The restoration of mobile dunes: Westhoek nature reserve

Nature and Forest Agency (ANB)

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Vedette

The - in this rapport mentioned works in the Sahara- are part of the Flemish and French Interreg project "Vedette" for the cross-border dune belt between Dunkerque and Westende. Together with Belgian and French partners, ANB wants to restore the Flemish Dunes and make it more attractive and varied for people and nature! The general coordinator of VEDETTE is the province of West Flanders.

1.Introduction

1.1 Sand drift

Sand drift is the natural process of the movement of grains of sand by the wind. The shifting dune landscape is the natural habitat of many characteristic plants, animals and mushrooms, such as the blue sea holly (*Eryngium maritimum*), the dune tiger beetle (*Cicindela maritima*), and the dune brittlestem (*Psathyrella ammophila*).

Due to the predominant north-westerly winds during storms at the Flemish coast, parabolic-shaped dunes (horseshoe-shaped dunes) develop. The sand is dispersed out to groundwater level and this dispersed sand piles up to form a parabolic-shaped dune, which then continues to move in a southeastern direction. In the wake of that shifting dune, a humid dune slack develops. This humid environment in turn forms a valuable habitat for quite a few special plants and animals. The rare natterjack toad (*Epidalea calamita*), for example, is able to breed here in spring, and interesting plants like grass of parnassus and diverse kinds of orchids occur here. The shifting dunes, together with these humid dune slacks, ultimately form a beautiful and varied dune landscape.

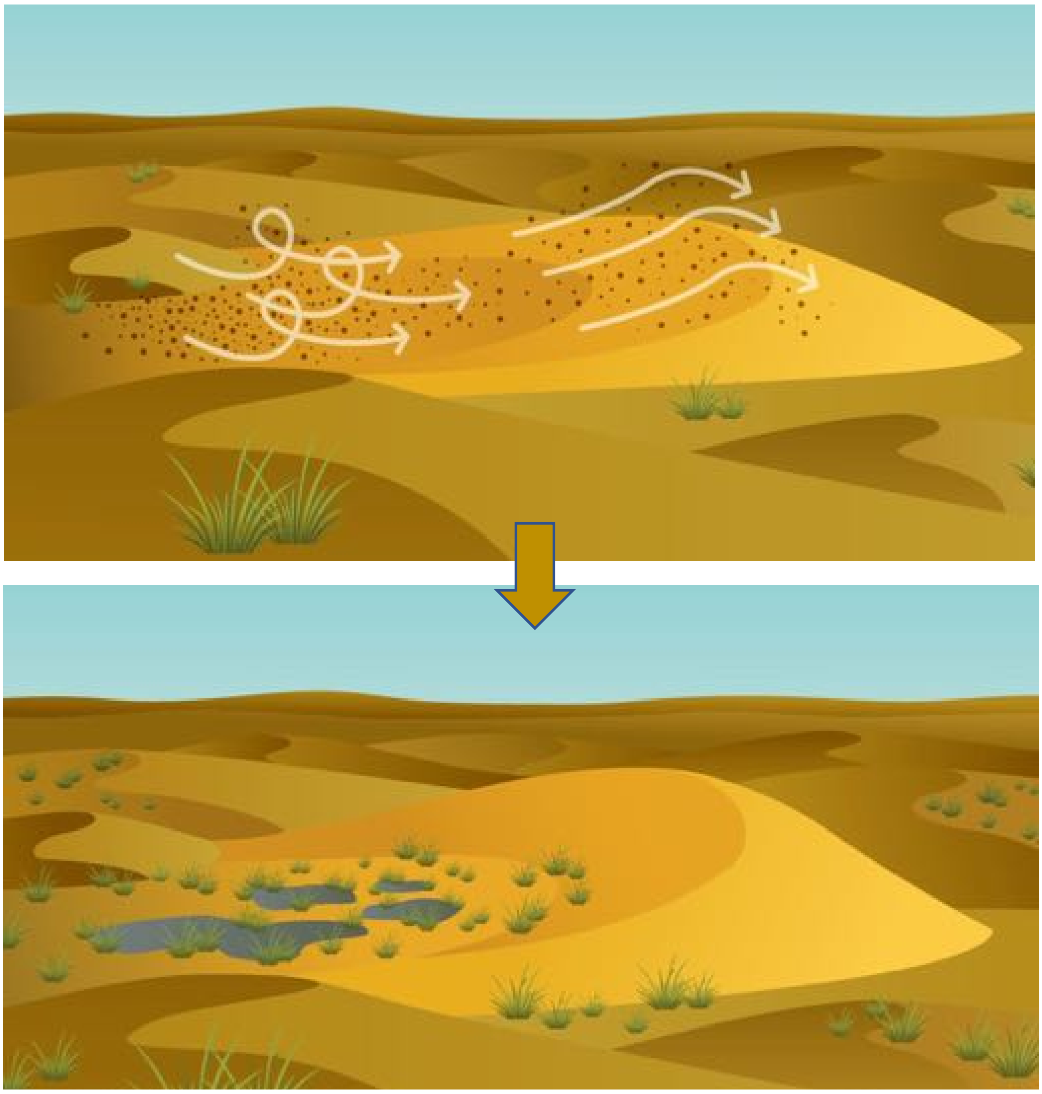


Figure 1: The effect of wind dynamics on parabolic dune formation and the development of dune slacks

Figure 2: natterjack toad (© Reinhardt Strubbe), dune brittlestem (© Reinhardt Strubbe), dune tiger beetle (©Koen Verschoore), *Dactylorhiza incarnata* (© Reinhardt Strubbe))

1.2 Fixation

These days, all along the coasts of Europe, the characteristic sand-drift dynamics unique to a dune landscape have practically come to a standstill. Species like European marram grass and sea-buckthorn are overtaking the dune regions and holding the sand in place. Human influences in particular are playing a major role in this process. The sand is no longer drifting, and because of that, the mobile dune landscape with its unique flora and fauna is disappearing.

Figure 3: Fixation of a former mobile dune (here in the Westhoek nature reserve in Flanders, Belgium) © Marc Leten.

1.3 Possible causes of the standstill in sand-drift dynamics

-Construction and planting
Due to the increase of buildings during the 20th Century, infrastructure and dikes along the coasts, dune belts have become extremely fragmented, leaving less space for sand drift. Moreover, the sand drift is artificially prevented by the planting of species like marram grass, Japanese rose and afforestation with white poplars and pine, intended to keep surrounding infrastructure free from sand.

-Sand shortage
The supply of sand from beaches to the dunes is hampered along the coasts by the construction of dikes and dune base reinforcements and the artificial planting of marram grass and brushwood.

-Climate change
The increase in CO_2 emissions has resulted in increased precipitation and shorter, warmer winters. This extends the growing season for plants. As a result, seedlings of species such as marram grass and sea buckthorn have a greater chance of surviving the winter.

-Increased nitrogen deposits
Nitrogen in the air, originating from emissions from cars, agriculture and industry, is leading to indirect fertilisation of dune soils and stimulates plant growth.

-Decreasing rabbit population
In some dune areas, rabbit populations have diminished drastically due to diseases. This has led to fewer holes being dug in the dunes, which results in fewer bare sand areas for the wind to get a grip on. The decrease in the number of rabbits also means less grazing.

1.4 Consequences of the standstill of the sand-drift dynamics

The complete extinction of the sand-drift dynamics will lead to the disappearance of habitat for many unique plants, animals and mushrooms. After all, sand drift is the engine for the development of a varied dune landscape in which a large number of species belong.

- Disappearance of bare and half-vegetated sand dunes: biotope of species such as the dune tiger beetle, the dune brittlestem, and the spider '*Haplodrassus dalmatensis*'.

- Valuable new dune slacks are no longer providing a habitat for countless species of humidity-loving plants and animals, such as the Grass-of-Parnassus, the marsh helleborine, and the natterjack toad.

- Decalcification of the soil: Calcicoles such as the common rock-rose will no longer find a suitable substrate the decalcified dunes.

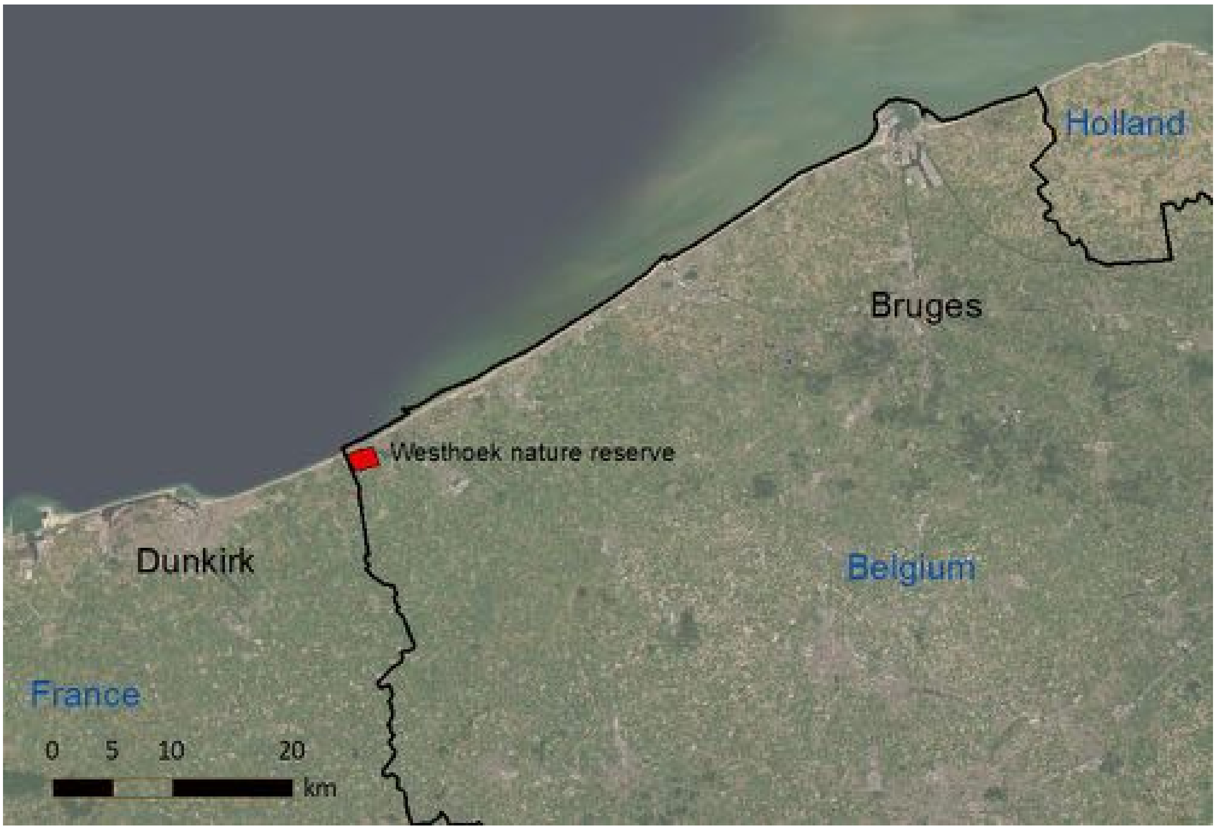
- Marram grass and shrubs, such as sea buckthorn, will overgrow completely the dune site.

Figure 4: Grass-of-Parnassus; Common rock-rose and Sea buckthorn (© Reinhardt Strubbe)

2. Case study: the mobile dune in the Westhoek nature reserve

2.1 The Westhoek nature reserve

The Westhoek is a 350 ha large nature reserve belonging to the Flemish region (Belgium), situated adjacent to the French border. In 1957, the Westhoek and the "Hautes Fagnes" in south-east Belgium became Belgium's first national nature reserves. The current landscape of the high dunes, called "Young", began to form with a large influx of sediment during the Little Ice Age (from the 14th century on). These high dunes formed over a much older dune base. Archaeological sites dating back to the Iron Age, the Gallo-Roman and the High Middle Ages have been discovered. Archaeological layers have even been exposed by wind action. In the 1970s, the base of the dune was reinforced with remains of demolished bunkers, on which a layer of concrete was then poured.



The initially open dune landscape became encroached by scrub following the abandonment of traditional agro-pastoral use. Only the large central mobile dune was spared until the 1990s from the invasion by sea buckthorn, privet and willows. Until 1996, management was limited to the maintenance by mowing of a few parts of dune slacks with a total area of only 2 ha. The first management plan for the Westhoek Nature Reserve dates from 1996 (almost 30 years after the creation of the Nature Reserve). Between 1997 and 2001, 30 ha were cleared from scrub and poplar plantations. Also grazing management by large herbivores (Highland cows, Shetland ponies and Konik horses), was introduced, all in order to restore the"2130* grey dunes" and "2190 humid dune slack" habitats. Ponds were also dug as aquatic environments for the crested newt, the natterjack toad, dragon flies, Characeae algae etc.

2.2 The situation previously and today: the disappearance of the 'Sahara' of the Westhoek

Until the mid-1990s, the dune region in the Westhoek nature reserve resembled a true desert landscape so much so that it came to be known locally as 'The Sahara of De Panne'. This 'Sahara' was a vast sandy plain where the wind had a major influence. The central shifting dune in the nature reserve was one of the most extensive sand dunes in all of Western Europe! The drifting used to cross borders and stretch from Dunkirk to Westende. In the mid-20th century (1948), the shifting dune region of the Westhoek covered 100 hectares of bare sand. By the turn of the century, this sand mass had shrunk to approximately 80 hectares.

A sudden change took place between 1999 and 2004. During this period, the shifting dunes shrank considerably until only about 40 hectares remained. This development continued, so that by 2010, the bare sand expanse measured barely 13 hectares. In recent years, the sand has been shrinking to a lesser degree. Today, only about 10 hectares of bare sand remains scattered over several locations in the former Westhoek shifting dune region.

Figure 5: The mobile dune of the Westhoek nature reserve in 1993 (© Marc Leten)

Figure 6: Current situation at the former mobile dune © Marc Leten

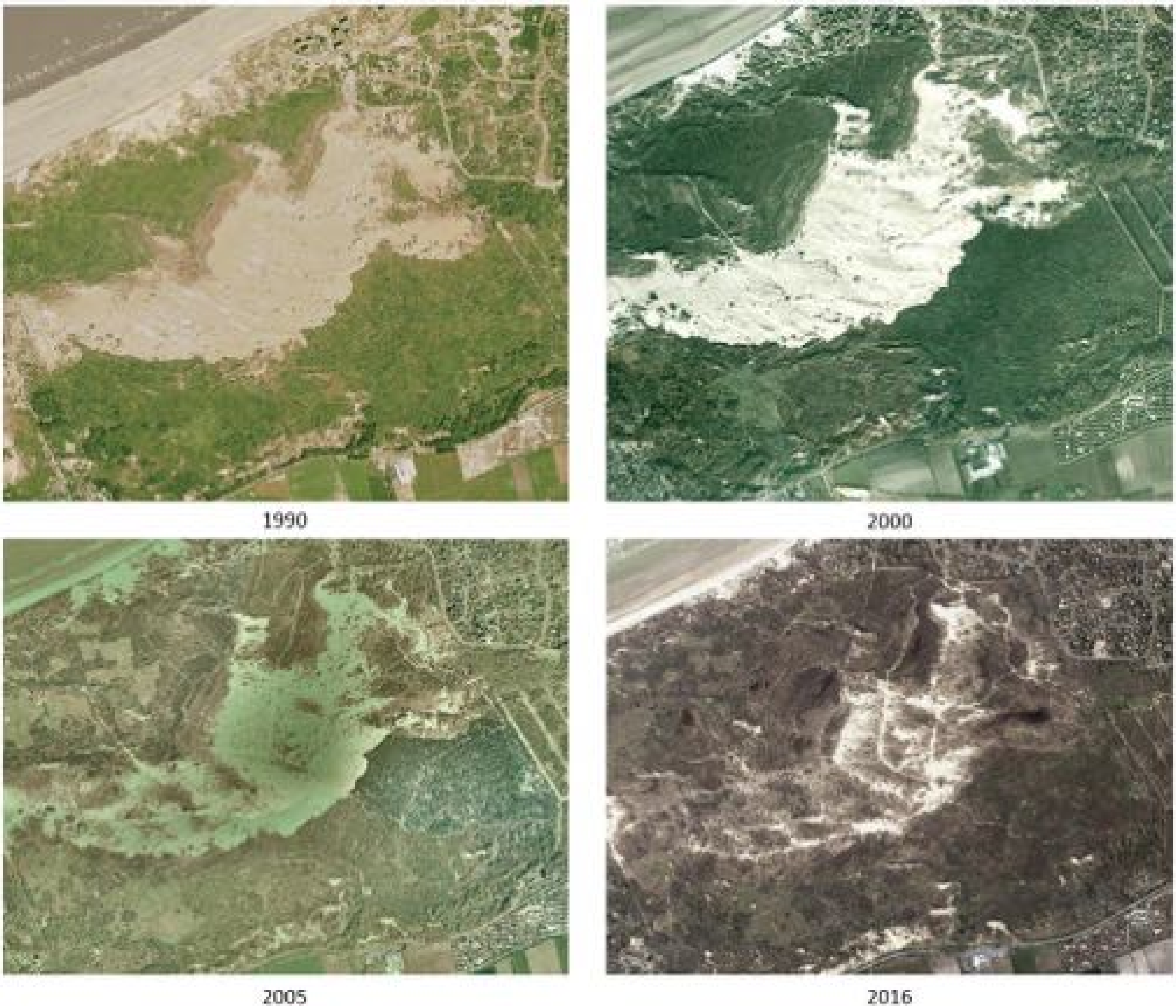


Figure 7: Evolution of the mobile dune of the Westhoek nature reserve. © Informatie Vlaanderen

2.3 Restoration of sand dynamics in the Westhoek nature reserve

2.3.1 Project area and project framing

As part of the Interreg V project VEDETTE, an area of 7 ha of the recently encroached large central dune was cleared in order to restore the 2120 "white dune" habitat and especially the aeolian sand drift. A scientific and geomorphological monitoring of the evolution of the dune has started since the beginning of 2022.

In the management plan for 'De Westhoek' (Cosyns et al., 2013) the problem of fixation of the mobile dune was addressed and from there the project 'Save the Sahara of De Panne' grew, which aimed to restore the drift dynamics locally by removing the vegetation. It was concluded that the most promising zone is located in the central part of De Westhoek. This zone was tackled as part of the VEDETTE project.

Figure 8: Situation of the project area within the Westhoek nature reserve

Figure 9: Project area in the former 'Sahara' of the Westhoek

2.3.2 Best practices study: partly restoration of the 'Sahara' of the Westhoek nature reserve

In march 2019, a best practices study about mobile dunes in Europe and restoration of the mobile dune in the Westhoek was finished by the consortium Witteveen+Bos, INBO (Sam Provoost) and Arens Duinonderzoek on behalf of ANB (Provoost et al. 2019).

Initially, the proposed project area was thoroughly inventoried for vegetation composition (figure 10). Separate maps were drawn up showing the dominance of marram grass (figure 11) and sea buckthorn (figure 12). Based on these vegetation maps, the project team worked out a concrete proposal for the re-dynamization of this area.

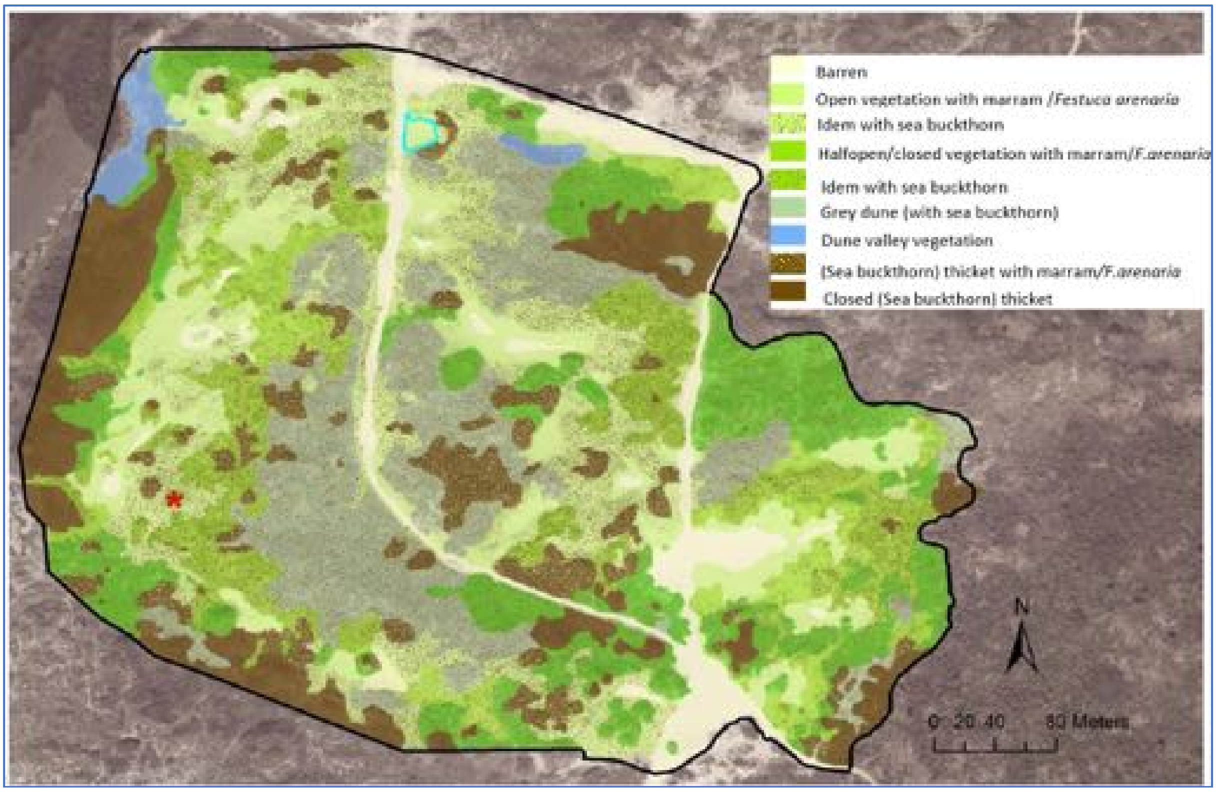


Figure 10: Vegetation map

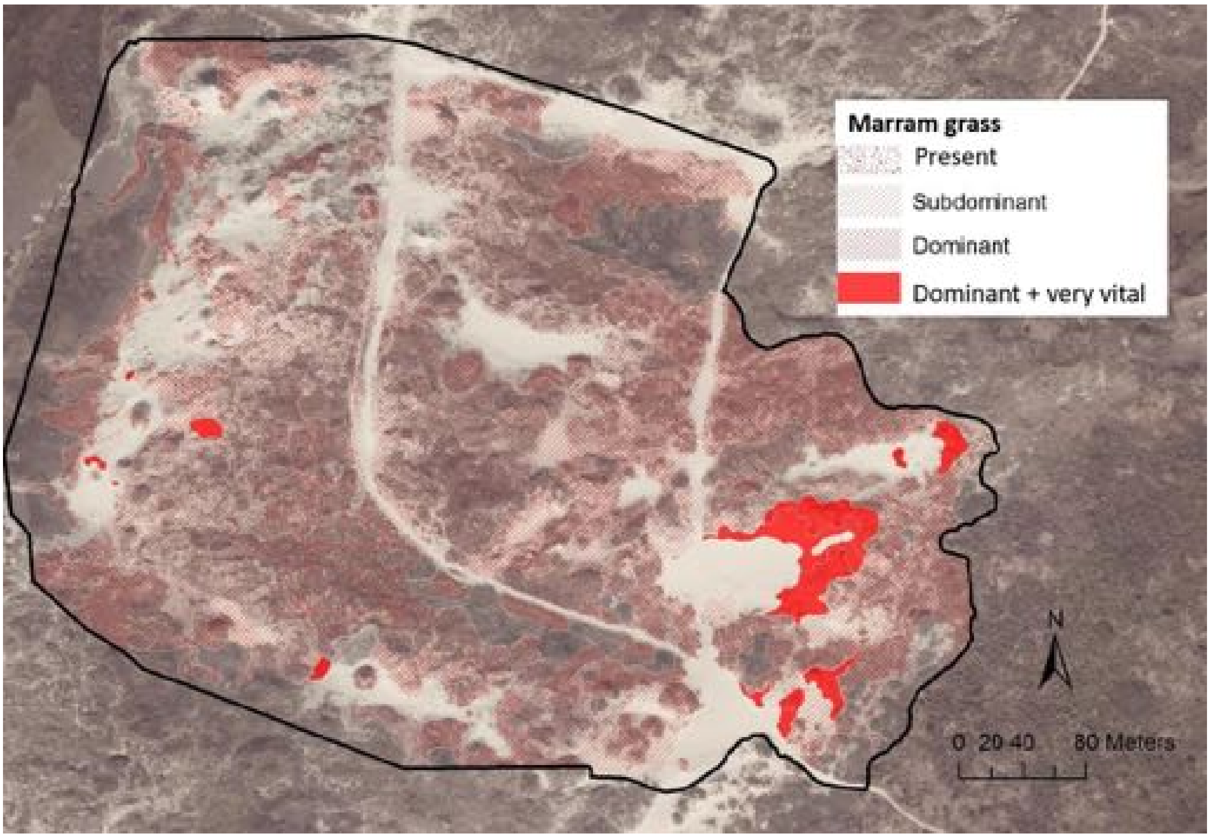


Figure 11: Inventory of marram grass in the project area

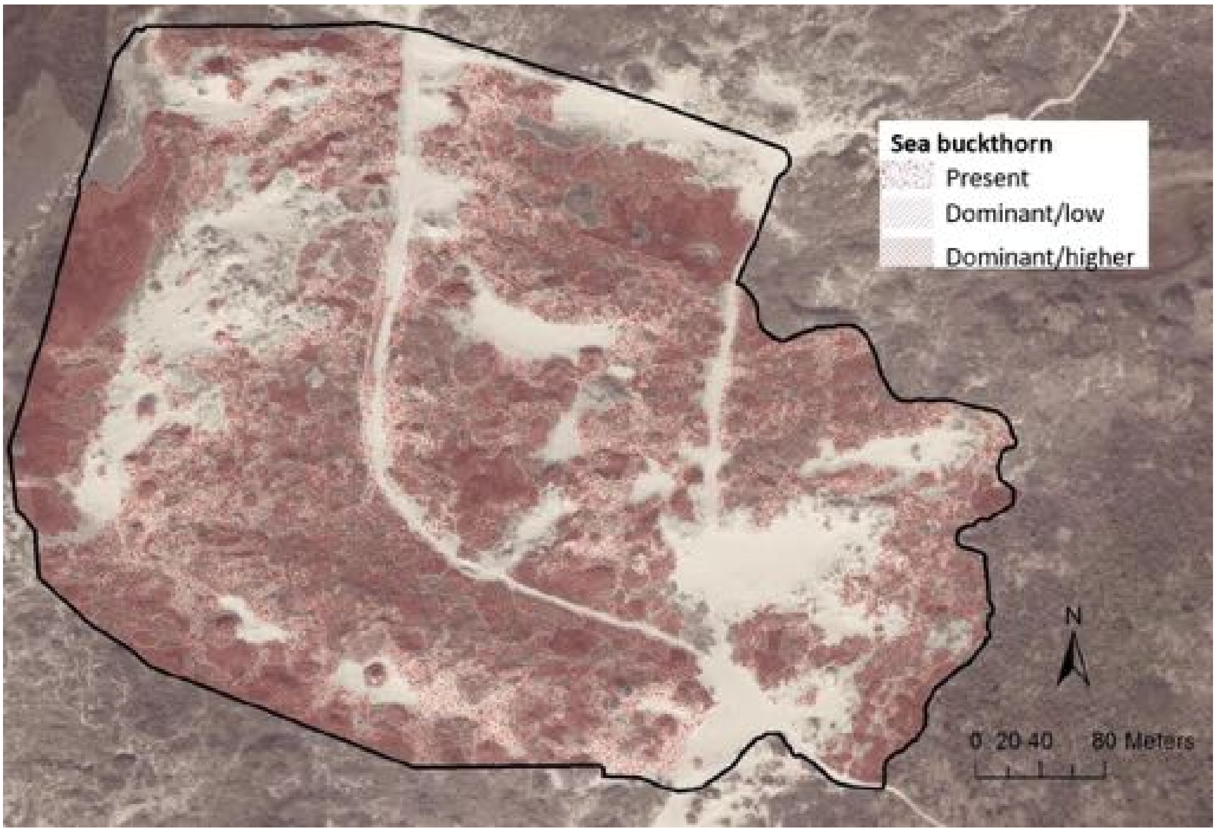


Figure 12: Inventory of sea buckthorn in the project area

Specifically, the following interventions were proposed:

1. large-scale intervention

The preliminary design is based on the excavation of two dune zones with an area of 4.6 and 2.2 ha respectively (together 6.8 ha) (respectively area A and B in figure 13). These were the zones with the highest potential for drift: on the one hand the highest parts of the windward side of the old dune (A in figure 13), oriented perpendicular to the primary wind direction, and on the other a more easterly part on the leeward side of the former shifting dune that is currently still largely active (B in figure 13).

The vegetation map and the digital terrain model were used to precisely define these zones and the associated intervention measures. The depth at which to be excavated depends on the vegetation present. Where vital marram grass is present, deep roots were taken into account. At these locations it was recommended to excavate to a depth of 1 m. In zones with sea buckthorn and dominance of (non-vital) marram, an excavation depth of 30 cm was maintained. In other zones, an excavation depth of 15 cm was sufficient.

Subsequently, the selected zones (zones A and B in figure 13) were reconstructed so that, where necessary, a homogeneous slope is realized across the width of the intervention zone. The exact slope of the dune is less important.

2. small-scale intervention

In addition, it was proposed to make a number of smaller south-west to south-east oriented slopes free of vegetation so that smaller blow outs could be created. The proposal concerned 16 zones with an area varying between 75 and 350 m², together 0.3 ha (orange shading in figure 13).

Here the vegetation was removed and excavated to a depth of 15 cm or 30 cm (where sea buckthorn is present) (figure 14). Sea buckthorn was also removed locally. This created a landscape with a wide variety of small-scale to fairly large-scale drift and associated environmental gradients. In the authors view, such an approach would yield maximum benefits in terms of biodiversity.

3. keep vegetation low locally

In order to obtain a sufficiently high shifting speed of the sand at the bottom of the project dune, obstructions before the dune (indicated as sub-area C in figure 13) west of the original project area, (sub-area A in figure 13) had to be removed. Most of the zones west of the project dune will be kept low according to current management. Under current management, encroachment is prevented there by regularly replacing the vegetation. Since in time, overflow will also extend beyond the boundaries of the current project area, management also looks beyond the predetermined boundaries of the project area to the area to the east of the former mobile dune (areas D and E). After all, it is expected that this area will become 'overflowed' after reactivation of the dune. In order to prevent stabilization of the drifting dune by obstruction, the vegetation will also be shortened up to a distance of approximately 200 meters from the mobile dune (D and E in figure 13). The intervention phase involved the removal of sea buckthorn and local cutting of trees within zones C, D and E (Figure 13 and Figure 14). According to the present design, a zone of approximately 12 ha was tackled.

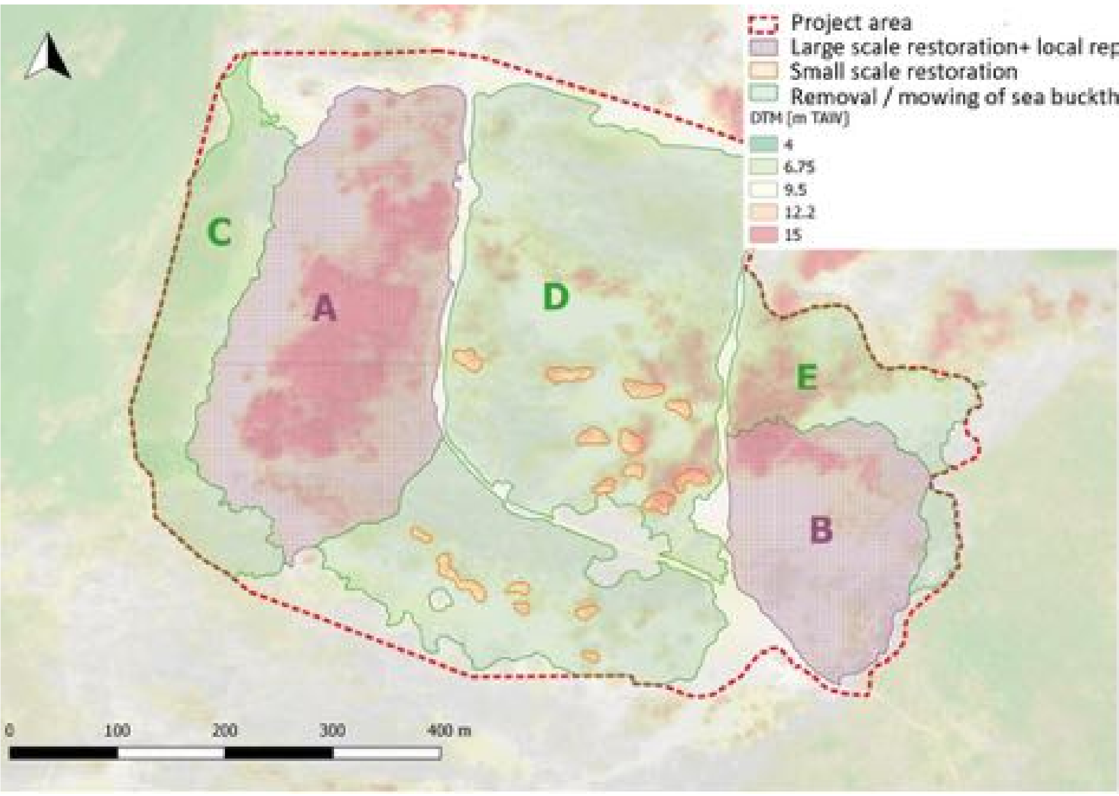


Figure 13: Proposed interventions in the project area

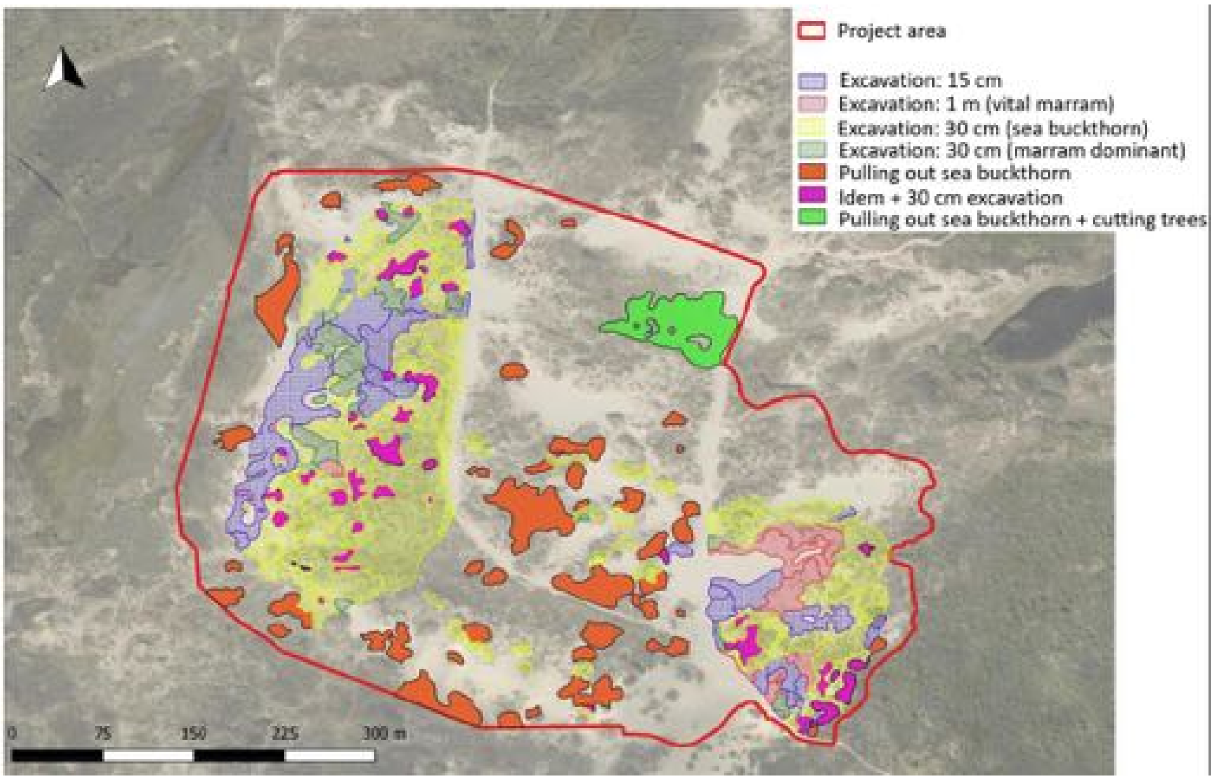


Figure 14: Specific intervention measures in the project area.

An important bottleneck for the future dynamics in the project is the presence of a concrete military road (figure 15). A small part of this road was already exposed. This part was removed during the intervention phase so that it wouldn't hinder the sand drifting process. However, most of the road is situated deep under the sand: perhaps up to about 9 m deep. Clearance of these parts during the intervention phase was therefore not practically feasible. However, these components are taken into account in post-management.

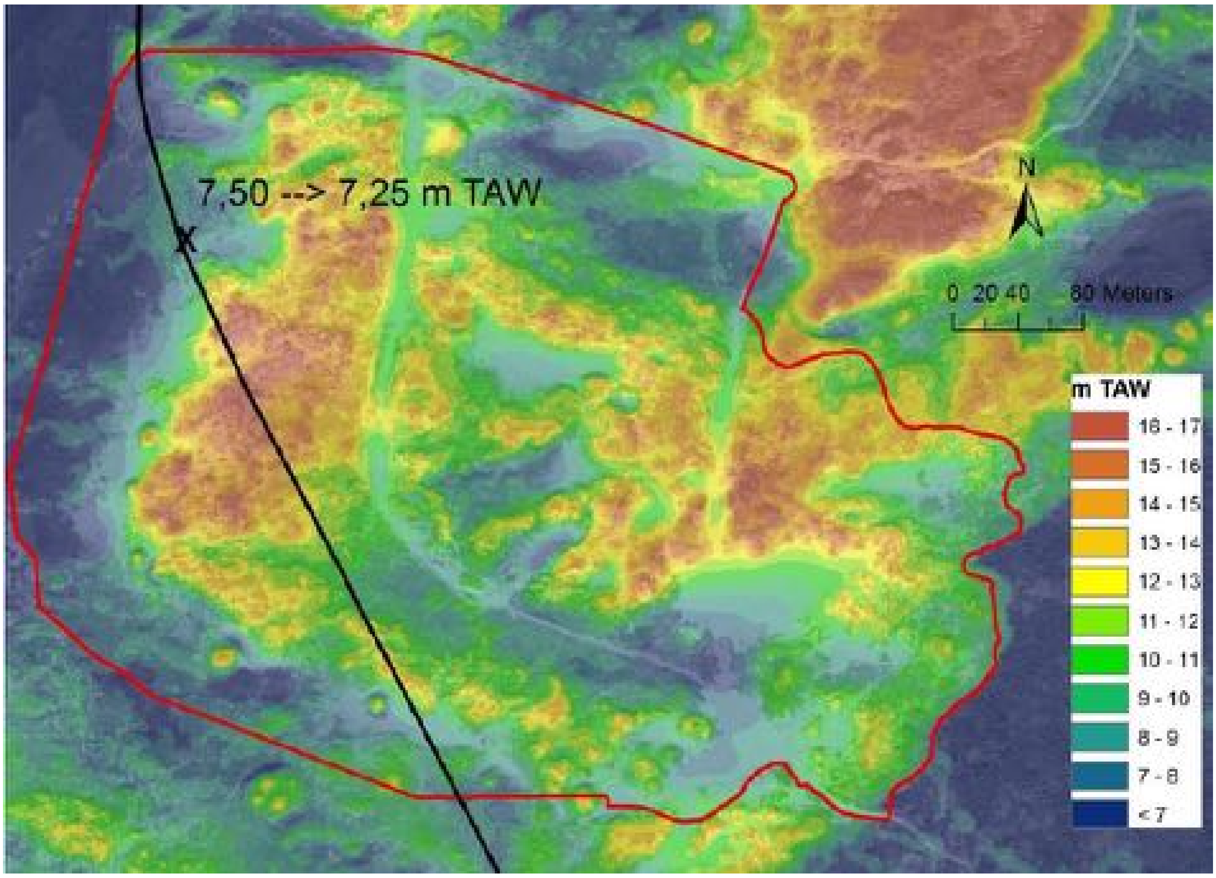


Figure 15: trace of the military road.

2.3.3 Best practices study: management after the initial works

In time, a gray dune will develop on stabilized parts. Stabilization of certain parts of the site may not be a problem, but should be seen in the perspective of the general development of the dune. Where stabilization is undesirable, because it hinders the large-scale sand drifting process, this must be counteracted with post-management. These zones will have to be determined year after year on the basis of the results of the targeted post-management monitoring. Annual management was recommended, in which the terrain should be worked with horse and harrow (with horizontal tines on the harrow) to remove emerging vegetation and roots. Another option is to connect the harrow to a tractor or to work with a single-axle tractor with cultivator. A grizzle (figure 16) would be useful on a larger scale and for larger plants.

Figure 16 : Grizzle (© Bas Arens)

Year-round grazing of the entire zone (A-E in figure 13) was not recommended because of vulnerable bottom-dwelling invertebrates (such as *Bembix rostrata*). Sheep grazing preferably takes place in the winter period (October-March), in order to allow flowering and to avoid soil disturbance for ground-dwelling invertebrates and disturbance for resting birds such as meadow pipit.

Figure 16: Bembix rostrata (© Reinhardt Strubbe)

Although summer grazing affects plants such as marram grass and *Festuca arenaria* (possibly) harder, winter grazing also tackles the grasses and creates open spaces. However, according to the authors, additional mechanical management of sea buckthorn and maintaining drifting dunes (manually or otherwise) will in any case be an issue.

Finally, the aforementioned concrete military road must be taken into account in post-management, which will gradually become exposed as the dune starts to drift again, possibly in combination with other debris. The moment the road and the debris will emerge strongly depends on the success of the intervention and the climate. After all, these determine the drifting speed. It was proposed to clear the blown up parts of the road and associated debris every few years.

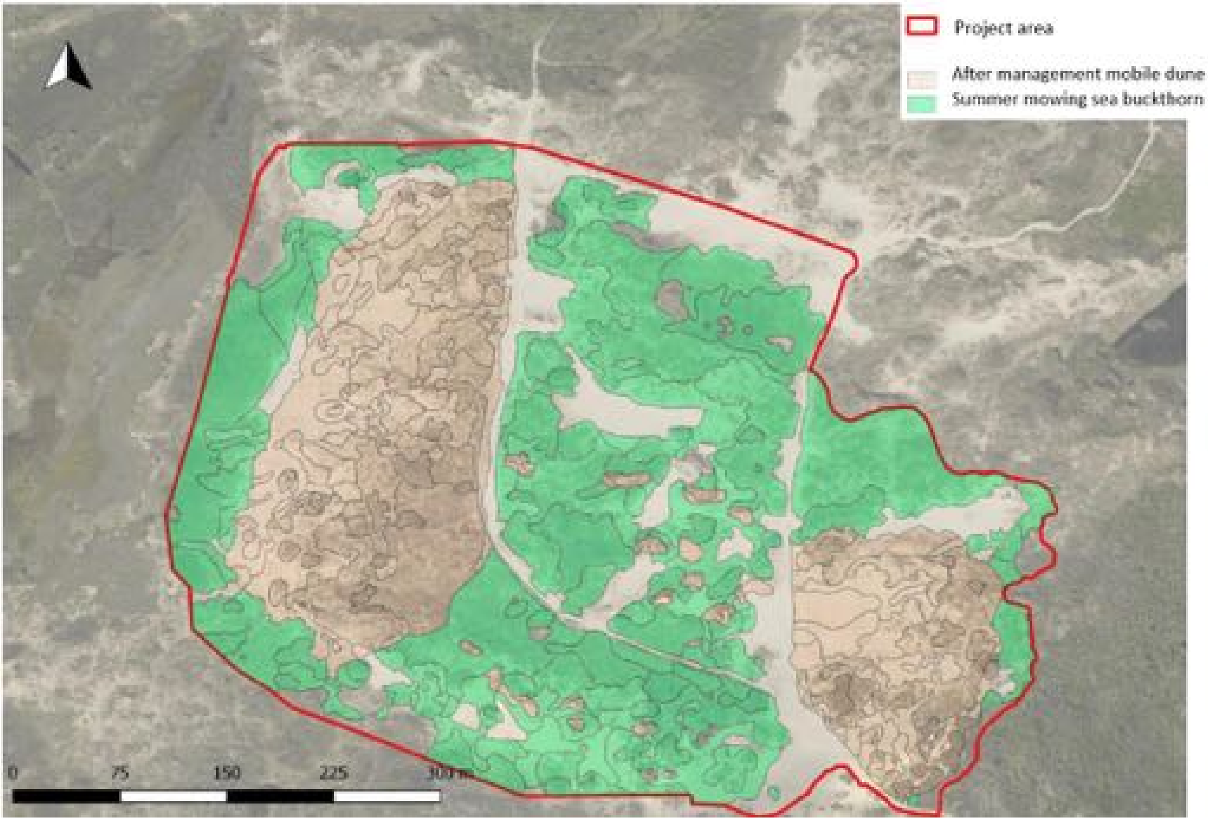


Figure 17: Proposed management after the initial works.

2.4 Restoration works

An excavator was used to remove the vegetation according to the depths specified in the best practices study (see title 2.3.2). A large tracked dumper then transported the plant material towards containers on the edge of the nature reserve. These were transported to a processing plant.

The works started on the 4th October 2020, and were inaugurated by the Flemish minister of environment Zuhal Demir. On the 12th of march 2021, the works were finished.

Figure 18: The excavator at work in the Westhoek nature reserve (© Reinhardt Strubbe).

Figure 19: The excavator and the tracked dumper during the works in the Westhoek nature reserve (© Reinhardt Strubbe).

Figure 20: A GPS was used in the excavator in order to excavate the vegetation according to the depths specified in the best practices study (© Reinhardt Strubbe).

Figure 21: The project area at the end of the works (© Reinhardt Strubbe).

Figure 22: The project area at the end of the works, with in the distance, the city of De Panne (© Reinhardt Strubbe).

2.5 Monitoring and after management

2.5.1 After management 2021

Initially, regrowth after the works was limited, but due to a wet summer with regular rainfall, the vegetation started to grow at the beginning of August. This concerned mainly sea buckthorn, marram grass and *Festuca arenaria*, but also a lot of annual composites and *Senecio inaequidens*.

First post management therefore started on 31 August and lasted 7 days. A small horticultural tractor on caterpillars was used, with a horizontally rotating blade. This cut through all the roots. A working depth of approximately 15 cm was used. This approach appeared to have worked relatively well, as in summer 2022 vegetation cover seemed to be very limited.

Figure 23: Cicindela hybrida and *Arctosa perita* in the project area (© Reinhardt Strubbe).

2.5.2 Monitoring

Next years (2022-2025) a monitoring of the projectarea will take place by the consortium INBO - Arens duinonderzoek - Natuurpunt. The consortium will monitor following aspects:

-flora and fungi (terrain mapping)

-breeding birds (terrain mapping)

-Insects (terrain mapping)

-Geomorfological changes: mapping via :

- Drone images (orthophoto and digital elevation model)
- LIDAR images
- GPS transect surveys on the field

The results of this monitoring will be described in (English) reports.

Acknowledgements

- Provoost S., Arens B., Bovend'aerde L., Strubbe R. (2019) Interreg V VEDETTE - Studie 'best practices' omtrent het herstel van de dynamiek van stuifduinen, 105 p.