ha), **De Westhoek** forms a unique wildlife area. The landscape of **De Westhoek** (not to be mistaken for the region with the same name in the south of West Flanders) has been protected as early as 1935 and was designated as an official state nature reserve in 1957. Almost any of the different types of vegetation of calcareous dune areas are found here and, as such, 'De Westhoek' has been included in the list of nature reserves receiving European protection (NATURE 2000 network). Since the seventies, however, the area suffered from drought as a result of the extraction of drinking-water in the nearby dunes. As a consequence, some of the rare types of flora and fauna are now seriously threatened. Nature management is therefore especially focused on preserving the grasslands and the wet dune slacks. To cope with the loss of this biodiversity, large areas of the reserve are now mown or grazed by half-wild cattle. One can freely walk through the nature reserve on signposted footways which give access to the adjacent **Krakeelduinen** and the **Calmeynbos** in de Panne, and to the French dunes of **Le Perroquet**. Guided walks in the reserve are organized on a regular basis.

REGULATIONS

The reserve is managed by the Agency for Nature and Forests in accordance with the Flemish and European legislation regarding nature conservation. The principal regulations of admittance are indicated at the entrances to the reserve. The fauna and flora at the nature reserve **De Westhoek** are very vulnerable. In order to protect this valuable wildlife we ask the visitor to abide by the following rules of conduct:

- DO NOT PICK OR DAMAGE ANY PLANTS
- DO NOT DISTURB ANY ANIMALS
- KEEP TO THE PATHS
- DO NOT MAKE ANY FIRE
- DO NOT DUMP ANY GARBAGE
- DO NOT BRING DOGS
- DO NOT FEED THE CATTLE

Agentschap voor Natuur en Bos

LANDSCAPE

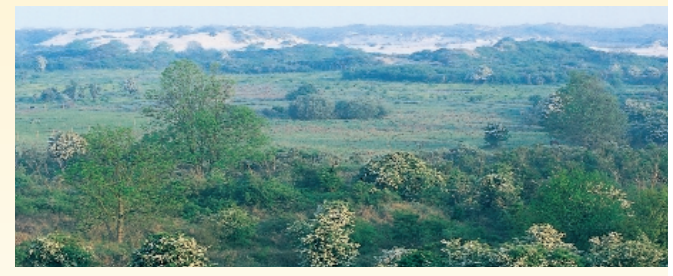
The nature reserve **De Westhoek** is of today the purest sea-dune landscape along the Flemish coast. The dynamic process of dune formation in its different stages can be observed here. In this way, De Westhoek offers a variety in dune landscape of very different ages, shapes and vegetation. From north to south and roughly parallel to the coastline, the following zones can be distinguished:

THE BEACH

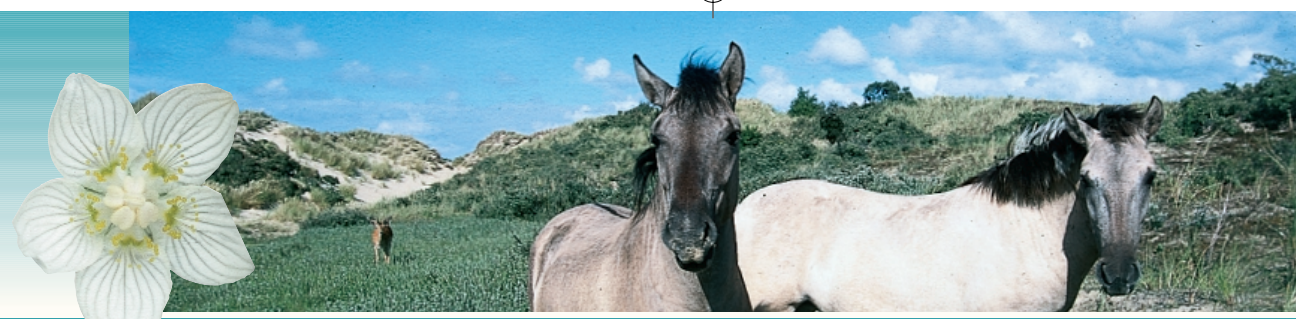
The highest part of the beach also belongs to the nature reserve. The *wet beach* is flooded with each tide, while the *dry beach* is only flooded at spring and storm tides. In the latter zone embryonic dunes may be formed, at present mostly stimulated by brushwood hedges.

THE FOREDUNES

Directly adjacent to the beach, a (fairly) small range of half-stabilised, half-high dunes forms a natural coastal defense. To prevent erosion, the base of these has been artificially fortified by a bank made



of concrete.
A project to give the sea limited access to the foredunes again *(sea inlet)* is now in the stage of realisation. Behind the foremost line of dunes there is a broadening zone of relieved dunes, called *chaotic dunes*, with small horseshoe-shaped ridges *(parabolic dunes)* to the east. The dynamic parts of the foredunes are almost bare or covered with Marram. In sheltered spots, mosses *(grey dunes)* and scrub vegetation with *Sea buckthorn* are dominant.

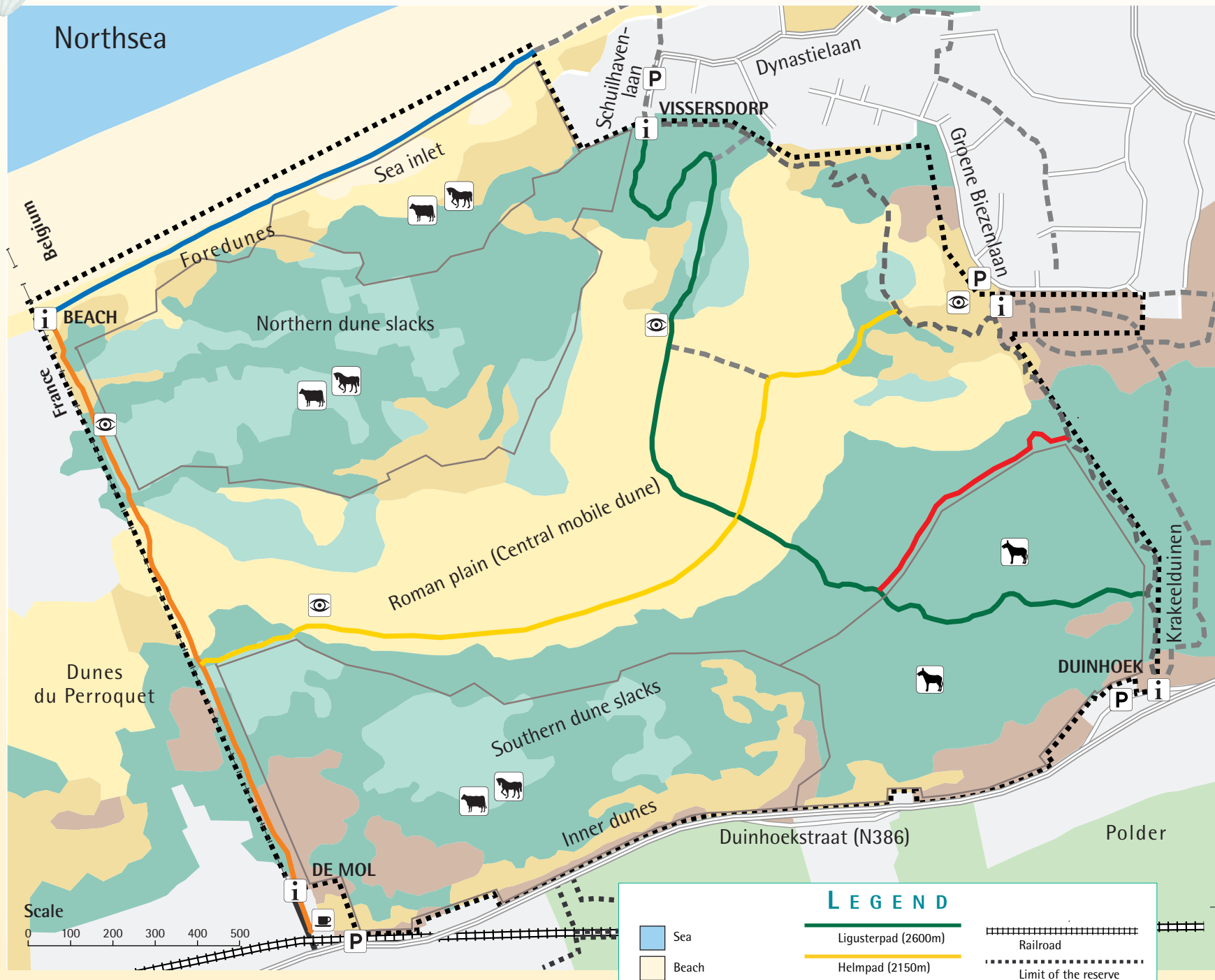


Nature Reserve De Westhoek

THE NORTHERN DUNE SLACKS

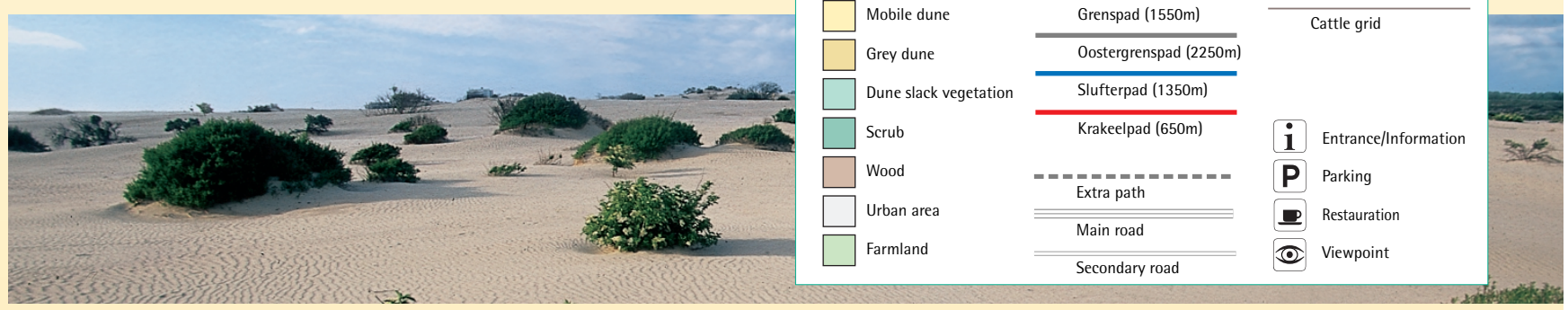
To the south of the foredunes and over a large area, the sand has been blown away as far down as ground water level. Thus, the so-called *dune slacks* or *dune valleys* were formed.
They are alternating with low ranges of *dune ridges*. Most parts of this zone are rather young (less than one hundred years old) and the zone is constantly enlarging into the direction of the south-east. It is now partly covered with moderately high thickets, alternating with stretches of *dune pastures* and *dwarf thickets*, rich in species.

Natterjack toad



THE CENTRAL MOBILE DUNE

(the Roman plain)
In the middle of the reserve, you will find quite an imposing, almost completely bare sand hill (mobile dune) covering more than 100 ha.
This huge mass of sand is being transported by the wind, predominantly eastward, at a rate of 5 to 10 metres a year. The eastern section of this zone shows a greater diversity of height (up to 23 m), dune forms (parabolic dunes) and vegetation.



THE SOUTHERN DUNE SLACKS

The sands from the central mobile dune slowly cover a southern belt of dune slacks, which are separated by a single parabolic dune ridge.
These valleys are centuries older and more decalcified than the northern dune slacks. They are colonized by a variety of high thickets, young dune woodlands and grazed pastures with grassland vegetation. Over large areas the groundwater table is lowered as a result of nearby water catchments.

Geopora arenicola

Common stonechat

Marsh Helleborine

THE INNER DUNES

Along the southern border of the nature reserve lies a narrow and quite old dune belt. It consists of high and low dune ridges, blow-outs and small dune slacks, a few former fields and a derelict sandpit. The vegetation in this zone consists of grey and white dunes, grasslands, various types of scrub and woodland patches. The transition zone between dunes and polders, which can be quite steep, is covered with a protective fringe of planted trees and thorny thickets.

Flora

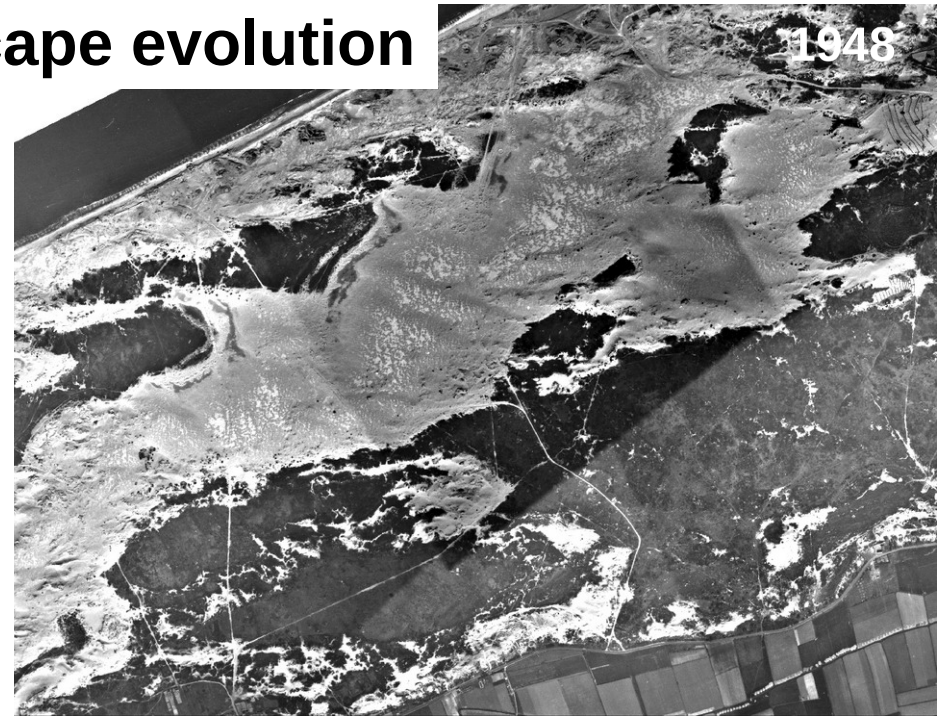
The nature reserve **De Westhoek** boasts an extremely rich vegetation. With more than 400 species of vascular plants, it is home to one third of all wild flora in Flanders. One in five of these species, moreover, is quite rare if not severely under threat elsewhere in Flanders *(Red List types)*. Furthermore, a number of special mosses, types of liverwort, lichen and fungi are dependent upon 'De Westhoek' for their survival.
Along the beach salt-tolerant pioneer plants grow, such as *Sea Couch* and *Sea Rocket*. *Marram* characterizes all white (mobile) dunes, while *Sea Spurge* is limited to the foredunes. Calcareous grey dunes are brightened up by mosses and short-living pioneer plants such as *Stork's-bill*, *Biting Stonecrop* and *Dune Pansy*. The older and more decalcified grey dunes contain *Grey hair-grass*. The young and moist dune valleys show a dune marsh vegetation rich in species, including *Centaury*, *Grass-of-Parnassus*, *Marsh Helleborine*, *Wintergreen* and *Creeping Willow*. Older and drier dune slacks are characterized by flowery grassland vegetation with *Rock-rose*, *Large thyme*, *Burnet-rose* and fungi like *Waxcaps*. If grazing or mowing is stopped, dune scrubs with *Sea Buckthorn*, *Elder* and *Sweet-brier*, and later also *Privet*, *Hawthorn*, *Blackthorn* and wildshoots of trees will dominate. On the inner dune ridges as well as elsewhere in the dunes trees have been planted, a.o. *Elm*, *Grey poplar*, *Ash*, *Abele*, *Maple* and *Alder*. Certain trees and scrubs carry a rich vegetation of bark-living mosses lichens.

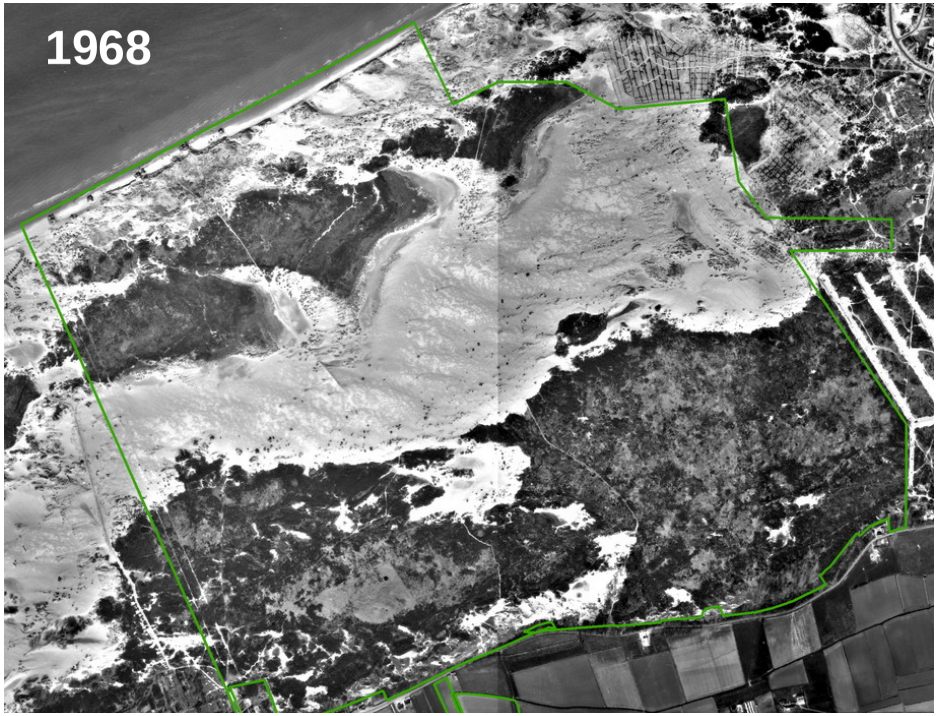
Fauna

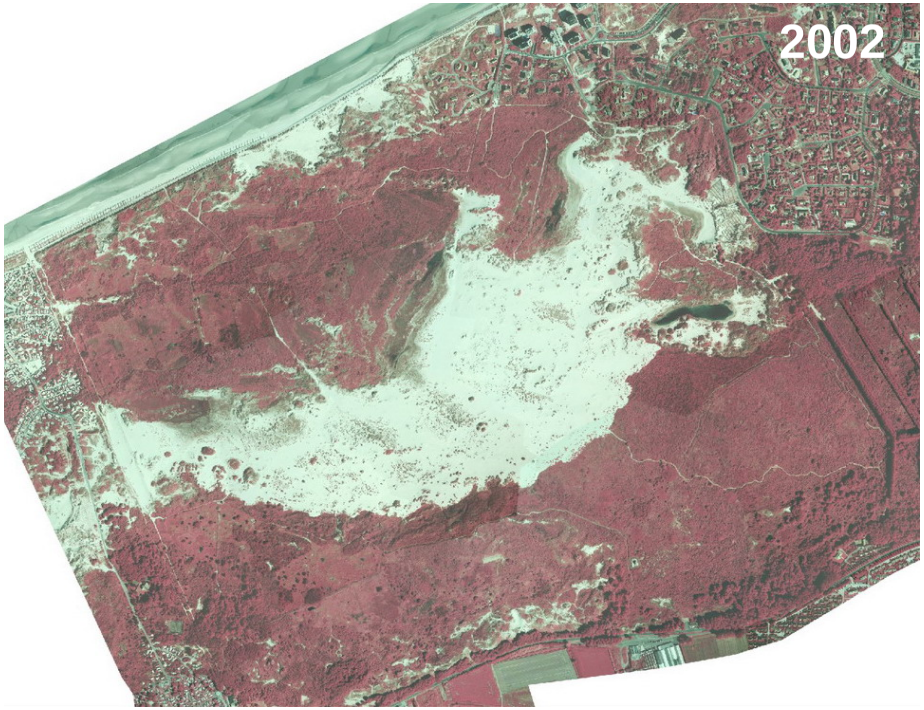
The reserve also boasts a great number of animal species. *Rabbits* naturally control the scrub and woodland development by feeding on it and, together with mice and other rodents, also serve as food for *Fox*, *Polecat* and other predators. The bird population mainly consists of types typical of dynamic coasts and open dunes, with *Kentish Plover* and *Little Ringed Plover*, *Northern Wheatear* and *Crested Lark*. Songbirds in particular find shelter in and around the scrubs and woodland: there one can see and hear *Common Stonechat*, *Nightingale*, *Grasshopper Warbler* and *Willow Warbler* as well as *Green Woodpecker*, *Turtledove* and *Eurasian Sparrowhawk*. During wintertime, the area is rich in migratory birds with large numbers of *Fieldfare* and *Redwing*, but also *Hen Harrier* and *Short-eared Owl*. In spring, rare amphibians such as *Natterjack Toad* and *Great crested Newt* breed in watering places for cattle and in temporarily submerged dune dips. Also, rare species of spiders, locusts, butterflies and beetles, such as *Pine Chafer* and *Blue-winged Grasshopper* belong to the fauna of the area. Many of these particular species prefer the open or mobile dune zones.

Grass-of-Parnassus

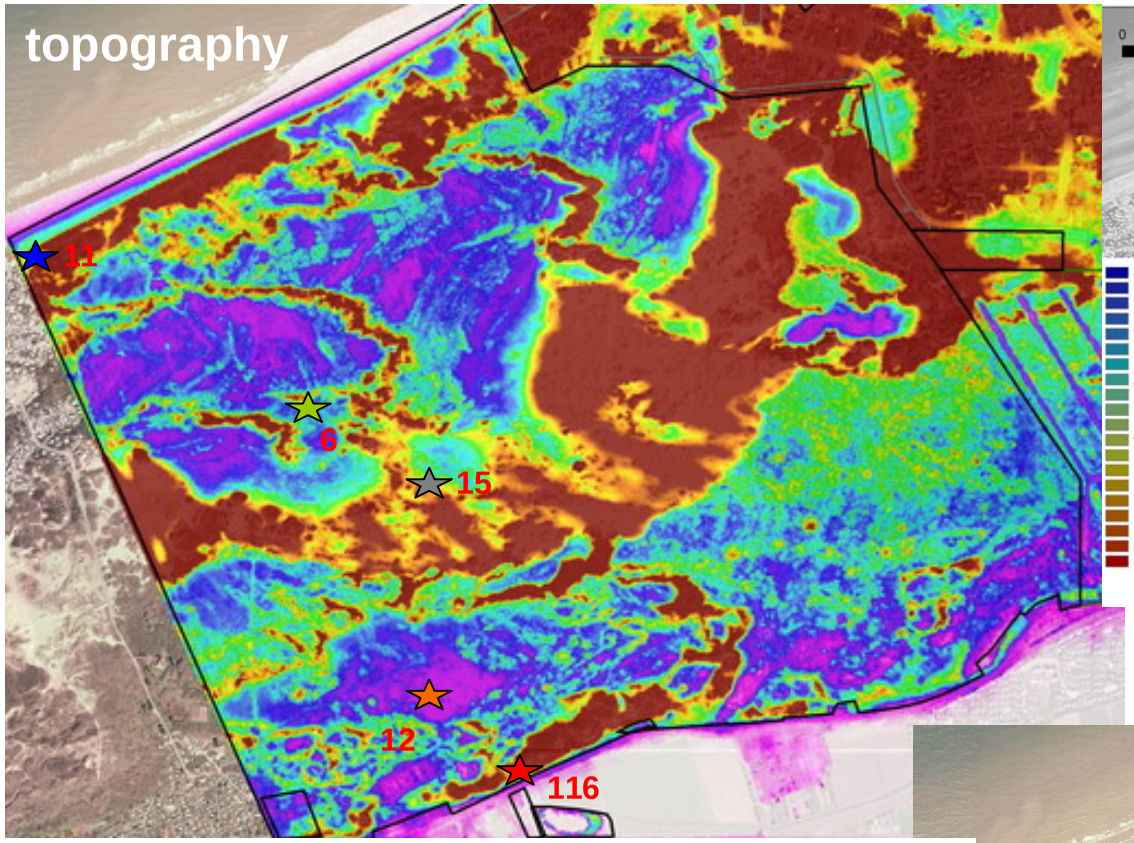
annex 3: landscape evolution

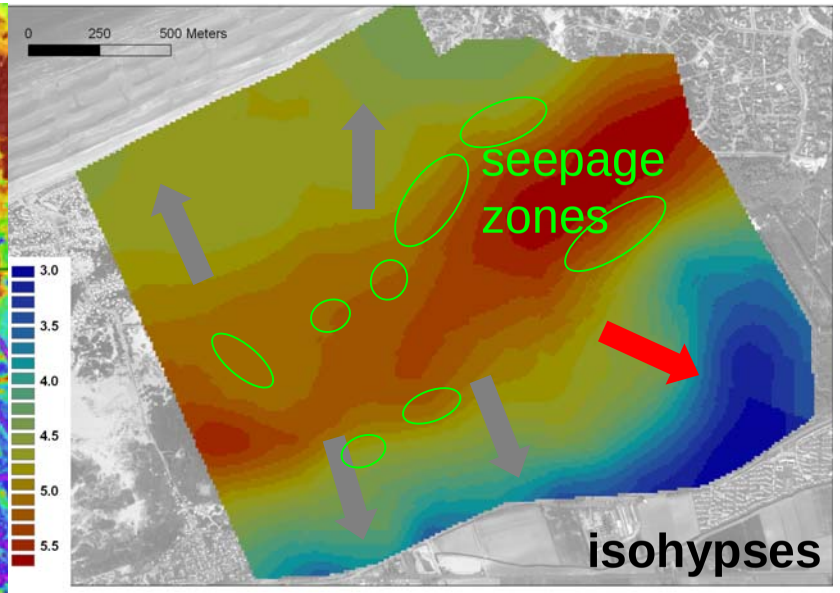


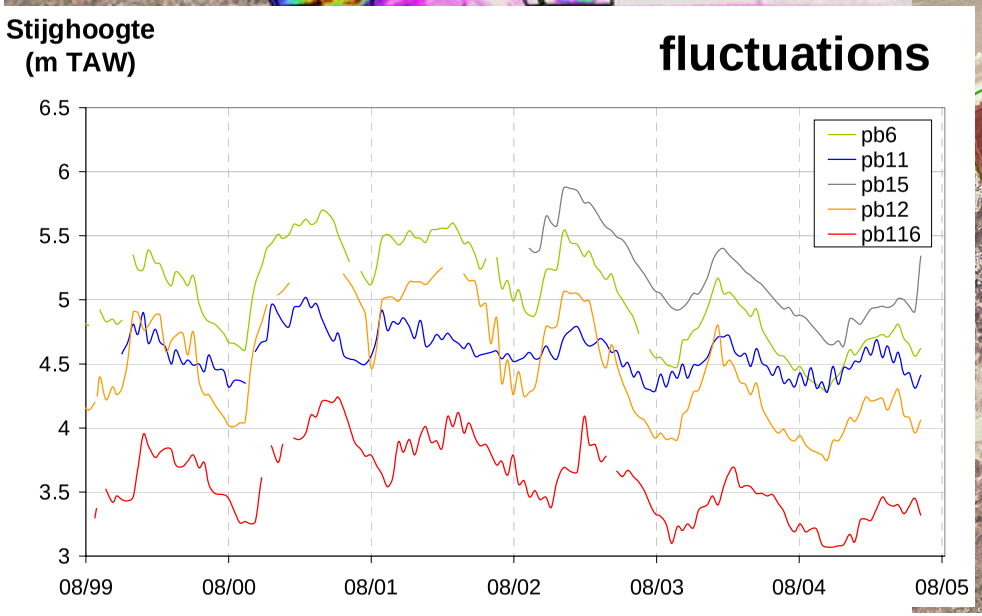


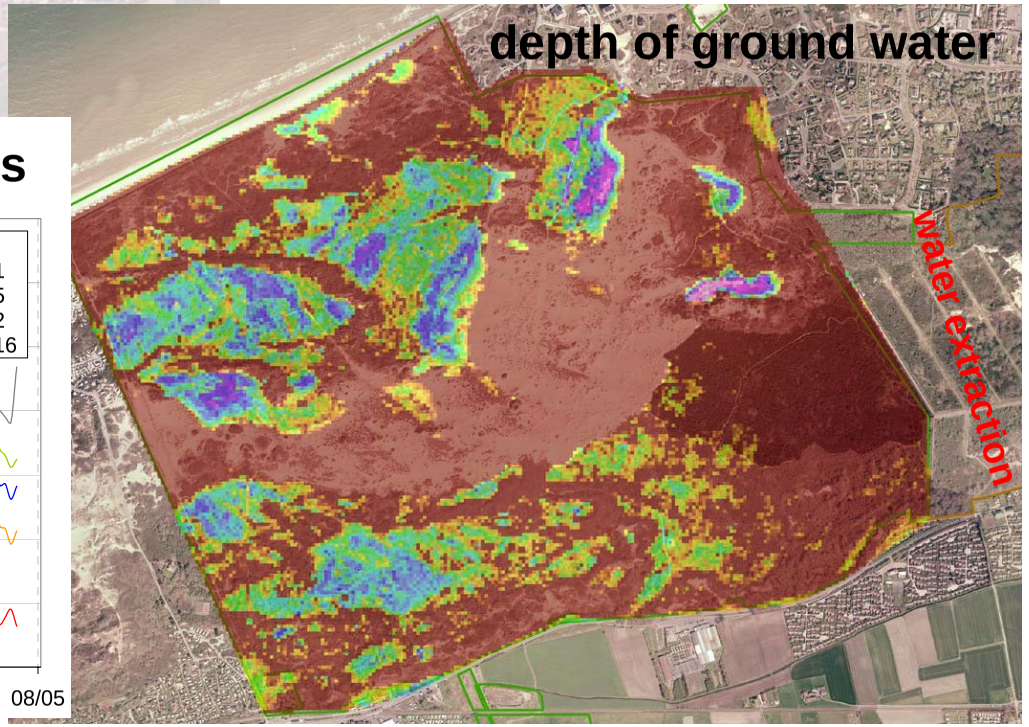


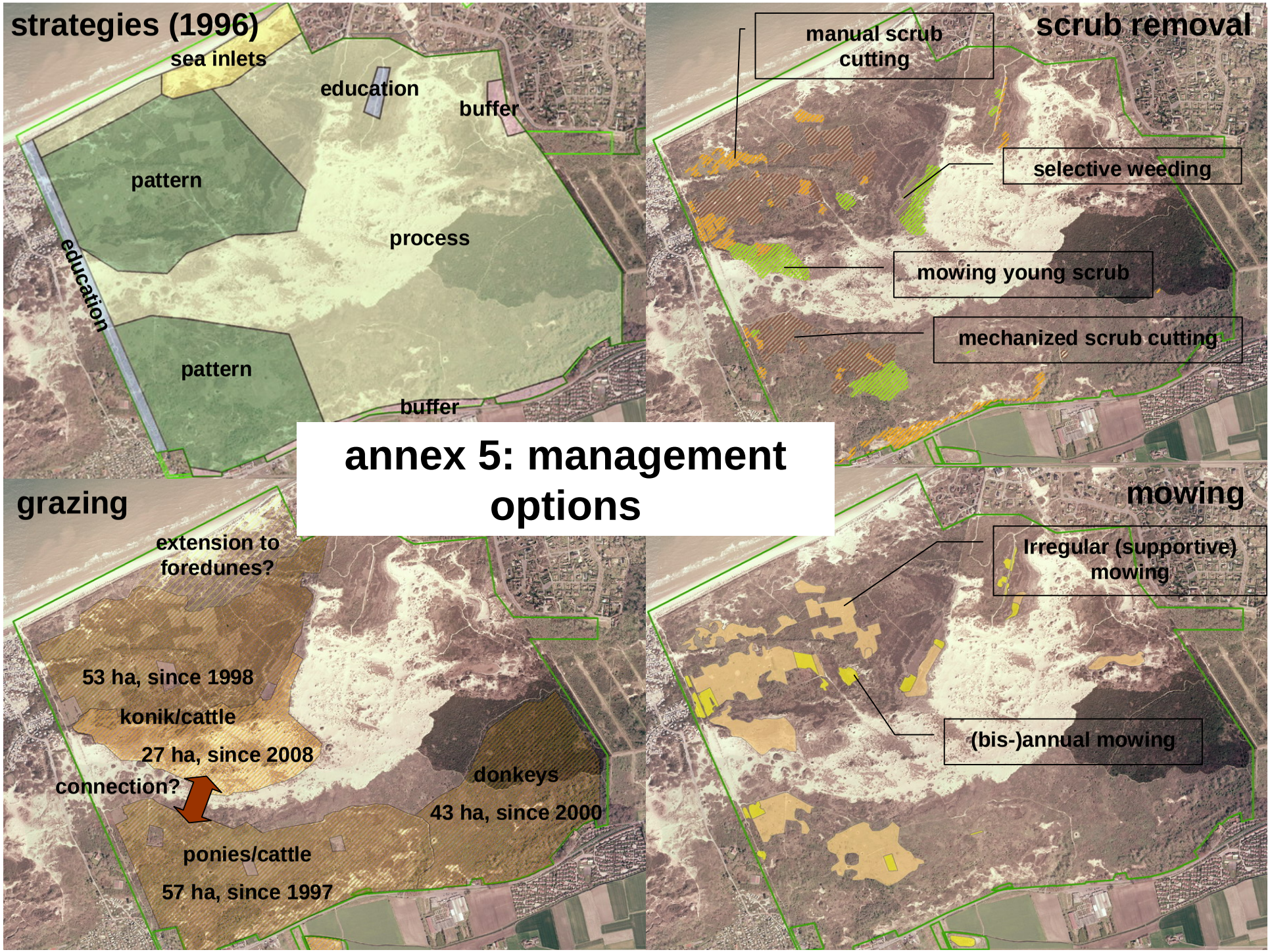
annex 4: hydrology



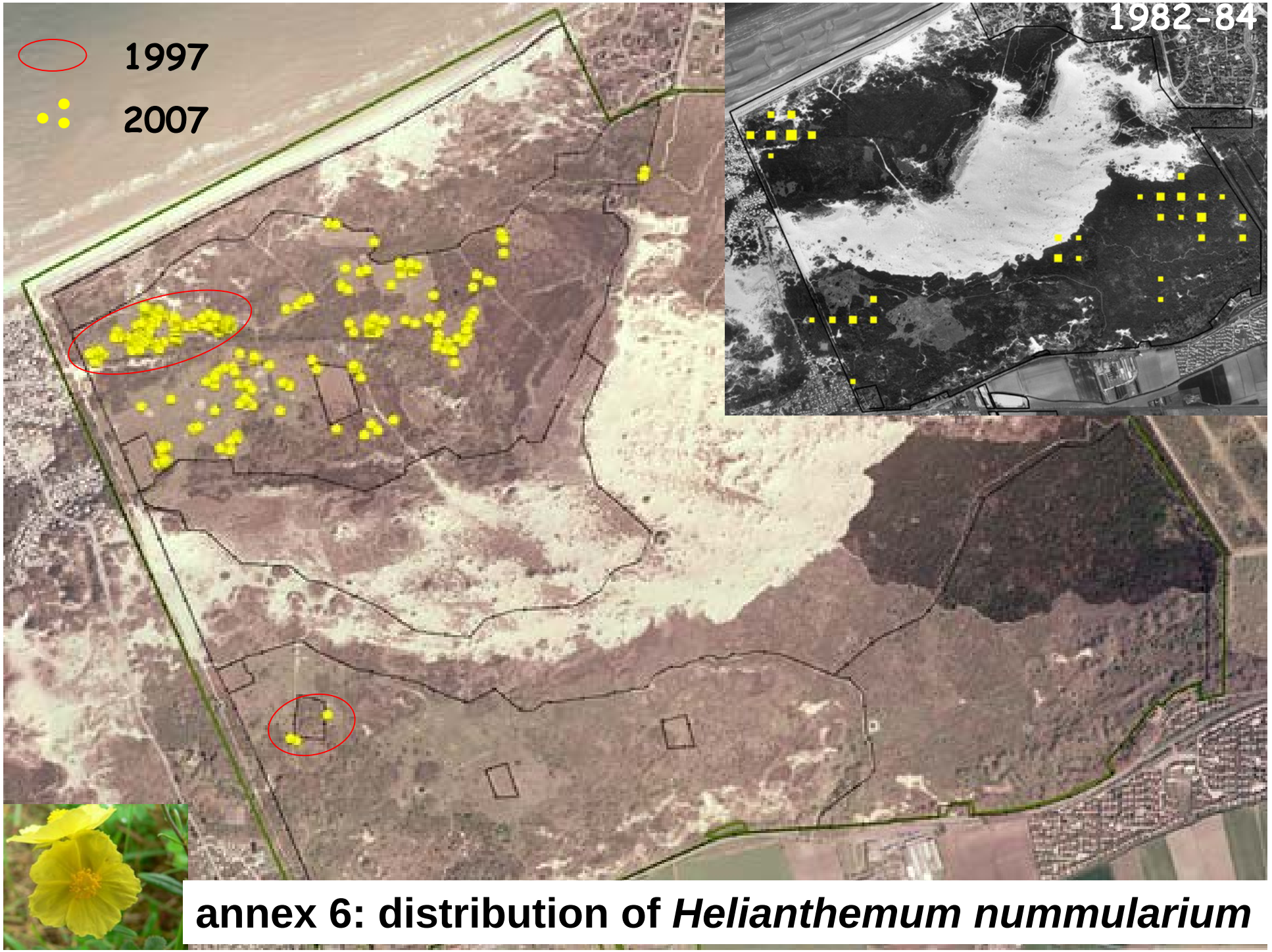








annex 5: management options



annex 6: distribution of *Helianthemum nummularium*

Annex 7:
Publication on dune slack restoration in Proceedings 'Dunes and Estuaries 2005'

Herrier J.-L. *et al.* (Eds). 2005. p. 1-3
Proceedings 'Dunes and Estuaries' – International Conference on Nature Restoration Practices in European Coastal Habitats, Koksijde, Belgium, 19-23 September 2005
VLIZ Special Publication 19, xiv + 685 pp.

Invasive scrub and trees in the coastal dunes of Flanders (Belgium): an overview of management goals, actions and results

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Abstract

Even in nature reserves and under the European Habitat Directive protected dunes of the Flemish coast, species and habitats of the open dune landscape (especially Habitat-types 2130, 2170 and 2190) have become seriously endangered. On the other hand, natural dune scrub and pioneer woodland (Habitat-types 2160 and 2180), together with alien species and manmade habitats (plantations, …), strongly increased. Since the Nature Division became responsible for nature management in Flanders (1995) and with the aid of European funding (Life-projects ICCI and FEYDRA), action was undertaken to stop and reverse this trend. The management dilemma (species rich open dune vs. natural scrub and woodland) is tackled on the basis of an Ecosystem Perspective for the Flemish Coast and by drawing up scientifically based management plans. This paper gives, from a nature managers point of view, an overview of the history and nature of these changes, the problems and dilemmas for nature conservationists, the extent and management techniques of scrub and alien tree removal and of open dune restoration, and a first evaluation of results.

Keywords: Flemish coast; Scrub encroachment; Biodiversity loss; Removal of scrub; Alien trees.

Introduction

Written and photographic descriptions (Massart, 1908a, 1908b, 1912) and botanical data (De Raeve *et al.*, 1983) picture the historic Flemish dunes as a very open landscape, mostly poor in shrubs and even completely lacking spontaneous trees and woodland. It was predominantly made up of (semi-)mobile dunes and low vegetation and was rich in typical open dune plant species and populations of what we now consider to be Red List or Target species (Biesbrouck *et al.*, 2001; Provoost and Bonte, 2004) of various dune valley habitats. The actual landscape of the protected dune areas looks very different: large areas of wet to humid dune valley systems and even dry dunes are covered with various thickets. Locally, even extensive plantations and scattered (sub)spontaneous pioneer woodlands have become established. Alien species form a growing part of the dune flora, even in protected nature areas. Parallel with landscape and vegetation change, important changes in species composition of the dune area occurred. A great number of highly specialised (plant) species of the open dune habitats has disappeared or has become very rare, while widely dispersed and less typical taxa are spreading. Alien species make up a growing part of the dune flora, even in protected nature areas. The direct impact of urbanisation and lowering of the water table on dune landscape, flora and fauna has of course been even more drastic than that of vegetation change, but is not the subject of this paper. As an evaluation tool, this overview mostly uses botanical criteria, but results and conclusions probably also hold when other organisms are concerned.

20th century scrub expansion in the Flemish dunes

The nature reserve De Westhoek (De Panne, Belgium; fig. 1, 5) is one of the best studied dune areas of the Flemish coast and may be used as a good example for the description of landscape and botanical evolution over the past century. Despite protection as Belgium's first public nature reserve (est. in 1957) and the presence of large-scale dynamic geomorphological processes with continuous formation of new wet dune slacks up to this day, a series of Red List species had become locally extinct or very rare by the 1980's (D'Hondt, 1981). Two groups of species and their habitats (Romao, 1999) seemed to be especially affected: "Humid dune slacks" (Natura 2000-code 2190), often intermingled with "Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*)" (code 2170) and "Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp." (code 3140), and dune grasslands belonging to the "Fixed dunes with herbaceous vegetation ('grey dunes')" (code 2130). Although the area of "Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')" (code 2120) and moss dunes (code 2130) also decreased (De Vlieger, 1989), this did not (yet) lead to the complete loss or endangerment of valuable plant species. Animals, especially invertebrates and birds, of the open dynamic dune landscape may however be much more influenced! On the other hand, dune scrub ("Dunes with *Hippophae rhamnoides*"; code 2160), mostly dominated by *Hippophae* and/or *Ligustrum vulgare*, and to a lesser degree "Wooded dunes of the Atlantic, Continental and Boreal region" (code 2180) increased. These phenomena were not restricted to De Westhoek, but were observed by scientists and managers in most of the coastal dune areas in Belgium and adjacent France (De Vlieger, 1989; De Raeve *et al.*, 1983; Provoost and Hoffmann, 1996).

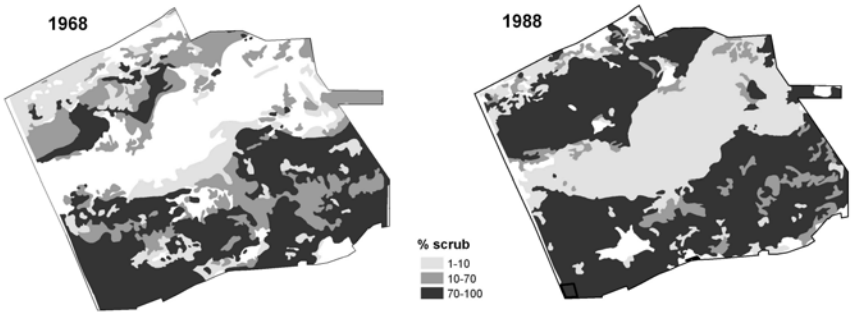

Fig. 1. Scrub extension in De Westhoek nature reserve (De Panne, Belgium) between 1968 and 1988 (Van Nieuwenhuyse, 2002, based on De Vlieger, 1989).

The decrease of wet dune slack species probably started in the 1950's or even earlier, for a large part due to the exponential expansion of *Hippophae*-scrub. At the beginning of the 1980's dense *Hippophae*-thickets had already colonised the open pioneer stage of all unmanaged Westhoek dune slacks some 15 (max. 20) years after their formation (fig. 1). By that time several typical Red List-species were extinct (*Liparis loeselii, Orchis morio, Teucrium scordium,* …) or had become very rare (*Schoenus nigricans, Equisetum variegatum, Herminium monorchis, Gentianella uliginosa*, …). Only species adapted to rapid spreading into the most recently formed dune slacks (such as *Centaurium littorale, Parnassia palustris, Sagina nodosa*, …) and/or commonly present in the local persistent seed bank (*Anagallis tenella, Carex trinervis, C. viridula*, …) were able to survive this evolution. Nevertheless, by 1984, the population of *Parnassia palustris*, symbol species of the nature reserve, was almost restricted to a central complex of young dune slacks, including some of the first actively managed (mown) parts (fig. 6c: with scores of 'occasional' and 'frequent' predominantly in the managed sites). This decline in species and quality was even (much) greater in the more isolated and/or less dynamic dune ecosystems, such as the nature reserve 'Dunes Marchand' at Zuydcoote (Fr.) or the 'Zwinduinen en -polders' at Knokke (B.).

Even though populations of humid and dry grassland species may also have been diminishing since World War II, it was only from the 1970's onward that a threatening decline really became obvious. Key species in this encroachment process was mostly *Ligustrum*, together with *Hippophae* and dominant grass species as *Calamagrostis epigeios*. Few species (e.g. *Anthyllis vulneraria*) disappeared completely from the reserve, but a high number became very rare (*Thesium humifusum, Asperula cynanchica, Briza media*, …) or survived only locally. For instance, by the beginning of the 1980's, *Helianthemum nummularium* had probably already suffered great losses, but was locally still widespread in scattered small open patches between the *Ligustrum*-scrub of late-medieval dune valleys and low dunes in the southern part of De Westhoek (fig. 6a). 20 years later, almost none of these populations still survive (fig. 6b). This also seems a general feature, even in areas where dune grasslands once dominated the landscape.

If scrub invasion of the open dune ecosystems caused the loss of important and vulnerable species and populations, it also raised the general number of species in the dune area. A considerable part of the present dune flora in fact consists of 'new' species, often species from disturbed sites or garden escapes, but also indigenous species related to scrubs and woods. The losses in biodiversity of the open dune landscape are partly outweighed by the gain of rare species such as *Polygonatum odoratum, Rhamnus catharticus, Rosa stylosa* and others. Just as in some dune areas the nightly concerts of *Natterjack toads* have been replaced by the singing of *Nightingales*. Also epiphytic mosses, lichens and fungi have often profited from this evolution (Provoost and Bonte, 2004). Most of these species, however, are generally increasing in the whole of Flanders. Of some of them (e.g. *Berberis vulgaris, Lonicera xylosteum, Narcissus pseudonarcissus*, …) the indigenous status is even dubious.

External factors, e.g. lowering of the water table (due to water abstraction, nearby urbanisation, etc.) or increasing N-deposition (due to air pollution), and the loss of geomorphological dynamics (sometimes called 'fossilisation' of the dunes; Van der Hagen, 2002) are often cited as the main causes for this expansion. Field-experience and historical data indicate however another important cause. Rapid and massive colonisation of the younger stages of secondary dune valley development by pioneering *Hippophae*-scrub may well be the normal natural process in lime-rich dunes, in Flanders and elsewhere in NW-Europe. In any case, pollen analysis reveals high amounts of *Hippophae*-pollen in dynamic medieval stages of landscape development (De Ceuninck, 1987). Also De Bruyne (1906) describes the presence (and extensive cutting!) of *Hippophae* in young dune valleys of the very dynamic historical dunes of De Panne. On the other hand there are no indications that the species-rich mixed thickets that are actually replacing grey dunes and older dune valley grasslands have ever existed in the medieval dune landscape.
The historical open dune landscape was probably the product of the introduction and breeding for hunting purposes of rabbits since late medieval times, the use as grazing ground for livestock (cattle, donkeys, sheep, …) up to 1940, the cutting of shrubs for firewood or dune stabilisation, etc. All these oppressing factors gradually came to an end by the middle the 20th century, at the time scrub expansion started. So, the almost completely open dune landscape of Massart (1908a, 1908b) must at least to some degree be considered as semi-natural. And the invasion of indigenous shrubs probably was the natural process of primary (*Hippophae*) or secondary (*Ligustrum* and mixed scrub) succession once the stressing and disturbing influences of agropastoral use had stopped.

Parallel to the increase of natural dune thickets, a new phenomenon came into view by the 1990's: the invasion of alien species, both woody and herbaceous. This tendency occurred in the already endangered open dune slack habitats, dry dune grasslands and moss dunes, but even more in the natural scrub communities and pioneer woods. It was essentially a somewhat postponed effect of the unrestrained urbanisation and fragmentation of the natural Flemish dune belt during the 20th century. Provoost and Bonte (2004) point out that, with the end of the 19th century as a reference, more than half of all plant species are 'new' to the actual coastal area and that no less then 20% are real aliens. Not all of those species act as aggressive threats ('pest species') to indigenous ecosystems. However, seedlings and shoots of some species derived from local plantations (*Populus xcanescens, P. xjackii, Acer pseudoplatanus, Salix* spp., …) or derelict brushwood used for the stabilisation of drifting sand (*Populus* spp.), garden escapes (*Mahonia aquifolia*, *Rosa rugosa*, *Claytonia perfoliata*, …) or accidentaly introduced species (*Senecio inaequidens*, …) can thoroughly influence (semi-)natural dune ecosystems and lead to an additional loss in biodiversity. Speaking of 'alien species' in this context may be somewhat ambiguous, as almost all trees in the actual dune vegetation descend from cultivated ancestors and some authors even regard species as *Populus (x)canescens* and *Acer pseudoplatanus* as indigenous in Flanders, albeit not necessarily autochthonous in the coastal dunes. Therefore, the emphasis is mostly on the 'invasive' character and the threat to historical biodiversity, rather than on the 'alien' character of the species.

Management planning

The evident decline in quality of the open dune habitats (especially wet dune slack vegetation and dune grasslands) caused by an, at least partially natural, extension of *Hippophae*- and *Ligustrum*-scrub creates a management dilemma for nature conservationists. International criteria are not very helpful either, as the EU-Habitat Directive Annex I obliges the protection of all (semi-)natural dune habitats, albeit that humid to dry dune grasslands and moss dunes (= 'grey dunes', Habitat-code 2130) enjoy a priority status. Do we thus accept the losses in historical and internationally valuable biodiversity connected to the actual, more or less autonomous (= 'natural') processes in vegetation development? Or do we interfere for the preservation of, in the actual situation, mostly semi-natural habitats with high biodiversity value, resulting in a loss in autonomy of the dune ecosystem as a whole? Or should we search for some compromise?

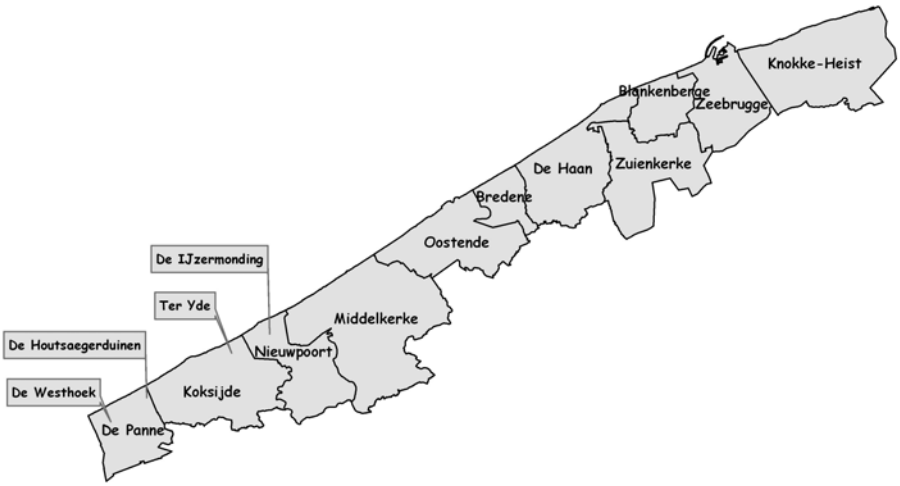

Fig. 2. Location of the concerned nature reserves and managed sites.

Due to the lack of a scientific and integrated approach of coastal conservation and the lack of sufficient means, the management policy remained ambiguous for a long time (Herrier and Killemaes, 1998). When the Nature Division of the Ministery of the Flemish Community became responsible for nature management in 1995, a general Ecosystem Perspective for the Flemish Coast (Provoost and Hoffmann, 1996; Herrier, 1998) and a number of specific management plans were drawn up, creating the necessary solid base for nature management. With Provoost and Hoffmann (1996) as a beacon, each management plan could emphasis its own specific aspects (location of concerned sites in fig. 2). On the military base of Lombart-sijde/Ijzermonding (30ha, Nieuwpoort), partly managed by the Nature Division, for example, a radical policy of preserving the completely open, '19th century' dune landscape with dune grasslands, moss dunes and dune slack vegetation was agreed upon (Degezelle and Hoffmann, 2002). *Hippophae*-scrub and *Populus*-plantations are systematically removed here. In De Westhoek (345ha; Hoys *et al.*, 1996a) a compromise-scenario was chosen, based on the (virtual) division of the reserve in a western part with emphasis on biodiversity and a variety of vulnerable habitats ('pattern-oriented management'), and an eastern part with emphasis on undisturbed natural vegetation development ('process-oriented management'). Extensive grazing by large herbivores and geomorphological dynamics act as unifying landscape processes. A comparable policy was developed for the nature reserve of Ter Yde (62ha, Oostduinkerke; Van Nieuwenhuyse, 2003). In the nearby Hannecartbos (32ha), the

remnant of a marshy medieval beach plain now largely covered by not very vital plantations, the restoration of wet dune slack grasslands, historical ditches and dry 'hedgehog-dunes' goes hand in hand with the conversion of the plantation towards a more natural dune woodland. Special attention is given to the connection with adjacent open dune ecosystems and the maintenance of tall-herb fringes (habitat of e.g. Annex II-species *Vertigo moulinsiana*) (Hoffmann *et al.*, 1999). On the other hand, the management plan for the Houtsaegerduinen (80ha; De Panne), an isolated reserve enclosed by urban area, aimes especially at the development of natural scrub and woodland and the suppression of aggressive alien species (Hoys *et al.*, 1996b). Grazing should maintain species and landscape diversity during this process. Here only some small patches of relict dune slack and grassland are temporary mown to prevent scrub encroachment.

Where preservation or restoration of open dune ecosystems is the primary goal, management plans generally aim at the creation of as large and little fragmented entities as possible. The creation or preservation of a diversified vegetation structure with extensive transitional zones is also a constant point of attention. An other basic principle, at least when reactivation of mobile dunes is not the main aim of the action, is a respectful approach towards conservation of the soil, seed bank, micro-topography, relict populations, etc., in other words: of the site's ecological history. It is, for instance, known that a too drastic removal of the topsoil is harmful for *Vertigo angustior*, an Annex II-species of lime-rich dune slacks (Janssen and Schaminée, 2004).

Management practice (Table Ia&b)

General features

Starting in the 1970's, active vegetation management in the Westhoek nature reserve remained restricted to the yearly mowing of a former farm meadow (<2ha) and of some small patches of wet dune slack vegetation ('maintenance management'). Regrettably, most of these initial management sites were situated in unfavourable parts of the reserve, as they where influenced by a gradual lowering of the water table due to adjacent drinking water exploitation, and some were later abandoned. Following the recommendations of D'Hondt (1981), the first more adequate measures were undertaken. Those early actions concerned the conservation of the often very small relict populations of vulnerable species like *Herminium monorchis* (<10 individuals), *Schoenus nigricans* (2 individuals), *Gentianella uliginosa* (<50 individuals) and others. They mostly consisted of (very) small-scale scrub cutting or tall grass mowing (sometimes less than 0.01 ha!). These surface areas were gradually extended in the 1980's and 1990's (c. 6ha by 1994), but remained a more or less anecdotal response (sometimes called 'eco-gardening') on the changes in the whole of the dune ecosystem. The same was true for Ter Yde (small-scale actions from 1994 on) and Hannecartbos (relict management from 1989 on).

Following the new management policy, which started in 1995, the first intervention was the gradual expansion of the area of young dune slacks that were kept in an open state by means of mowing or selective weeding of *Hippophae*-seedlings ('maintenance' management: 10.75ha by 2004). On the most vulnerable or inaccessible sites, relatively small-scale grassland and dune slack restoration through careful manual cutting of scrub (including the use of small machinery as brush cutters and chainsaws) and removal of litter of course continued and was even intensified (by 2004: 12.35ha, generally in small individual patches). It was mostly executed by the staff of the Nature Division, partly with the help of social employment projects. Large-scale mechanical actions, executed by specialised contractors, proved however necessary to realise the management plans.

With the help of EU-funding (Life-programs ICCI and FEYDRA; Herrier and Killemaes, 1998; Herrier and Van Nieuwenhuyse, 2005), the often high goals set by the management plans could (or will) be reached in a relatively short time (already 21.47ha by 2004). At last, the (manual) treatment or removal of invasive alien trees (pest control), also took place on a large scale (20.89ha), although this figure of course includes sites where only scattered individuals were treated.

Table I gives a more detailed overview of the actions undertaken by the Nature Division since the start of active vegetation management in the Flemish coastal reserves and nature domains (in total c. 1300ha by the end of 2004). The 6ha of dune habitats that up to 1995 were managed by way of pattern-oriented or pest-controlling actions, have since been multiplied by ten and management plans, approved or in preparation, foresee a substantial extension still. An overview of Target Habitats (fig. 3) shows that 3/4 of the actions concerned the restoration or preservation of dune slack vegetation (codes 2190/2170) and of dry dune grasslands or moss dunes (code 2130; priority habitat). This is in line with the earlier mentioned, most urgent conservation needs. Most of this management took place in De Westhoek, Ter Yde/Hannecartbos and Lombartsijde. A small but significant area of scrub or plantation removal in these dune slacks was needed to create or restore dune pools (codes 2190/3140). In Ter Yde, also the restoration of a large area of shifting dunes (code 2120) made the removal of scrub and planted trees necessary. Selective cutting of invasive (alien) trees (pest control) to restore natural dune scrub (code 2160) or woodland (code 2180) concerned some 15% of the area, in all reserves. Specific action towards the creation of humid tall herb fringes

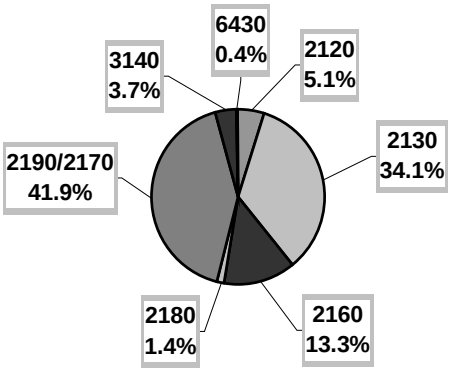

Fig. 3. Target Habitats of the management actions involving removal of scrub and pest control in the nature reserves of the Flemish coast.

("Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels"; code 6430) was only very locally undertaken in the Hannecartbos, but this habitat is, on a small scale, often a 'side product' of local scrub removal or natural scrub succession.

In all restoration actions involving removal of scrub or plantations, several executive phases could be distinguished:

1. the cutting of shrubs or trees by means of hand material (small-scale actions) or through chopping with a woodchopper (mostly large-scale actions)
2. the removal and processing of coarse woody debris
3. the (careful) removal of stumps, fine organic litter and/or topsoil.

As experience grew, the importance of preparatory action became more apparent:

1. the administrative and judicial preparation, incl. financing of the actions (is of course crucial and often time and nerve consuming, but will not be treated here in further detail)
2. the acquiring detailed knowledge of the site and conceptual preparation
3. the planning and creation of (temporary) service infrastructure

Even more then expected, direct follow-up and scrupulous evaluation of the results proved to be essential.

4. 2. Executive phases

Large-scale action for the restoration of the open dune valley landscape of De Westhoek started in 1997, with the reclamation of 6.7ha of (partly already perishing) *Ligustrum* and mixed scrub in the late-medieval and least vulnerable southwestern dune slacks. The technique used generally followed the example of the actions undertaken some years earlier in the French nature reserve Dunes Marchand: a tractor with an improvised woodchopper first 'smashed' the scrub to pieces, only sparing scattered *Quercus* and *Crataegus* trees and some islands of *Prunus spinosa*. In a second stage a caterpillar crane with toothed shovel concentrated the debris and coarse litter in compact heaps. Some of the fine litter was later manually removed with rakes, but most of it was left on the site. The woody debris was burned on the spot and the ashes were transported outside of the reserve. In a last stage, the soil underneath the stakes was excavated and used for the creation of permanent service tracks. The excavations were transformed into (drinking) pools.

In later large-scale actions in the vulnerable young up to middle-aged northern dune slacks of De Westhoek, on the very vulnerable peaty soil of the fossil beach plain of the Hannecartbos and in Ter Yde, a more 'professional' heavy woodchopper mounted on the 7 meter-arm of a caterpillar tracked vehicle was employed. Despite the heavy weight of the vehicle, the use of caterpillar tracks combined with the length of the arm and the technique of employing a thick layer of woody debris as an underground for temporary service ways resulted in a remarkably limited disturbance or compaction of the soil. Sole problem proved to be the (high) working speed: sometimes the supervising personnel was not able to correct small errors in time!

The later stages of open dune restoration proved to be more problematic. Even if the basic technique for the removal of woody debris and coarse litter (scraping it together with a toothed shovel) gave good results, removal of the finer litter caused more problems. A variety of techniques was tried out, some of them not very successful (e.g. the use of a street sweeper), some successful but very labour-intensive and costly (e.g. complete manual removal with rakes), some of them mostly creating a lot of dust… It often obliged the managers to finish off the action by cutting shallow sods (if possible less then 5 cm and preserving at least part of the A1-soil horizon). Both manual (with simple shovels) and mechanical (caterpillar crane with flat shovel) techniques were successfully tried out. In De Westhoek, these sods were later used to stabilise service tracks.
As, since 1999, the use of fire (and thus the burning of woody debris) in the Flemish nature reserves was no longer considered justified, the problem augmented. The only efficient solution left was to remove debris and litter together with as little of the topsoil as possible (fig. 4). Of course, this was only possible in more or less flat dune slacks and risked to be in conflict with the aim of restoring open dune ecosystems while respecting soils, micro-topography and relict populations. The creation of an optimal starting point for the restoration of dune grasslands on undulating dunes and in small slacks thus remains a problem that can probably only be solved through high investments in manual labour.

Fig 4. A caterpillar crane with flat shovel scrapes away woody debris, litter and part of the topsoil in a wet dune slack of De Westhoek (2000).

When accessibility, finances and legal conditions made it possible, the mixture of debris, stubs, litter and topsoil was removed from the reserve (Hannecartbos, Ter Yde), if not it was concentrated and locally stacked as an artificial dune (De Westhoek, Houtsaegerduinen). In all cases, vehicles with low soil-pressure tires or caterpillar tracks were used for transportation. Stems and branches resulting from the smaller-scale manual scrub-cuttings could mostly be chopped with an independent chopping utility and were used to stabilise footpaths in the reserves.

Preparatory action

Because of the difficult accessibility, the demarcation of the first reclaimed Westhoek-site (1997) was rather improvised and often dictated by the topographical features that were, sometimes rather unexpectedly, met with on the spot. Learning from this experience, later actions were prepared in more detail. For instance, in the last, most elaborately planned reclamation site of De Westhoek (2000), the scrub removal phase was preceded by the creation of a raster of passage ways (50mx50m) that was meticulously set out on the spot and executed with a simple woodchopper on a tractor. Meanwhile, based on vegetation mapping, topography, age of the various dune slack parts, old botanical records, etc. a complex reclamation pattern was drawn on detailed aerial photographs in order to create a site with an 'optimal' mixture of open dune vegetation and scrub of all age categories, humidity, etc. This pattern was marked on the now better accessible site, whereupon the caterpillar driven woodchopper neatly 'cut out' this pattern. It resulted, from an aerial view, in a rather artificial looking landscape pattern (fig. 4: most northeasterly reclamation site), but should guarantee a maximum of diversity in the restored low vegetation as well as in the remaining scrub.
Another type of preparatory action was needed in the Hannecartbos, where a dying 60-year old plantation of *Alnus incana, A. glutinosa* and *Populus xcanadensis* was felled. Here, relict populations of *Valeriana dioica* and especially sedge populations with the Annex II-species *Vertigo moulinsiana* had to be searched beforehand and carefully marked in order to preserve these vulnerable species. All these kinds of preparatory activities may take some time and expertise, and can influence a rational execution of mechanical actions. They nevertheless prove to be essential.

A thorough study of historical sources and the situation on the site can also be very useful in the planning of necessary service infrastructure. In De Westhoek, for example, half-hardened derelict tracks dating from World War II that visibly had become almost untraceable on the site, could be 'recycled' as permanent service tracks with the help of old maps.

Control and follow-up management

As ecosystems are often rather unpredictable and natural conditions can rarely be described up to the smallest detail, small changes of the specifications on the planning documents (the contractor's base for the execution of the works) were often necessary and sometimes had to be decided instantly on the spot. A direct and intensive control of the actions on the site proved to be essential to obtain the best possible results or even to avoid 'collateral damage'.
On the other hand and independent of action-scale, scrub-cutting and efficient litter-removal are rarely solely sufficient for successful restoration of vulnerable habitats. Regrowth of wildshoots, seedling establishment on the bared soil, etc. negatively influenced desired vegetation development in almost all reclaimed sites and during some years a follow-up management (mowing, weeding seedlings, …; mostly executed through a social employment project) always proved necessary. In some cases, periodical cutting of regrowth of e.g. *Hippophae* or *Prunus spinosa*, is already foreseen in the future management scheme. Anyway, preventive action, e.g. the preliminary search for and elimination of undesired seed-bearing trees (*Salix alba, Alnus glutinosa*, …) in the direct neighbourhood of the management site, might prevent later problems. Also remaining stubs, rubble, pits, etc. sometimes hampered follow-up management.

Pest control of invasive (alien) trees

Suppression of invasive alien species, mostly trees, was necessary in almost all managed dune areas. The first actions against invasive alien trees were undertaken in 1996, with the removal of 2.5ha of trees and wildshoots of *Populus (x)canescens* and *P. alba* from valuable moss dunes of the inner dune ridge of De Westhoek. Trees were simply cut and removed. In the following years, even more extensive action against especially *P. xjackii*, but also *P. (x)canescens*, *Robinia pseudacacia*, *Prunus serotina* and others, was undertaken in De Houtsaegerduinen, partially through the very careful use of a herbicide (glyphosate). In Ter Yde the problem concerned mainly wildshoots from derelict brushwood used to stabilise the dynamic dunes (mostly *Populus xcanadensis*). Because of vulnerable orchid populations in the nearby dune slacks, no herbicide was employed here. So extensive mowing and manual uprooting was used as a management technique. Where possible, stems were almost completely removed from the site and branches were burned on the spot or, later, chopped and transported. Sometimes (e.g. dispersed individuals in hardly accessible scrub) treated or felled alien trees where left on the spot. In general, litter removal was not necessary, but the removal and processing of stems and branches had often to be done with great care, e.g. when moss dunes (Habitat-code 2130) were concerned. In all cases an intensive follow-up management (repeated mowing, uprooting of wild shoots and even renewed use of glyphosate) was needed to prevent regrowth.

Evaluation and discussion

Parallel to the execution of the nature management plans, a scientific monitoring project was set up in 1997-1999, continued in 1999-2002, by the University of Ghent and the Institute of Nature Conservation, under the supervision of the Nature Division. It focused on the nature reserves of the western coastal area, especially De Westhoek and De Houtsaegerduinen and was supported by the EU-Life-project ICCI (Herrier and Van Nieuwenhuyse, 2005; Hoffmann *et al.*, 2005). However, it is still too soon after management actions to draw definite and general scientific conclusions, especially when taking into account the very abnormal hydrological conditions of 2001 and 2002. And, as the emphasis of the study lay on the effect of extensive grazing, conclusions have less to do with the specific effects of scrub and tree removal. In any case, one of the main management questions, namely whether grazing in itself can transform scrub into valuable dunes slack vegetation or grassland, can probably only be solved after some decades of study. At the moment, however, there are no indications to suggest such a development. At Oost-duinkerke and Nieuwpoort a new monitoring project was set up in 2004 (up to 2008, supported by Life-project FEYDRA) and contracted out by the Nature Division to the University of Ghent and a couple or other scientific consultants. It is of course still in the starting phase. This last monitoring project aims specifically at an evaluation of the effects of scrub and plantation removal. A provisional evaluation by the management team itself, based on empirical, non-systematic observations, of the scrub removal actions is however possible. So, some impressions rather then hard conclusions can already be presented and discussed.

The small-scale actions undertaken since the 1980's to protect relict populations of very rare species were mostly successful. Almost all target species could be saved, although accidents did happen (e.g. the loss of *Schoenus nigricans* due to inadequate mowing of the site), populations remained very localised and small, and were sensitive to fluctuating climatic conditions (drought, inundation, …). Nevertheless, as only very few of the species lost before the 1980's were able to recolonise the site, these results stress the importance of a management stage of careful 'eco-gardening' of vulnerable relict populations. This may be even more the case, where some vulnerable invertebrates are concerned.

4-6 years after large-scale scrub removal and restoration of nutrient-poor soil conditions, species rich vegetation is developing in almost all 'young' (25-50 years) and even 'middle-aged' (50-100 years) wet dune slacks (northern part of De Westhoek, Ter Yde). It includes not only the species commonly present in the early stages of natural vegetation development of newly blown-out slacks, but also some of the later-stage species. Part of the colonising plants no doubt derived from a local persistent seed bank (*Carex*, *Juncus* and *Centaurium* species, *Blackstonia perfoliata*, *Anagallis tenella*, *Sagina nodosa*, …), while most of the undesired seedlings from this seed bank (*Urtica dioica*, …) seem to be lacking. But also the relict populations in the early (<1996) managed sites (*Epipactis palustris, Dactylorhiza incarnata, Parnassia palustris, Gentianella uliginosa, Linum catharticum*, …) had a clear and positive impact on the colonisation of the newly managed sites. A good impression of the combined results of local maintenance management in young dune slacks, large-scale scrub and litter removal and follow-up by mowing or extensive grazing, is shown by the distribution of *Parnassia palustris* in 2004 (fig. 6d).

Some remarks are however necessary. An absolute condition to obtain desired results is the thorough removal of litter and A_0-soilhorizont or shallow sod cutting. Where removal of organic debris or the A_0-layer was inadequate, the site became quickly dominated by competitive species such as *Agrostis stolonifera*, *Ranunculus repens*, *Trifolium repens*, *Lycopus europaeus*, ..., and colonisation by Red List-species was feeble. Some difference remained between areas where only the fine litter was thoroughly removed and those where sods were cut. Later stage species like *Gentianella uliginosa* and *Linum catharticum* seemed to prefer the sites, with a somewhat more closed vegetation, where only litter was (carefully) removed, while species like *Parnassia palustris* and *Carex viridula* had a clear optimum in the open vegetation of areas where shallow sods were cut. On the other hand, after some years, there was hardly any difference left between areas where sods were removed manually or mechanically.
Secondly, at this very early stage, follow-up management by mowing or extensive grazing may not yet be essential (no control plots have been established, however), but it is probably crucial in the long run. Anyway, both the maximum slack-age able to support species rich dune slack vegetation and the obvious recovery of many species from the local persistent seed bank seem to contradict the rather pessimistic conclusions of Bossuyt *et al.* (2003) and Bossuyt and Hermy (2004). We should nevertheless not be too optimistic: in centuries-old, superficially decalcified wet dune slacks with a deep humic soil (southern part of De Westhoek), vegetation development after scrub removal mostly resulted in species and vegetation of more eutrophic soils (*Juncus subnodulosus, Lychnis flos-cuculi*, …).

As was feared that the chances for recovery of the vulnerable old humid and dry valley grasslands were rather low, special care was undertaken to preserve at least the old grassland soils underneath the cut *Ligustrum* scrub. But even in areas with large-scale mechanical scrub-cutting and debris removal, and probably thanks to the care that was taken as to not unnecessarily disturb soils, recovery of some of the basic species of this habitat, such as *Luzula campestris, Veronica chamaedrys, Rosa pimpinellifolia*, …, was almost immediate. Others, such as *Viola hirta, V. canina, V. curtisii, Arabis hirsuta, Erigeron acer* and *Polygala vulgaris*, some of them possibly originating from a local persistent seed bank, also quickly established, but may indicate just a temporary 'clearing-effect'. In general however, recovery from a persistent seed bank may play a minor role in the preservation of Red List-species of this habitat. *Anthyllis vulneraria* and *Primula veris*, both with new populations after scrub removal in De Westhoek, may be some of the exceptions. Most promising, however, was the establishment, within 4 years after large-scale scrub removal, of some small but completely new populations of target species such as *Helianthemum nummularium* (fig. 6b), *Asperula cynanchica* and *Thymus pulegioides* in relatively 'young' parts of the dune system. As for some more common grassland species, (endo-)zoochorous dispersal by grazing animals may be responsible for these new establishments (Cosyns, 2004).
First results thus seem to indicate that the combination of cautious removal of scrub and litter and the introduction of extensive year-round grazing may be a successful instrument in the conservation of this priority Habitat (code 2130).

As the more radical actions of deforestation and upper soil removal (Hannecartbos) and scrub cutting with complete removal of the humic soil layer (Ter Yde) are too recent (2004) and still incomplete, they can not yet be evaluated properly. The general impression of the experimental deforestation of 1.3ha in the Hannecartbos is however positive, as it already became clear that even large-scale action with heavy machinery on a marshy and vulnerable soil can be executed without too much damage to the soil. Intensive follow-up by manual actions (local supplementary removal of litter, removal of stubs and remaining roots, mowing regrowth and undesired tree seedlings, …) must however be foreseen.

The results of the suppression of invasive (alien) trees are less uniform and clear. Especially *Populus (x)canescens* and *P. alba*, but to a lesser degree also *P. xjackii* and *P. xcanadensis*, proved hard to handle, as wildshoots regenerating from remaining root fragments were strongly stimulated after cutting of the parental trees. Even the (controlled) use on stubs or stems of a herbicide (glyphosate) did not give completely satisfying results. The foreseen prohibition of the (even very careful) use of herbicides in public domains can however seriously affect future pest control initiatives. Action against these species will therefore include long-term and labour-intensive measures of follow-up management. Some small-scale actions against *Rosa rugosa*, *Symphoricarpos albus*, etc. led to the same conclusion.

Sometimes scrub or tree removal was essential for the restoration of dried up or overshadowed dune pools. Some pools even were the product of the reclamation action itself (conversion of stakes, see above). Nevertheless, also in these cases the removal of scrub or woodland often proved to be a sound decision. In the Houtsaegerduinen a long lost population of the Annex II-species *Apium repens* grew up from the seed bank after

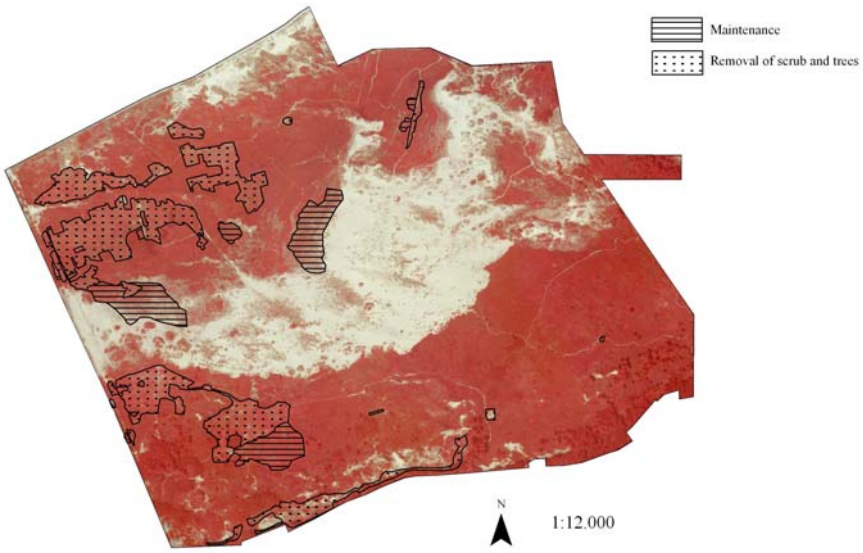

Fig. 5. Management sites in the Westhoek nature reserve (false colour aerial photography, AERODATA 2004). See Table I.

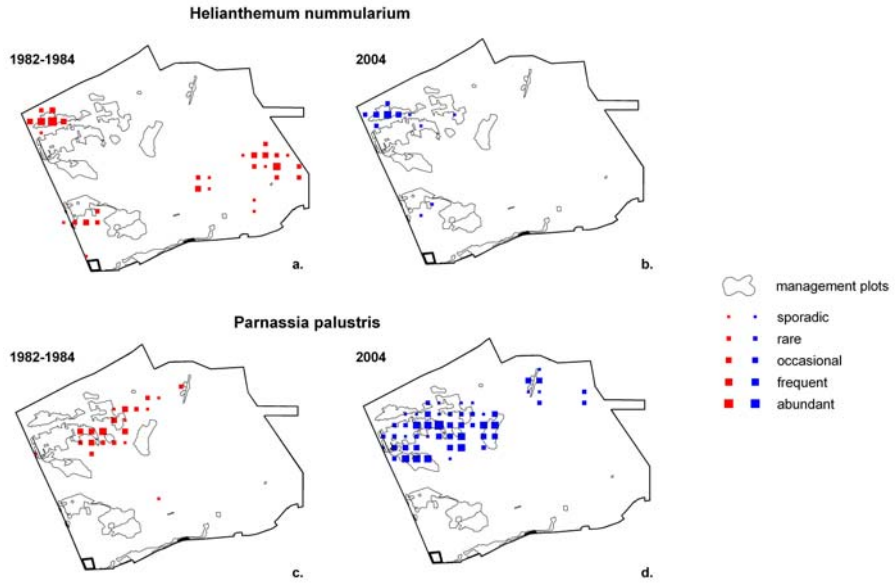

Fig. 6. Distribution of dune grassland-species Helianthemum nummularium and dune slack-species Parnassia palustris in the Westhoek nature reserve (personal data M. Leten).

felling overshadowing trees and shrubs and deepening of the old dune pool 'D'Achte'. In that same pool, but also in restored pools in De Westhoek, another Annex II-species, *Triturus cristatus*, appeared, while *Bufo calamita* (Annex IV) colonised most of the newly created pools in all nature reserves. Several of the newly created or restored dune pools even guarantee the survival of the protected *Characeae*-habitat (Natura 2000-code 3140) in the Flemish dunes (Denys and Packet, 2004).

One somewhat negative and generally neglected aspect of large-scale mechanical management actions may be the possible introduction of new species and genotypes through the used machinery. Although recent newcomers in De Westhoek like e.g. *Juncus acutiflorus*, *J. subuliflorus* and *Glyceria declinata* probably originated from the Ardennes where the vehicles were employed earlier, they could still be considered as harmless for the local flora[F.W.1]. The introduction of species and genotypes from agricultural and urban habitats or far-away ecodistricts can nevertheless profoundly alter local vegetation and the genetic identity of local populations. Examples are the gradual disappearance in De Westhoek of genetic and morphological features of the autochthonous variant of *Cerastium fontanum* (= ssp. *glabrescens*) through introduction of the common *C. fontanum* (= ssp. *vulgare*) and of the local *Erodium lebelii* through introduction of the common *E. cicutarium* s.l.

Monitoring and evaluation, whether on a thoroughly scientific or on an elementary empirical base, prove to be essential for nature management, in order to be able to plan and eventually make adjustments through new actions and to be able to quickly react on negative developments. Thus monitoring should also produce direct and practical advice for nature managers. As the effects of large-scale measures can mostly not be reversed, small-scale preparatory experiments, although often difficult to execute as deadlines and contractual, legal and administrative restrictions are a severe limiting factor, are of high importance.

Nature conservation theory and management plans often set high and not always reconcilable goals. In reality it proved not always self-evident and sometimes almost impossible to realise all of them within the strict limits set by urban planning, site status, judicial conditions, financial and personal means, technical complications and nature's own unpredictable behaviour. We consider the first results of planned management action in the nature reserves along the Flemish coast generally as very promising and have good hopes that most of our aims will be reached. The future effects of world wide changes, however, can not yet be foreseen and only the future can judge whether the choices and realisations of this generation of nature managers will have satisfyingly resolved the dilemma's and technical problems of nature conservation in the Flemish dunes.

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