

RESTORATION AND MANAGEMENT OF SANDY HABITATS IN SOUTHERN SWEDEN



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PREFACE

When we enjoy the sun in a sand dune or on a sandy slope in pastureland, we are also spending time alongside a great diversity of plants, animals and fungi that are adapted to and dependent on the special nature of the sandy environment. The exposure to wind and ocean currents and the variation of calcareousness, pasture, history of land use and topography has led to a large diversity of species.

The sandy environments of Southern Sweden have really been through a lot of things. During some periods, humans have exploited the landscape so intensely that the forests became thin or almost totally disappeared. The sands drifted in the wind and expansive fields of shifting sands and high sand dunes were created. Over the past 150 years, this development has been reversed and the sandy habitats have been planted with forests, become overgrown or been built on.

Since the middle of the 1990s, the high natural values found in the open sandy soils warmed by the sun along the coasts of Southern Sweden have attracted more and more attention. The critical situation for the tawny pipit in Sweden, together with the results of surveys of insects forced the nature protection problems into the glare of the headlights. The sandy habitats were beginning to become overgrown at a rapid rate and with their unique natural values becoming threatened.

The values of the sandy habitats also attracted attention within Natura 2000, the European network for protected nature. In the EU Sand Life project, major restoration work has been carried out at 23 Natura 2000 sites in Halland and Skåne and on Öland. The results are really heartening. The tawny pipit's range is growing and threatened bees and butterflies and other insects are recolonising the restored sandy environments at a rapid rate, in both project areas and other areas restored through similar methods.

The restoration and management methods described in this manual are important for protecting the sandy habitats' natural types and diversity of species and the ecosystem services they contribute to, such as the pollination the great numbers of bees and bumble bees are responsible for. We hope therefore that the manual will be shared and used by many stakeholders so that we can continue to enjoy the wild thyme, the mason bee and the tawny pipit while we lie in the sand in the heat of the sun.

Claes Svedlindh

Head of Department Swedish Environmental Protection Agency





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1. THE SAND LIFE PROJECT

HOW THE IDEA FOR SAND LIFE CAME ABOUT

Driftsand fields and sand dunes were regarded for a long time as unproductive areas that could also cause problems unless the sand was kept under control. Driftsand was prevented from moving, and open areas of sandy soil were planted with pine trees and became overgrown. A number of large sandy habitats along the coastline of southern Sweden became nature reserves and were protected in the latter half of the 20th century, but with the aim of stopping development and promoting open-air activities.

It was not until the early 21st century that there was full realisation of the outstanding natural value of sandy soils and the critical acceleration of overgrowth. Targeted insect surveys carried out in the coastal sandy soils of Halland provided new information. These showed that insect diversity in sandy soils are high, but that there is also an urgent need for restoration. Increasing work on Action programmes for endangered species and Natura 2000, the EU network of valuable habitats provided further information and insights. This was supported by the situation of the tawny pipit, Anthus campestris, the top indicator species for open sandy soils, which showed that numbers of this Swedish breeding species were declining alarmingly quickly. At the same time, it became clear that viable populations of many rare sandy soil species could be found on military training grounds in both Skåne and Halland, where there was still a high level of disturbance. When restoration of overgrown sandy soils began in Halland and various methods were developed for achieving this, it also became clear that sandy soil species were able to find their way back quickly to the restored

Nature conservation experts and other people interested in nature met up at a seminar on sandy soils that was held in Åhus, north-eastern Skåne in 2008. It was established here that the situation as regards biodiversity in sandy soils in southern Sweden was serious, and that a lot of work needed to be done. Restoring the proportion of bare sand in the landscape was the key that could turn the tide – that much was agreed. However, as things stood at that time, nature conservation resources were in short supply and would not suffice to implement the fast-paced, large-scale efforts that were needed.

After the seminar, the Skåne County Administrative Board took the initiative to hold a meeting with relevant counties in southern Sweden. Its aim was to discuss options for joint applications for funding for a major collective restoration project. After a few years, this culminated in the Sand Life project.

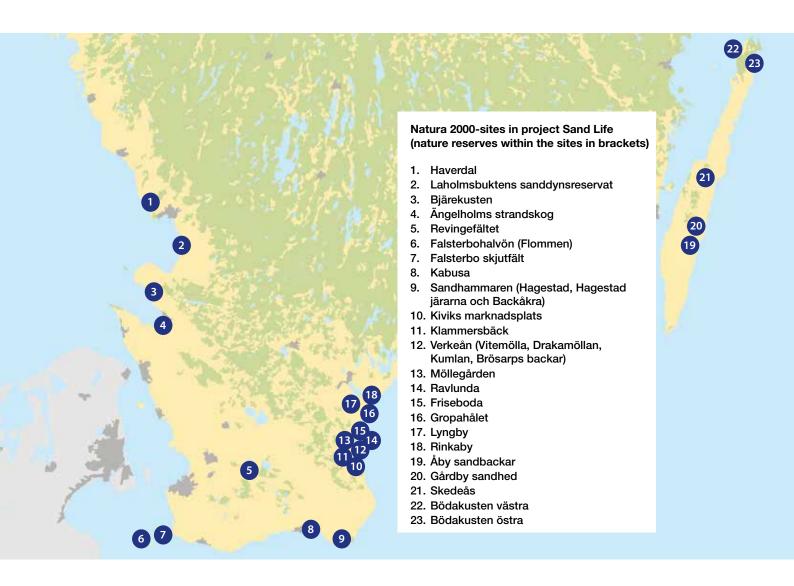
THE SAND LIFE PROJECT

Sand Life began in August 2012 and ended in July 2018. Extensive measures have been implemented in Skåne, Halland and Öland over this six-year period. Above all, the project has focused on recreating open sandy soils and promote the survival of many different kinds of plant, fungus and animal. At the same time, these efforts have also restored environments, making them accessible so that people can experience nature. This restoration work has included everything from clearing trees and bushes to creating patches of exposed sand, burning unwanted vegetation and reintroducing grazing. How these measures have affected plants and animals has been monitored by mapping the changes and surveying species and environments. A great deal of emphasis has also been placed on outreach information and discussion in order to increase awareness and understanding of sandy soils.

PROJECT PARTICIPANTS

Sand Life has been a partnership project involving the County Administrative Boards of Skåne, Halland and Kalmar, Lund University and the Municipality of Kristianstad. Skåne County Administrative Board coordinated the project and held responsibility for contact with the EU Commission and other contributors. The project budget totalled EUR 7,8 million. The EU has contributed half of the funding via its Life+ Nature programme, while the project partners contributed the rest together with co-financing partners the Swedish Environmental Protection Agency and the Skåne Landscape Foundation (Stiftelsen Skånska Landskap).

Each County Administrative Board has been responsible for implementing the various measures in the project areas in their respective counties, as well as other measures such as the production of new maintenance plans, information signs and guided tours. Monitoring on the development of natural assets in the sandy soils restored has been a vital part of the project. Lund University has been responsible for this follow-up. Raising awareness of our sandy soils and increasing understanding of the need for restoration and maintenance have been key factor to the project. Production of 12 permanent outdoor museums has been an important element in the distribution of information, and the municipality of Kristianstad, via Kristianstad Vattenrike Biosphere Reserve, has been responsible for this.



WHICH AREAS HAVE BEEN RESTORED?

The project has been implemented in 23 Natura 2000 sites in the counties of Skåne, Halland and Kalmar. Restoration plans have been devised for all project sites, describing the purpose and procedures for all planned restoration and maintenance measures.

Skåne included 16 Natura 2000 sites covering wooded coastal dunes from Ängelholm in the north-west to Gropahålet in the north-east, inland grass moorland in Vombsänkan and the areas around Brösarp, and a number of sandy grassland areas in eastern Skåne. Two major Natura 2000 sites along the coast of Halland have been restored; the Laholmsbukten sand dune reserve and Haverdal. The county of Kalmar has included five Natura 2000 sites on the island of Öland; two sand dune areas in Böda to the north of the island, and three sandy grassland areas.

WHAT RESTORATION MEASURES HAVE BEEN USED?

The Sand Life restoration operations have included measures to open up wooded dunes, clear overgrown areas, loosen up dense turf, remove old vegetation and create more sunlit sand in the landscape.

Clearence of trees and bushes

Bush and tree overgrowth or planting were mainly seen in the dune areas along our coasts. Open sandy soils have been restored as part of the project when trees were felled, bushes were cleared and stumps were pulled by the roots. The invasive Japanese rose has been dug up from the sand dunes and the roots have been removed from the sand. Dense pine forests have been cleared in order to thin them out, encourage old, solitary trees to grow and open sunlit glades with bare sand. The remains of cleared trees have been removed, but dead wood has been left in place in order to benefit insects, fungi and lichens that live on wood.

Measures to promote more sand in the landscape

One of the primary aims of the project has been to increase the amount of bare sand in the various project areas. Measures of various different kinds have been implemented as part of Sand Life with a view to disturbing the soil. This has involved everything from harrowing and ploughing in order to thin out the vegetation, to larger-scale excavations of the uppermost, nutrient-rich layer of soil and deep excavations to bring up clean, nutrient-poor and sometimes more calcareous sand.

Burning as a conservation measure

Prescribed burning can be used as an effective conservation measure and is a way of restoring and maintaining grasslands and moorlands. Old grass and brushwood is burned, increasing the pH of the soil and causing certain nutrients to go up in smoke. After burning, it is easier for plant seeds to grow, heather is rejuvenated and patches of bare sand are able to form.

INFORMATION AND RAISING AWARENESS

Information has been an important part of the project. Our aim has been to use events, gatherings and guided field tours to help people understand more about biodiversity and the conditions that are needed to benefit species in sandy environments. Holding discussions with local residents and other interested parties, as well as providing direct information, have been fundamental elements in our attempts to attain support for our restoration work and maintenance, helping us to explain the reasons for this work and why it is so important.

Signs that the project areas provided information on planned measures throughout the project. Twelve permanent outdoor museums have been set up in the same number of project areas. These provide information about sandy soils in general and the project in particular, as well as the history of the location and specific natural assets. Information has also been distributed via the project's website, folders, lectures, courses, media, etc.

MONITORING THE RESTORATION WORK

The development of various species and structures has been monitored in order to find out what effect the various restoration measures implemented as part of the project have had. This monitoring has been coordinated by Lund University, which has also selected and designed monitoring methods, carried out remote analysis and performed the various field surveys. The results of the monitoring were not yet compiled by the time this document was produced, so these will be presented in a separate report.

Changes in vegetation and the percentage of bare sand has been monitored by means of remote analysis and surveys both before and after restoration and maintenance measures. Surveys of flowering plants, *Hymenoptera*, beetles, butterflies and moths have been carried out in the same areas. Conditions for the tawny pipit, woodlark, *Lullula arborea*, and European nightjar, *Caprimulgus europaeus*— three of the characteristic species for sandy soils—have been monitored. The project has also examined changes of attitude among visitors and local residents.

WHAT WILL HAPPEN AFTER SAND LIFE?

For the restoration work to have a long-term effect, sandy habitats will have to be maintained when Sand Life has come to an end. The ongoing administration of protected areas will take over maintenance when the project has come to a close, and each of the respective county administrative boards will be responsible for this. This will include devising what is known as an After-Life plan, which will describe the focus of continued efforts.

There are more areas to restore, and this work will need to continue; albeit on a smaller scale. All the new information and expertise produced by Sand Life will benefit these continued efforts.

Find out more about the project at www.sandlife.se

LIFE+ NATURE

Sand Life has been funded via Life+, the EU's programme for the funding of major environmental and nature conservation projects in Europe. The EU allocated around EUR 2.1 billion between 2007 and 2013 to projects relating to nature conservation and biodiversity, environmental policy and environmental management and information and communication. The EU is contributing primarily to efforts to improve nature in Europe thanks to its two programmes Life+ Nature and Life+ Biodiversity.

The primary purpose of Life+ Nature is to implement the EU's Birds Directive and the Species and Habitats Directive, primarily within the scope of the European Natura 2000 network. The measures to be implemented within the scope of Life+ Nature must be tried and tested and help to ensure that species and habitats achieve favourable conservation status.

More information on Life+ can be found on the websites of the Swedish Environmental Protection Agencyand the EU Commission.

www.ec.europa.eu www.naturvardsverket.se

NATURA 2000

The Sand Life areas are all covered by Natura 2000, a network of protected natural sites in the EU. The aim of this network is to halt the extinction of plants and animals and improve their habitats. There are more than 3500 Natura 2000 sites in Sweden. These are the most valuable natural areas in the country, and many of them are also protected as national parks or nature reserves.

These sites have been selected on the basis of two EU directives, the Species and Habitats Directive and the Birds Directive, which together provide protection for some 900 plant and animal species and 170 different habitats throughout the EU.

In Sweden, Natura 2000 covers more than 100 plant and animal species and 90 habitats in accordance with the Species and Habitats Directive, as well as more than 60 bird species in accordance with the Birds Directive. As far as these species and habitats are concerned, it is up to Sweden to provide them with the best possible protection and care, allowing them to achieve favourable conservation status in order to guarantee their long-term survival in Sweden.

More information on Natura 2000 can be found on the websites of the Swedish Environmental Protection Agency and the EU Commission.



80 guided field tours

550
hectares of tree felling or bush clearing

hectares of Japanese rose has been dug up

200

hectares of sand have been exposed

2. THE HISTORY OF SANDY SOILS

The sandy landscape has a long and varied history. Coastal areas that were previously wide, open pasturelands where the sand whirled around periodically are now pine forests along sandy beaches where lots of people want to live and spend time in order to relax and enjoy the countryside. What used to be lean sand heaths on the plains are now highly productive arable land thanks to irrigation and fertilisation.

Historical descriptions from the sandy areas of southern Sweden frequently refer to the battle against driftsand. History frequently fails to include the tales of how sandy heaths, farmlands and coasts have given humans pleasure and benefits in a variety of ways over thousands of years. In the same landscape, there was also species-rich plant and animal life on sandy soils, to an extent that we may find difficult to imagine nowadays. What we are primarily aiming to call attention to with the Sand Life project and in this manual are the valuable sandy soil areas we have left, their unique plant and animal life and the vital link with human history in the landscape. A number of these areas have been restored as part of the project – for the sakes of the species that live there, and for our own sakes. Open sandy soils are a significant part of our history. Restoring them allows us to go back in time and benefit species-rich environments that are endangered in today's landscape.

WHERE DOES ALL THE SAND COME FROM?

Sand is one of the end results of the slow processes that are constantly ongoing on our planet when the bedrock slowly decomposes into smaller and smaller components gravel, sand and clay. The decomposed material is moved on by gravity, glaciers and wind and water. These processes form different types of soil.

Sweden's sandy soils and sandy coastal areas primarily date back to the last ice age. 18,000 years ago, the ice had begun to leave western Skåne and slowly melted away towards the north. Mighty ice rivers containing meltwater from the ice carried with them enormous quantities of sand and built delta environments and along sandy beaches where in the areas where the rivers flowed out into the sea or meltwater lakes. The land that had been pressed down by the ice slowly rose out of the seas and ice lakes, and the sand was again worked by waves, currents and howling winds. This is how our sandy plains and coasts were formed. After the ice age, open, virgin sand lay awaiting plants, animals and people.

THE FIRST FOOTSTEPS

The first humans came to southern Sweden at least 14,000 years ago. They were hunters from the south, tracking wild reindeer. They found their way here across a land bridge

from the continent. The people continued living as hunters, fishers and gatherers for more than 10,000 years after that. We have found traces of them along some sandy coasts. Worked flint shards in the sand, left over from their manufacture of tools. Hunters had very little influence on the landscape and vegetation. Thus far, only wild animals kept the landscape open. Initially, wild reindeer handled all the grazing. When the climate turned warmer and the vegetation changed, they migrated northwards and were followed by aurochs, European bison, elk and Irish elk, dominant grazing animals throughout the entire Mesolithic period.

SANDY SOILS FOR GRAZING AND CULTIVATION

6000 years ago, humans began to keep tame grazing animals and break ground in order to cultivate plants. People became increasingly settled and were happy stay in sandy areas, which were easy to farm. Around this time, forests in the coastal sandy soils, were mainly consisted of oak and pine. Farming, grazing and exploitation of the forests opened up the landscape bit by bit. Animals could sometimes stay out all winter in the mild climate of southern Sweden.

In the agricultural landscape that started to be established more than a millennium ago, farms were gathered together in villages in areas with the best soils to farm. Fields and meadows (infields) were situated close to the village, while grazing animals used the leaner land outside (outfields). Firewood, timber and turf were also gathered in the outfields. On slightly better land such as the calcareous sandy soils of eastern Skåne, temporary fields were also cultivated in the grazed outfields. It was possible to grow crops here for two or three years until the sand was exhausted and needed a long fallow period.

In his descriptions of his travels through Skåne in 1749, Carl Linnaeus provides a picture of how important it was to allow the soil to lie fallow with this kind of roving agriculture, which is known in Swedish as trädesjordbruk.



there are many outfields here at Raflunda that are merely used once every 10 years. Buckwheat is sown here in the first year, rye in the second, and then no more. The rye that grows in these dry lands is thin but gives fairly white flour. If this outfield is sown every 6, 7 or 8 years, it becomes worn out and yields nothing, not even weeds, but looks like a bare sand heath



TRAVELS IN THE SAND

The coastal population has had many different reasons to travel across the sandy outfields and dune areas throughout the ages; on foot, with or without wheelbarrows, or with carts and draught animals. Each and every one of them took their own route, taking the nearest way to where they wanted to go. All this activity has helped to keep this land open in various ways.

Grazing animals that needed to be seen to and milked crossed the sandy pasturelands. Firewood, timber and brushwood had to be gathered and driven home. Large quantities of seaweed and eelgrass were collected on the beaches well into the 20th century. The seaweed – which contained the most nutrients – was used mainly for fertilizing the fields, but also as emergency fodder for livestock. The poorer, tougher eelgrass could be used to cover roofs, insulate buildings and build fences.

Activities linked with coastal fishing and with ancient beach rights, the right to salvage wreckage, also helped to ensure that people travelled and settled along the flat sandy coasts. A string of old fishing hut can still be found along the sandy shores of Hanöbukten, and around them areas of activity and transport routes where flowering plants, insects and birds benefit from the sand being kept open.

WAR AND SAND DRIFT

Pressure on the landscape increased in southern Sweden during times of population increase and unrest. Southern Sweden was in an almost constant state of war from 1560 and for more than 150 years after that. The war affected the rural population extensively. Large quantities of firewood and timber being taken led to coastal forests being more or less devastated. The outfields became treeless heaths where people took grass and heather turf to use for fences, roofs and fuel as nothing else was available. Large quantities of grass turf were also taken along the sandy coast of Halland in order to build ramparts and fortifications at the towns. The subsequent effects of the war were probably a major contributory factor in the long period of large-scale sand drift that began in southern Sweden around that time. The coastal areas of Skåne and Halland were affected for the most part, but so were the sandy areas on the islands of Öland and Gotland.

Historical descriptions of sand drift problems in southern Sweden are known, dating back to the late 16th century onwards. According to historical sources, sand drift appears to have reached a peak towards the mid-18th century. But not everything was miserable. At the same time, the rich variety of flowers in the open sandy soils and the significance of these areas as grazing and arable land were described by both Carl Linnaeus on his journey through Skåne and by his pupils Lars Montin and Pehr Osbeck, who travelled through Halland.



Carl Linnaeus strolls around the tops of the dunes in the driftsand fields of northern Öland.

FERTILE MEADOWS, GOOD GRAZING AND DRIVING SAND

Linnaeus travelled to Öland in the summer of 1741 and was fascinated by the driftsand that he saw being blown around by the wind from the beaches and across the coastal road on northern Öland. At Grankulla, he describes how the dunes migrated into the pine forest and all but buried the huge pines: "it was nice to walk on these sand dunes and browse among the treetops". At the open sand dunes, Linnaeus studied how *Ammophila arenaria* and sand sedge stabilised the sand: "Bristle oat, *Avena strigosa* grew like tufts on these sandy mounds and prevented the sand blowing away. We tried to dig up the roots, but they went so deep that we were unable to reach the bottom".

Carl Linnaeus headed out on his journey through Skåne in 1749. As he travelled through Åhus and southwards along the east coast, he marvelled at the diversity of the blossoming sand heaths. He noted that many plants, such as Breckland thyme, Thymus serpyllum, dwarf everlast, Helichrysum arenarium and sand pink, Dianthus arenarius, thrived best in the open driftsand, and sand pink particular thrived best along the tracks of the wheels on the sandy roads. "The driving sand" at Skanörs Ljung, the south-western tip of Skåne, was described by Linné as very favourable for the cultivation of both trees and spices, and the grazing was also "fat and good". Cattle were able to withstand a little sand between their teeth or in their stomachs, and there were household remedies that could be used if necessary. On his journey around Ängelholm, on the other hand, Linnaeus' descriptions are characterised by the town's major problems with driftsand and how to build sandbreaks and plant marram grass, Ammophila arenaria and sand ryegrass, Leymus arenarius, on a large scale in order to bind the sand.

In 1768, Linnaeus pupil Lars Montin travelled along the coast of Halland to gain a perception of the extent of the sand drift and see what could be done about the situation. He also looked at the sandy soils with the eye of a botanist and described how the sandy slopes and dune fields of Halland had a flora that "far exceeds what can be found in very many fairly fertile meadows". To summarise, described around 90 different species from the sandy soils of Halland and summed up his observations by stating that the best way of dealing with the problem of driftsand would be to do what nature does; first stabilise the driftsand with plants, then with bushes, and finally with trees.

A number of areas of common land were donated to the state as a result of the all the new restrictions. Large-scale planting of Leymus arenarius, *Ammophila arenaria* and pine under the auspices of the state began and continued throughout the entire 19th century, and many areas of sandy soil in Halland and Skåne and on northern Öland were turned into productive woodland with profitable returns by the end of the century. Where conditions proved to be too dry for regular pines, large numbers of mountain pine were planted from the late 19th century onwards with the goal to cover each area of sandy soil and to make it productive.

STATE MEASURES TO PREVENT SAND DRIFT

Although the sand sometimes whirled across roads and around the corners of houses, the country folk did not always consider sand drift to be a problem in the same way or to the same degree as the authorities. Although attempts were made by the authorities in the 17th and 18th centuries to remedy sand drift in various ways, it was only in the early 19th century that the state really began to get to grips with the troublesome matter of sand drift in southern Sweden. Grazing, felling trees, peat extraction and driving seaweed across the driftsand fields were all banned in 1826, and anyone crossing the land was threatened with fines if they failed to follow staked-out routes.



HOLIDAYS, SEASIDE TOURISM AND NATURE RESERVES

In 1936, a state survey found that measures to prevent driftsand in southern Sweden had been successful but that the forests in the driftsand fields should be classified as protected forests for safety's sake, with special rules on felling. A couple of years later, general holiday was pre-scribed by law in Sweden. Seaside tourism, which had begun to develop at the start of the century, blossomed and construction of summer houses began to grow rapidly along the coasts. In the second half of the 20th century, many nature reserves were created in the coastal sandy areas, mainly for the purposes of promoting outdoor recreation, preserving the driftsand fields as a geological phenomenon and providing protection against exploitation.

BRUSHWOOD COVER, PROTECTIVE FENCING AND NO TO DUNE JUMPING

Open areas of mobile sand could cause problems when building bathing huts and summerhouses into the dunes, and again people began to be concerned about driftsand. Surveys and action programmes were devised to look at how the sand could be controlled, and these were applied on a broad front, even in undeveloped areas. Dune morphology surveys of the sandy coasts of Halland and Skåne carried out in 1973 and 1985 describe the risk of wear, damage, destruction of vegetation and erosion as a result of seaside tourism. Maintenance plans and regulations for the newly formed reserves were also strongly characterised by a conservation approach. Pedestrian traffic through the dune fields was to be channelled along trails and boardwalks. New patches of exposed sand were to be covered with brushwood or seaweed.

Dune grass planting at Ullahau, Fårö. Photo taken in 1907, Swedish University of Agricultural Sciences Historical forest images.

Protective fencing was constructed along certain sections of coast with a view to stopping the sand. Active dunes were fenced in or covered with nets, and children were told not to jump around in the dunes on family holidays.

"Wear occurs at certain points, particularly when visitors dig themselves into the sand with a view to sheltering from the wind, resulting in wind erosion and destruction of vegetation."

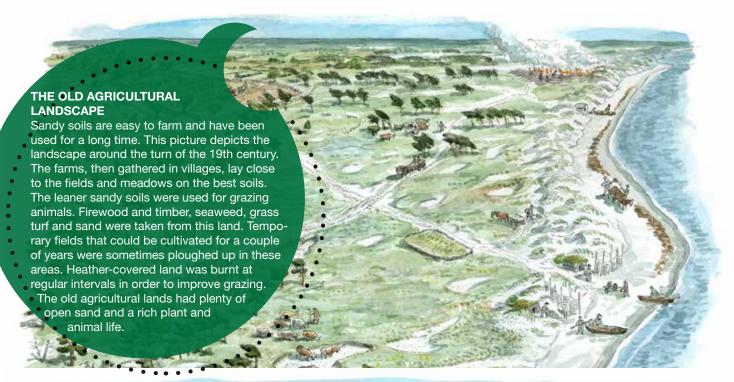
From the county administrative board report "Dynmorfologin längs Hanöbukten" [Dune morphology along Hanöbukten], 1985.

"A number of parallel fences and extensive planting activities, with later provision of long-acting fertilisers, may sometimes be needed when building up dune edges that have been completely destroyed. In some areas, covering the land with seaweed, brushwood and/or large bales of straw may be appropriate. The remedied areas must be made inaccessible to the general public in an appropriate manner."

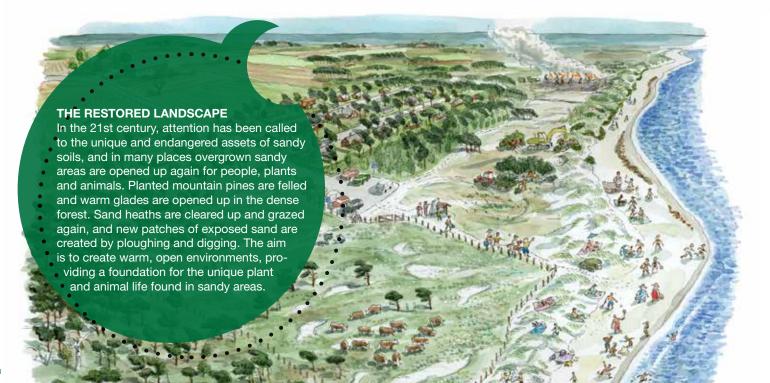
From "Riktlinjer för skydd och vård av den halländska sandkusten" [Recommendations for the protection and maintenance of the sandy coast of Halland], 1993.

SANDY SOILS BECOME OVERGROWN, AND NEW INSIGHTS

All the conservation measures implemented into the 1990s, together with the effects of nitrogen precipitation and acidification, caused overgrowth to accelerate. From the early 2000 onwards, nature conservationists began more and more to pay attention to the situation as regards the outstanding natural value of the open sandy soils warmed by the sun. Above all, the critical situation for the breeding of tawny pipit in Sweden and the results of a number of insect surveys in the sandy soils of Halland shone a spotlight on an acute nature conservation problem. Species-rich sandy soils were becoming overgrown at a rapid pace, and unique natural assets were endangered. Sweden's membership of the EU came with an obligation to protect valuable nature and endangered species as part of the Natura 2000 network. Work on action programmes for endangered species in Sweden was extended at the same time. Greater attention was paid to sandy soils on a number of counts, and they were given a more prominent position in nature conservation initiatives.







3. SPECIES IN SANDY HABITATS

Extremely dry, poor in nutrients, scorching sunshine and howling winds. In sandy soils, conditions are harsh for anything wanting to live there. On the other hand, the warm spring sun get things off to an early start, the nutrient-poor sand holds off competition from demanding plants and digging and growing in the sand are easy. Sandy soils also offer wide variation of micro-environments thanks to the constant changes that take place when the land slowly becomes overgrown. All stages of overgrowth are needed for maximum species diversity. This is why it is important with a constant access to exposed sand where everything can start all over again.

LONG, SPECIES-RICH HISTORY UNDER THREAT

The history of Swedish sandy soils extends back to the final stages of the last ice age, 18,000 years ago (you can find out more about this in the section on the history of sandy soils). Species have migrated here, one after the other, for thousands of years, leading to an increase in diversity. The plants, animals and fungi that came here have adapted to various conditions, depending on differences in climate and other conditions that have varied through the ages. Arctic species appeared here soon after the ice age, while species requiring a warmer climate turned up at times when the area was warmer than it is now. Many have managed to survive even though the conditions have changed. This is why we may sometimes find northerly and southerly species living side-by-side in the same area of sandy soil.

Areas of open sandy soil, with their natural vegetation and animal life, have declined at an ever-increasing pace over the past century. There are still areas with both rich and diverse plant and animal life, but this diversity is becoming increasingly limited. More than 300 species in Swedish sandy soils are red-listed, and almost 200 of these are directly endangered, according to the Swedish Red List for 2015.

Some 40 action programmes for endangered species relate to species found in sandy soils, and Natura 2000, the European network for nature that is worthy of protection, includes nine sandy soil habitats, two of which are classified as high priority and particularly worthy of protection.

WHAT IS THE DIFFERENCE BETWEEN ENDANGERED SPECIES AND RED-LISTED SPECIES?

"A national red list is a summary of species status (risk of extinction) within the borders of the country. The status of species is assessed by means of a number of criteria which include estimates of population size, occurrence, spread and trends. The species are placed in different categories on the basis of this assessment."

Source: Swedish Species Information Centre, Swedish University of Agricultural Sciences

The Swedish Red List is produced and updated by the Swedish Species Information Centre. This list is then established by the Swedish Environmental Protection Agency, and the latest list (2015) includes 4273 species. The Red List is an important nature conservation tool. It forms the basis of various action programmes for endangered species, is used to follow up successful attainment of environmental targets and forms the basis for assessment of the status of natural areas. The Artportalen database, which is also run by the Swedish Species Information Centre, is an important Citizen Science tool that anyone can use to search for and report the occurrence of both red-listed and other species.

The endangered species category forms part of the complete group of red-listed species. Species characterised as Critically endangered (CR), Endangered (EN) or Vulnerable (VU) are endangered. Besides all the endangered species, red-listed species also include species that are Near Threatened (NT), Regionally Extinct (RE) and Data Deficient (DD). However, species that are categorised as Least Concern (LC) are neither endangered nor red-listed.

We have chosen to use red-listed species in this book. Appendix 1 contains a list of all species referred to in the book, listed with their Latin names and their status in the 2015 Red List, where applicable.



Grey hair-grass, Corynephorus canescens

ADAPTATION AND SPECIALISATION

Dry sandy soils quickly warm up in the spring sunshine. This provides a warm microclimate, getting the plant, insect and breeding season off to an early start. At the same time, anything living in the most extreme locations must be adapted to cope with the differences between chilly night time temperatures and the quivering heat of summer, which can be almost desert-like. The heat of the sand allows many heat-dependent species to live here in the north, on the margin of their distribution areas. Some of the species in sandy habitats in Sweden can normally be found on the sandy grasslands of central Europe and further east. Many of them established themselves here during the warm, dry period 8000-4000 years ago, known as the period of postglacial warming. In those days, the average temperature was several degrees higher than it is today. There was also a land bridge to the continent in those days, which made it easier for species to spread northwards. Many populations died out during later, colder periods, while others were able to survive in places where conditions were sufficiently warm and dry. These species live here on the margin of the distribution areas and would be unable to survive if the sandy soil were to become overgrown. This would make their habitat far too cold and damp.

The plants found in nutrient-poor sandy soils have adapted by means of evolution so that they can survive on tiny amounts of water and nutrition. Grey hair-grass *Corynephorus canescens*, for example, has narrow, rigid blades so that it does not dry out, while the blades of the stonecrop *Sedum*-species are plump and thick and can store water. The dune grasses *Leymus arenarius* and *Ammophila arenaria* specialise in growing in dry sand and are able to withstand being covered by sand. Deep root systems allow them to reach the groundwater, and they can also send up new shoots quickly when they are covered by sand.



Biting stonecrop, Sedum acre

Many of the pioneer plants found in sandy soils are also annual. They flower early, before the summer drought, and focus all their efforts on producing lots of seeds which then germinate in the open sand.

In the nutrient-poor, dry sand, the sandy soil specialists avoid competition from rapidly growing plants and grasses that require a lot of nutrition. The calcareous sandy soils benefit species that can grow even though the lime binds the nutrients in the soil and may even act as a toxin in many other plant and moss species.

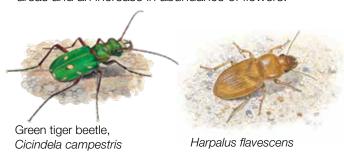
Over the ages, evolution has developed various adaptations and links between plants, animals and fungi. Some insects are dependent on a specific plant to survive, while others need a particular insect-species to parasitize. Some fungi need a particular plant to live on, and many insects have to have access to specific structures such as open sand or dead wood so that they can build nests and reproduce. A few examples of all these exciting species and some of the fascinating links between them that can be studied in our sandy soils are described her



LIFE IN SANDY SOIL

WILD BEES AND OTHER HYMENOPTERAS

Many of the 295 wild bee species found in Sweden live in sandy soils. Many of them are under threat as their sandy environments have changed or disappeared completely. The Swedish Red List includes almost 100 wild bee species. By way of example, around 40 red-listed wild bees are known to live at the sandy Revingefältet in the middle of Skåne. A number of our wild bees are covered by national action programmes, where the most important measures include the creation of exposed sand in sandy areas and an increase in abundance of flowers.



A number of wild bees dig their nests in the ground. They then build brood chambers where they lay their eggs on clumps of pollen, providing food for the growing larvae. A lot of pollen needs to be gathered, and the bees need nectar to give them energy to work. This is why access to flowering plants is crucial for successful rejuvenation and survival. A number of bees gather pollen from just a single plant species or group of plant species. Dasypoda hirtipes, one of the more common bees found in sandy soils, is one example. It mainly flies to hawkweed Hieracium-species, where it gathers pollen with its long-haired hind legs. After a successful harvest, the hairs are full of pollen and look like yellow trousers. There are also parasitic bees, known as Nomada, "cuckoo bees". Like the cuckoo, they lay their eggs in the nests of another species. Some Nomada specialise in parasitizing a particular species, so these are particularly vulnerable and entirely dependent on their host bee. One example is Andrena hattorfiana, which is a relatively common bee found in soil with flowering scabious Scabiosa-species, warmed by the sun, while its cuckoo bee, Nomada armata, is less common.

Megachile leachella lives along the sandy coasts of Halland, Skåne and Öland. The females dig their nests in bare sand exposed to the sun and construct each of the brood chambers with pieces of leaf. The less common Osmia maritima is also linked with the sandy coasts of southern Sweden and is totally dependent on access to the legumes Lotus corniculatus or beach pea Lathyrus japonicus so they can gather pollen for their larvae.

A large number of other *Hymenoptera* predate on various insects. A number of them are strictly linked with parasitizing a particular species, which makes their survival particularly vulnerable. One example is *Chrysis scutellaris*, which

only parasitizes Osmia maritima or Megachile leachella. Charismatic and rare Bembix rostrata can be seen in locations exposed to the sun on sandy soil. This is our biggest sphecoid wasp. They dig their nests for their larvae on patches of sand warmed by the sun, feeding the young with flies. They suck nectar from Breckland thyme Thymus serpyllum to keep them going. Bembix rostrata has large, green eyes and persistently patrols its nesting site, which it often shares with a number of other Bembix rostrata in a collective colony. The more common European beewolf Philanthus triangulum can be seen flying low above sandy soils on its way to its nest, carrying an anaesthetised honeybee to feed to its larvae.

BEETLES

Beetles are one of our most species-rich insect orders in Sweden. Many of these species live on dry, sandy soils. The green tiger beetle *Cicindela campestris* can come flying, sparkling, like a green jewel, and coming to rest on sandy paths. The northern dune tiger beetle *Cicindela hybrida* is a close relative. Both beetles are relatively common in southern Sweden. The rare dune tiger beetle *Cicindela maritima*, on the other hand, is less common and lives in damp, exposed sand along waterways or at humid dune slacks.

The early blister beetle *Apalus bimaculatu* can be found flying through the western Swedish sand dunes and sand and gravel pits of central Sweden as early as March or April, when the first warm rays of the sun have heated up the sand. The larvae of the early blister beetle parasitize the bee Colletes cunicularius and live on nectar and pollen collected by the bee for its larvae.

For many dung-living beetle species, well grazed sandy areas with low vegetation and patches of exposed sand are important environments. Grazing throughout the entire season provides constant access to fresh dung in which

eggs and larvae can develop. A number of species, such as *Copris lunaris*, dig brood chambers deep down in the sand and carry down balls of dung in which the larvae eat and develop over the winter.

Harpalus is a group of beetles where a number of species live on oil-rich seeds from annual plants. These thrive best in sparse areas of vegetation, interspersed with patches of exposed, sunlit sand. Various *Harpalus* species can be found in coastal sand dunes and on inland grassy sand dunes.

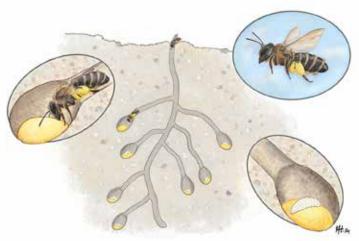


bimaculatus

Corpus lunaris



GET TO KNOW THE SOLITARY BEES



Mining bees Andrena

MINING BEES ANDRENA

All species of the genus Andrena, are bees that build their nests in sandy soils and are generally called mining bees. Many mining bees have a hairy body and can give a shabby impression. Mining bees are 6-17 mm long. Many species of mining bees live from food from a single or a few host plants. This makes them extra vulnerable and about 20 species are therefore red-listed.

The grey-backed mining bee, Andrena vaga, is 13-15 mm long. It is a black bee with grey hair that collects nectar from willows. It wakes up early in the spring, sometimes already in late February!

BLOOD BEES

contrast to the black colour of other rest of the body.

When the larvae are hatched, they eat the pollen stores there are 16 species of blood bees, of which four are red-listed.



LEAF CUTTING BEES

Leaf cutting bees of the genus Megachile are heavily built bees, 7-17 mm long. The females collect pollen on their abdomen and are therefore hairy on the underside of the abdomen, often colored in yellow and orange.

In Sweden, there are 12 species of the genus Megachile, of which three are red-listed. One species is Megachile lagopoda - our largest and most spectacular solitary bee, 14-17 mm long. It lives on sandy fields and collects pollen from cornflowers and thistles.



Leaf cutting bee

CUCKOO BEES

The genus Nomada is one of the largest genera in the family Apidae, and the largest genus of kleptoparasite "cuckoo bees". They look like wasps, with yellow and black, 6-14 mm long. Cuckoo bees do not build a nest of their own, but like blood bees, they put their eggs in nests of other species. Cuckoo bees of the genus Nomada specialize in utilizing mining bees as host. In Sweden, there are 34 species of cuckoo bees, 13 of which are red-listed.

GENUS DASYPODA

Legs with long hairs are the main characteristics of the genus Dasypoda. In Sweden, there were previously three species of Dasypoda, but today two species are considered extinct. Only Dasypoda hirtipes is found in Sweden. It is 12-15 mm long and specialized in hawk bits (genus Leontodon) and can be found in sandy grasslands in July-August.

* Red-listed species are such species that are so unusual or decrease so rapidly that they risk disappearing from the country. Many red-listed solitary bees are included in the Swedish Environmental Protection Agency's action program for endangered species. This applies, for example, to many mining bees and cuckoo bees.



IN YOUR GARDEN

Make sure to have some open sand areas in your garder and put up nest boxes for bees in the warmest corner of your garden.

Plant flowering plants that both bees and butterflies like. Ask your gardener for advice on good plants.

Plant willow and lots of spring bulbs. Gardens are perfect places for a bee in early spring.

Make a small meadow in your garden. Use special seed combination for meadows and let the flowers grow all summer. Do not mow until late in the summer or wait and burn the meadow in early spring.

HELP THE SOLITARY BEES!

You can create nesting places. Solitary bees need open sand. Place nesting areas in the edges between forest and open areas or in south-facing slopes with lots of sun. Bees love warm sand, the hotter the better. Just place a pile of sand or dig a small pit (1-2 square meters) and fill with sand - the bee nesting place is ready!

Rotate grazing and mowing during the season so that there are always some areas with flowering plants. It is important to wait with mowing areas that are not grazed until the end of the summer.

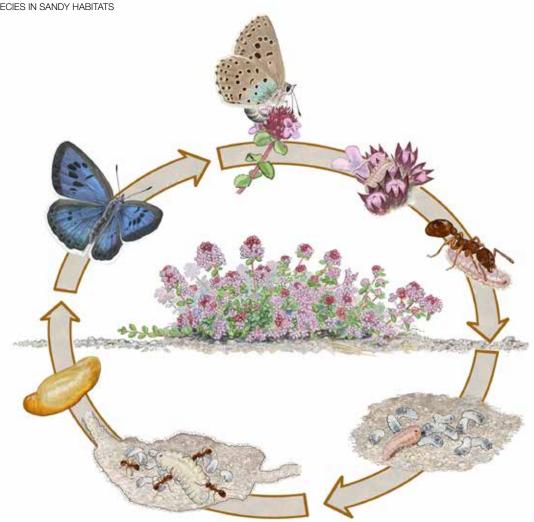
Burning grassland and meadows early in the spring is a very good management method. It leans out the ground and favors plants that are not as competitive as other, more common species.

Take care of willows. They are breakfast for solitary bees when they wake up from winter sleep. The flowering in different Salix species are vital for the survival of many solitary bees.

If you have a small sand or gravel pit, make sure it does not become overgrown. Take some sand occasionally so that there is always exposed sand.

If you use chemical plant protection products, please use those that do not harm pollinating insects.





One of the most charismatic butterflies found in sandy soils in south-eastern Sweden is the Large Blue Maculinea arion. This is the biggest of our blue butterflies and lives in unique harmony with both Breckland thyme and Myrmica sabuleti ants. This butterfly lays its eggs in Breckland thyme flowers. The larvae live there for a short time and then crawl down onto the ground, where the ants are fooled into thinking that the butterfly larvae is one of its own larvae. Then the ants carry the larvae away to their nests, where the butterfly larvae live off ant larvae. They then hibernate and pupate there before hatching to create a new butterfly in summer.

BUTTERFLIES

Rich butterfly fauna can be found in areas where there are plenty of flowering and nectar-rich plants. Many butterfly species are dependent on a specific plant species or group of plants in order to survive. Areas that are home to plants such as field scabious Knautia arvensis, hoary alyssum Berteroa incana, Breckland thyme Thymus serpyllum, sheep's bit Jasione montana, violets (Viola sp) and kidney vetch Anthyllis vulneraria are frequently home to a variety of butterflies as well. The shiny metallic green forester Adscita statices, the feathered footman Spiris striata and many varieties of Polyommatini, Lycaenidae, Zygaenidae and Heliconiinae flutter through the flower-rich sandy soils.

Everyone has seen colourful butterflies, but all the tiny butterflies that live in the vegetation of the sandy soils are less well-known. Most of them are active at night, many are common and others are extremely rare. A number of varieties are strictly linked with hairy greenweed Genista pilosa, the characteristic species of the sandy broom heaths of Halland. Agonopterix atomella, Coleophora genistae and Syncopacma suecicella are just three of them. All of them are found in extremely limited numbers in Sweden. On the sand dunes of the south coast, the larvae live off the tiny Pelochrista infidana moth, which lives on the roots of Artemisia campestris. Other examples are the Eublemma

minutata, which only lives on Helichrysum arenarium, and the extremely rare Caryocolum schleichi, which is only known from two sites in eastern Skåne. Its larvae develop on sand pink Dianthus arenarius.

FORMICA CINEREA AND ANTLIONS

Formica cinerea is one of the characteristic ant species on open sandy soils. It establishes itself in areas of sand that are open to the sun, where there is sparse vegetation. Formica cinerea does not build ant hills, its colonies are built down in the sand. It can be recognised from its grey, shiny body hair. In southern Sweden, it can be found in Halland, eastern Skåne and Blekinge, and on the island of Öland. Formica cinerea ants are fair game in areas where antlions Myrmeleontidae are also found. Sweden has three antlion species, all of which are linked with sandy soils. Myrmeleontidae live in the larval phase for about a year. The larvae are known as antlions and dig a funnel-shaped trap pit in the sand. The antlion sits at the bottom of the pit, hidden in the sand, waiting for its prey to drop down. It spatters its prey with sand using its head in order to surprise and trap it, then it catches it in its large jaws.

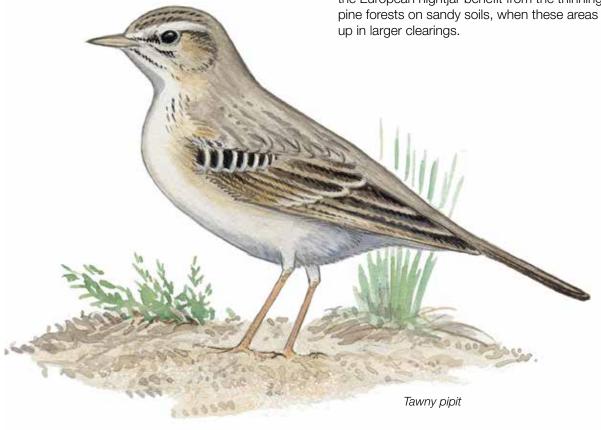


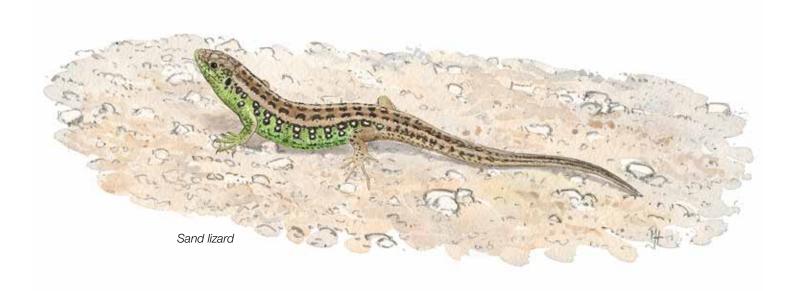


BIRDS FOUND IN SANDY AREAS

Sandy soils also have characteristic bird species. The most characteristic is the tawny pipit *Anthus campestris*. This bird is entirely dependent on large areas of open sand, where it breeds and forages for food. This bird was much more common in the open landscapes of ancient times, rich in open sandy soils. There were 500 pairs throughout much of Götaland in the 19th century. Their numbers declined as sandy soils became overgrown throughout the entire 20th century. The tawny pipit has only bred on the east coast of Skåne, from Åhus in the north to Vitemölla in the south, for a number of years now. A survey carried out in 2013 found 33 territories in eastern Skåne. A second survey carried out in 2017, following most Sand Life actions, the number of territories had increased to a pleasing 42.

Woodlark *Lullula arborea* and European nightjar *Caprimulgus europaeus* are two of the characteristic species in wooded sandy soils. Both are dependent on the mosaic of enclosed and more open sandy soils with lots of insects. The woodlark is one of our smallest larks and can be recognised from its short tail and characteristic flight call, li-li-li-lililylylu. The European nightjar is nocturnal and has well camouflaged plumage which makes it difficult to see as it sits motionless during the day. Both the woodlark and the European nightjar benefit from the thinning of enclosed pine forests on sandy soils, when these areas are opened up in larger clearings.





GREEN LIZARDS IN THE SAND

Dry, warm sand where eggs can be buried and left to hatch is the ideal environment for the sand lizard *Lacerta agilis*. It also needs access to grassland, brushwood and bushes, where it can find food and seek shelter. The sand lizard is one of the species that established itself in Sweden during the period of postglacial warming 8000–4000 years ago, when it migrated from the south just like other species, using a temporary land bridge to the continent. Today, when the climate has turned colder, sand lizards can only survive in areas where sandy soils and sun create a warm, local climate. The sand lizard has characteristic dark patches with a white dot in the middle, known as ocelli, along its back and sides. The male is particularly easy to recognise during the breeding season as its planks turn a striking green colour.

FLOWERING PLANTS, GRASSES, FUNGI, MOSSES AND LICHENS

As indicated previously, a rich and varied selection of plants is necessary for a rich animal life in sandy soils. Vegetation and fungus variety in turn are dependent on a number of different criteria, with a unique composition for each individual location. In the coastal dune areas the sand moves around in the wind that also brings salty spray from the ocean. On hot summer days the heat can quiver and the nights be cool like in the desert. Grazing, manure and animals walking by create different conditions on grazed sandy soils. Inland, you may find a wide variety of flowers on lean ruderal land, in pits, on racing tracks and on verges that are mown. The climate to the west is rainy, while to the east it is drier. The sand may be very calcareous in eastern Skåne and on the island of Öland, and this benefits species-rich plant fungus and animal life. On the west coast, you will rarely find a single hint of lime in the sand, but there are other characteristic species here that are used to living in leaner, rainier conditions. In addition to this, you have the character of each area linked with factors such as land use history, size and the ambient conditions in the landscape.

SANDY SOIL VEGETATION - COASTAL AND INLAND

Coastal sandy soils can be divided into various vegetation types, depending primarily on various phases of overgrowth – succession. The overgrowth phases in turn control access to open sand and the content of various species. All the different succession phases can be found in the sandy coastal areas that still have an active sand dynamic, from the bare shifting dunes on the open shore to the wooded dunes a short way inland. The various vegetation types and how they relate to one another are described in greater detail in the chapter on coastal sandy environments.

Similar successions to those along the coasts occur in the various types of open sandy soil found in sandy habitats inland, primarily grazed sandy soils and military training grounds. Inland, vegetation is divided mainly into various grassy sand dunes and dry sand heaths. In sandy soils with a high lime content in eastern Skåne and on the island of Öland, there are almost steppe-like conditions in places, with unique vegetation known as sandy calcareous grassland. More information can be found in the chapter on inland dunes and grass-covered sandy soil and sandy calcareous grassland.

SANDY SOIL HABITAT TYPES AND SPECIES WITHIN THE EU AND LIFE

The EU's Species and Habitats Directive and Birds Directive categorises the habitat types and species that are considered worthy of protection from a European perspective. As regards sandy soils, these directives include both different habitat types and a few characteristic species for sandy soils.

Each member state has an obligation to ensure that all species and habitat types included in the directives have a favourable conservation status. This means that the distribution areas, area size, population development and other qualities must be maintained, and reinforced if necessary. Life+ is the EU's economic tool for co-funding of major environmental and nature conservation projects in its member states. One important aim of LIFE is to reinforce protection and enhance the status of valuable habitats and endangered species throughout the EU. Sand Life is one example of a LIFE project with precisely this objective. The following habitat types and species covered by the directives are linked with sandy soils of various types:

SANDY SOIL HABITAT TYPES IN ACCORDANCE WITH THE EU'S HABITATS DIRECTIVE (HABITAT TYPE CODE):

Shifting dunes (Embryonic shifting dunes; 2110)

White dunes (Shifting dunes along the shoreline with Ammophila arenaria; 2120)

Grey dunes (Fixed coastal dunes with herbaceous vegetation; 2130)

Lime-deficient dune heathland with crowberry (Decalcified fixed dunes with *Empetrum nigrum*: 2140)

Dunes with creeping willow (Dunes with *Salix repens* ssp *argentea*; 2170)

Wooded dunes (Wooded dunes of the Atlantic, Continental and Boreal region; 2180)

Humid dune slacks (2190)

Dry sand heaths with Calluna and Empetrum nigrum; 2320

Grassy sand dunes (Inland dunes with open Corynephorus and Agrostis grasslands; 2330)

European dry heaths (4030)

Sandy grasslands (Xeric sand calcareous grasslands; 6120)

Siliceous grasslands (Fennoscandian lowland species-rich dry to mesic grasslands; 6270)

SPECIES ACCORDING TO THE EU'S SPECIES AND HABITATS DIRECTIVE (92/43/EEC):

Dianthus arenarius ssp arenarius; 1954

Large blue (*Maculines arion*; 1058) Sand lizard (Lacerta agilis; 1261)

SPECIES ACCORDING TO THE EU'S BIRDS DIRECTIVE (79/409/EEC):

Tawny pipit (Anthus campestris; A255)

Woodlark (Lullula arborea; A246)

European nightjar (Caprimulgus europaeus; A224)



PLANTS IN SANDY SOILS

LIVING IN SAND

Anyone who has ever walked barefoot along a sunny beach knows that sand can get very hot. Sandy soils are also poor in nutrients and not very good at retaining water. Strong winds can move the sand around. In other words, living in sand may present quite a challenge; but despite this, there is enormous species diversity in sandy soils. Some of the grasses and plants found in sandy soil are common and occur elsewhere as well, while many are very specialised.

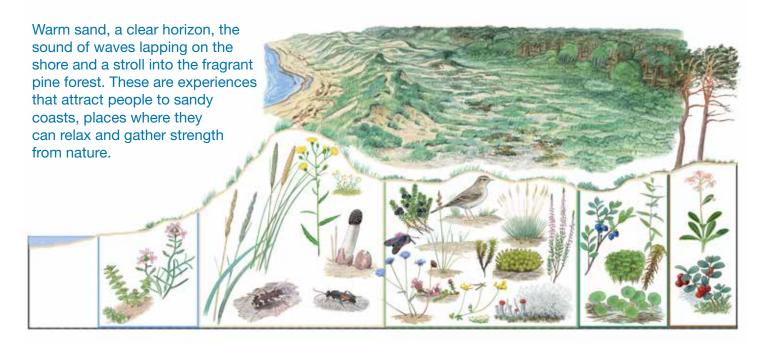
GRASSES AND PLANTS IN SANDY SOIL

Plants in sandy soil have adapted in a wide variety of ingenious ways so that they can withstand the heat and dryness. Some of them have downy leaves or narrow, rigid leaves so that they do not dry out. Many plants that thrive in sandy soil are annual. They often flower early, before the summer heatwave, and produce lots of seeds. Bare sand is essential for these plants as the seeds are unable to grow if the plant cover is too dense.





4. COASTAL SANDY HABITATS



This is where we will also find a wide variety of plants, animals and fungi that are dependent on the unique nature of the sandy coast and on one another as well. Many of them found their way here several thousand years ago and have special qualities that allow them to live in these dry, nutrient-poor areas, subjected to the howling wind and the hot rays of the sun.

Coastal sandy habitats can be divided into various characteristic habitat types from the sea and in across the land. From the open shore to the mature forest, they make transitions from one to the other in various phases of stabilisation and overgrowth. Although it is possible to characterise habitats in this way, it is necessary to remember that each location is unique. The habitat types can be categorised in different ways and be present to varying degrees. Exposure to the wind and ocean currents, the calcareous nature of the sand, grazing and the history of the use of the land are other factors that give each and every area its own special character.

Large-scale initiatives implemented in the 20th century designed to bind the sand, along with nitrogen deposition and acidification, have helped to accelerate natural overgrowth. This has resulted in by far the biggest change in the sandy coastal landscape. The habitat types offered by the open dunes have largely given way to forests and overgrown land. We have largely been successful in reversing this trend in the Sand Life project areas.

This chapter begins by describing the characteristic habitat types and species found on the sandy coast, followed by a presentation of some of the Sand Life project areas and the activities implemented there.



BEACHES AND SHIFTING DUNES

Sandy beaches and the outermost sand dunes nearest to the sea are alive and changing. In stormy weather and choppy seas, large amounts of sand may be washed back out to sea from the outermost dune face. New sand is brought back up onto the shore with the ocean currents and waves. These dynamic processes are always ongoing and must not be confused with erosion, which involves permanent removal of sand. When the sand has dried in the sun, a short way beyond the reach of the lapping waves, the wind blows it a little further up onto the beach and builds low shifting dunes. The vegetation on these is sparse, and sea sandwort, Honckenya peploides, sea rocket, Cakile maritima, and prickly saltwort, Salsola kali, are some of the rugged plants that live here and are able to withstand salt, dryness and occasional waves. A number of highly specialised insects live here too, plant-eating weevils and beetles that have adapted to life in this barren environment. The protection of the sparse vegetation in the shifting dunes can also provide refuge for the common ringed plover, nesting and foraging for food on the beach.



White dune



WHITE DUNES

Above the beach and the shifting dunes is a more or less steep dune face. This is where the white dunes begin. This face may be several metres high on the west coast, where the winds blow more fiercely than in the east. The winds from the sea blow sand from the beach up over the dune face, where it drops down into elongated slopes when the wind loses impetus. This forms undulating dune systems parallel to the shoreline, the dunes constantly being built up and reshaped by the wind. The intensity of the wind, the vegetation and the access to open sand all regulate the width of the belt of white dunes. Large dune systems formed quite a long way into land when the coastal landscape was fully open, but nowadays the white dune zone is generally narrow as the winds have been attenuated by overgrowth and planting. The percentage of open sand must account for at least half of the area for white dunes to have a beneficial status from a nature conservation standpoint.

The vegetation in the white dunes is fastidious and well suited to the moving sand. Mosses and lichens do not thrive here, and few flowering plants grow here. The dune grasses marram, Ammophila arenaria and lyme grass, Leymus arenarius dominate. These survive thanks to deep root systems and grow quickly if they are covered by sand. Sea holly, *Eryngium maritimum* and beach pea have adapted to the exposed conditions right at the front of the dune face and are two of the few flowering plants in the white dunes. There are a number of special fungi here as well. These include Mycena chlorantha and dune stinkhorn, both of which live on dune grass. A range of specialised insects also form part of the wide variety of species in the outermost dunes. A number of these are plant-eating beetles and bugs that feed only on dune grasses and various ground beetles, Hymenoptera and flies, which in turn eat or parasitise the plant eaters.

GREY DUNES

When the active white dunes are stabilised, they make the transition to a calmer phase in which sand sedge, various grasses and flowering plants establish themselves initially, followed by the gradual migration of soil-living mosses and lichens to the area. Although this type of habitat is known as grey dunes, this name may appear to be misleading as grey dunes are some of the most flowery environments along the sandy coast. In summer, they are painted bright colours by the flowering Breckland thyme, sheep's bit scabious, violets and hawk-weed, *Lotus corniculatus*. The wealth of flowers, the open sand and areas warmed by the sun and protected from the wind create rich insect environments, and all these factors help to make grey dunes the most important coastal habitat type from a diversity perspective.

Plant and animal life in grey dunes may vary widely, depending on a number of conditions. Areas where calcareous sand is found are considerably richer in species than the quartzrich sandy soils. Undulating dunes offer plenty of warm slopes and open sand. There may be damp depressions in flat areas that make their own contribution to the variation. Grazed dune areas are ideal for low-growing grasses and plants, and mosses and lichens are pushed back. Where you have grazing animals, you also have droppings; which in turn add various dung beetle varieties to the beetle fauna.

Grey dunes characteristically have 10 to 50% open sand. As far as diversity is concerned, the more, the better. New patches of exposed sand are formed constantly in dune systems with active sand dynamics as a result of storms and windy weather. The open sandy areas become home to sparse vegetation, with grasses and flowering plants. Sand sedge spreads with long runners, and grey hair-grass grows quickly, like tiny grey shaving brushes in the sand. The rootlets stabilise the sand, and many digging insects live here, where they can dig their nesting holes in stable sand lit by sunlight. The insect fauna of grey dunes is both varied and rich, with species diversity that includes a number of insect groups. Aculeata, beetles, butterflies and spiders are just a few groups that are well represented in dunes. A number of these insects are highly specialised and live solely on a specific plant or parasitise a specific insect species.

The sandy grass heaths of the grey dunes also provide a home for a number of characteristic fungi. Deconica montana, Geoglossum arenarium, Clavaria argillacea and Handkea utriformis are just some of them. Just as with plant and animal life, a higher lime content in the sand increases fungi numbers and provides a habitat for rare fungi.

LIME-DEFICIENT DUNES AND DUNES WITH CREEPING WILLOW

Brushwood of various kinds can gradually migrate to stabilised dunes. Crowberry and heather primarily establish themselves in drier sandy soils from which minerals have leached out. Creeping willow takes over in wetter soil. Brushwood can often be found as smaller patches out in the grey dunes. The brushwood can cover increasingly large areas over time, primarily in lowland, wetter places, and as long as the land is not disturbed by grazing or in any other way. In the long term, larger areas of lime-deficient dunes me make the transition to an overgrowth stage where deciduous and pine seedlings take over.

Although lime-deficient dunes and dunes with creeping willow are considerably poorer in species than grey dunes – as regards both plants and animals – they are all part of the rich tapestry of the dune landscape, where they occur as smaller elements among the grey dunes.

HUMID DUNE SLACKS

Humid dune slacks form in places where the groundwater reaches the surface of the soil. Depending on local conditions, humid dune slacks may vary; from different types of marsh, wet heaths and wet scrub two areas of open water. Particularly species-rich fen vegetation may develop on calcareous sandy soils. Grazing generally increases natural assets and helps to keep wetlands open. Humid dune slacks, particularly when they are open, are extremely important to overall diversity in sandy soil areas, with all the birds, amphibians and insects that they attract.

Few dune areas in southern Sweden are grazed nowadays, which is why many humid dune slacks are more or less overgrown with brushwood and shrubs or have turned into swamp forest, becoming part of the wooded dunes habitat.



WOODED DUNES

Wooded dunes are rich in variation and include both forests that have grown naturally and planted forests that have developed into a more natural state. The tree cover must be in excess of 30%, and this type of habitat also includes wooded humid dune slacks.

In the history of sandy soils in southern Sweden, forests along the coasts have either been opened up substantially or devastated completely through the ages. This is why there are no or very few areas of natural forest nowadays with a completely unbroken history. The forests of today have developed over the last two centuries and are largely derived from pine planting, natural overgrowth or a combination of the two. Dune forests that have grown naturally often include a mixture of pine, oak, birch, aspen and alder. The variations depend on the level of soil moisture, pine and oak growing best in the dryer soils and alder, birch and aspen dominating the wetter ones. Pure deciduous forests in dry, sandy habitats are rare but can be found occasionally, primarily in southern Skåne. The present-day forests found along the sandy coast are largely planted pine forests that are still in their first generation. If they were allowed to develop freely, more and more oak trees would grow among them in the long term.

Although the coastal forests have been ravaged or completely devastated at times, there have nevertheless been places where scattered trees and groves have remained in the landscape, and as a result species linked with pine – for example – have been able to live on through the ages.

A number of different structures are of major significance to the preservation and development of major natural value in wooded dunes:

- Glades with sand and sunlit trunks
- Old trees
- Dead wood in various forms
- Sunlit dead wood
- A sparse and varied tree layer
- Long continuity of trees and natural species composition

The undulating dune landscape of the old driftsand fields has stabilised beneath the canopy of trees and the ground is covered with a carpet of lichens, mosses and brushwood. In the forest, steep dunes may be found in areas where there are still glades open to the sun. These are kept open naturally at the points where the sand tumbles into the slopes, the sun beats down and not much is able to grow. Older pine forests with old trees, dead wood and glades, with open sand and tree trunks warmed by the sun provide environments for species that are linked with both forests and the open, sandy glades. Typical forest varieties are umbellate wintergreen, various pyrolas and orchids such as creeping lady's-tresses, Goodyera repens, and broad-leaved helleborine, Epipactis heleborine. The pine forests are also home to special fungi, with soil fungi such as Sarcodon squamosus, Hydnellum peckii and Tricholoma apium, and the wood fungus Phellinus pini on the old tree trunks. The older pines attract insects that need dead wood and sunlit trunks, and antlions dig their trap pits and other insects dig their homes in the warm sand.

Pine forests that grow into the outermost dune belt may be significantly sparser. The close proximity to the sea and wind keeps the trees low, while the supply of new, moving sand makes the soil thinner and drier. Fruticose lichens dominate the soil, together with sand sedge and grey hairgrass. Between the sparse trees are open areas of sand protected from the wind. On sunny summer days, the heat quivers through the trees and these desertlike can overcome overgrowth for a long time.



Västra: 742 ha **Östra:** 1021 ha

Managed by: County Administrative Board

Other types of protection: Nature reserve

Habitat types according to The Habitats

Directive in project Sand Life: 2110,

SOME OF THE PROJECT'S COASTAL SANDY SOIL AREAS

The Sand Life project has involved restoration measures in a number of different project areas along the coasts of Öland, Halland and Skåne. Some of these are presented here. Each and every one has its own selection of characteristic habitat types among the dunes and driftsand fields. There are many similarities as regards needs and conditions for restoration and maintenance. At the same time, every area has its own history and character and its own unique values depending on how it was used in the past, its location, local climate and a number of other factors.

ÖLAND - BÖDAKUSTENS VÄSTRA OCH ÖSTRA

Northern Öland's Ekopark Böda is home to one of the country's biggest, most well-developed driftsand fields. This area, which was known as Böda kronopark until 1906, was also a common outfield area for the local villages. Here, on either side of the island, are the nature reserves of Bödakusten Västra and Bödakusten Östra, both of which are also Natura 2000 areas.

Pollen analyses from Byrum on the western side of the island show that the area has been grazed for at least 600 years and that pine has been the dominant tree variety for the same time. Large timber harvesting initiatives in the 18th and early 19th century led to the northern Öland sand pine forests becoming significantly more sparse. Grazing animals meant that the vegetation no longer bound the sand, and sand drift came to characterise the landscape, with large systems of sand dunes that migrated as a result.

This is how Carl Linnaeus described his experiences of driftsand on his trip to Öland in the summer of 1741:

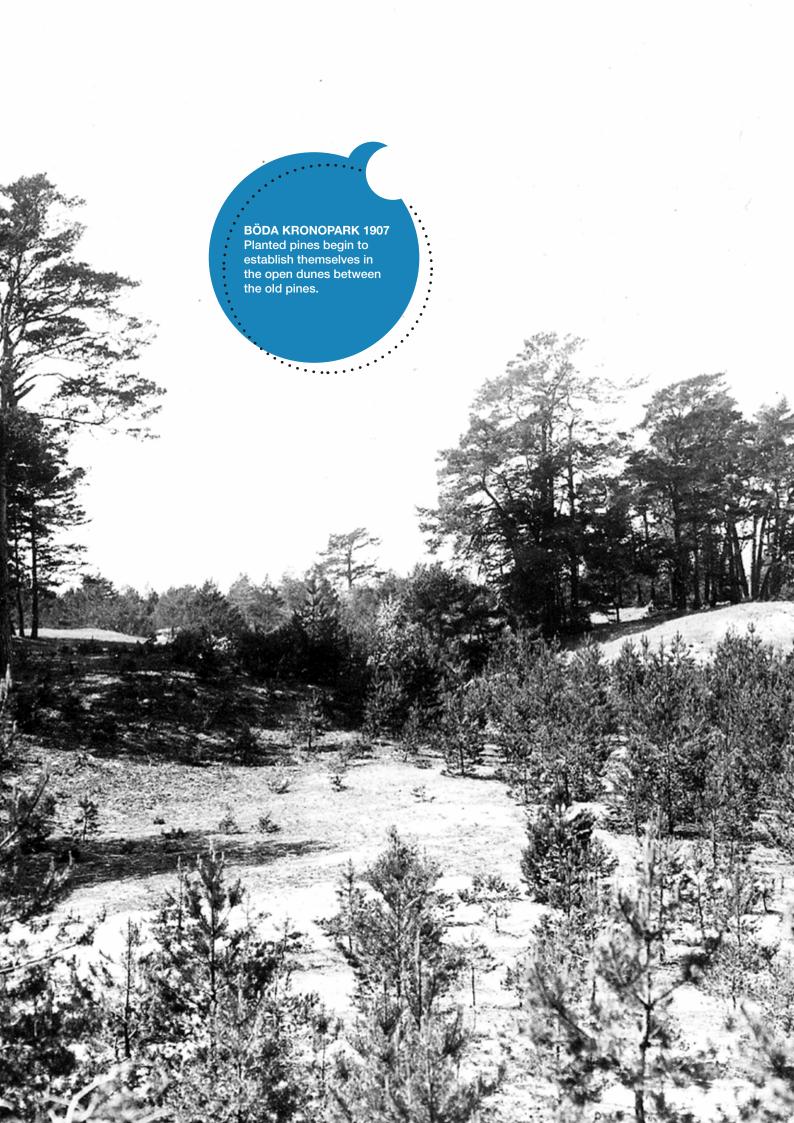
"The driftsand was driven up out of the sea with a strong southerly wind flying towards the north, laying itself down over the entire field it passed, but not stopping until it reached the calm of the forest, where the violence of the storm had no further power; here, large sand drifts could be seen lying like huge snowdrifts at the side of the forest, burying the large pine trees so that scarcely a third of the tops of the trees could peek up out of the sand on the inner side of the sand drifts."

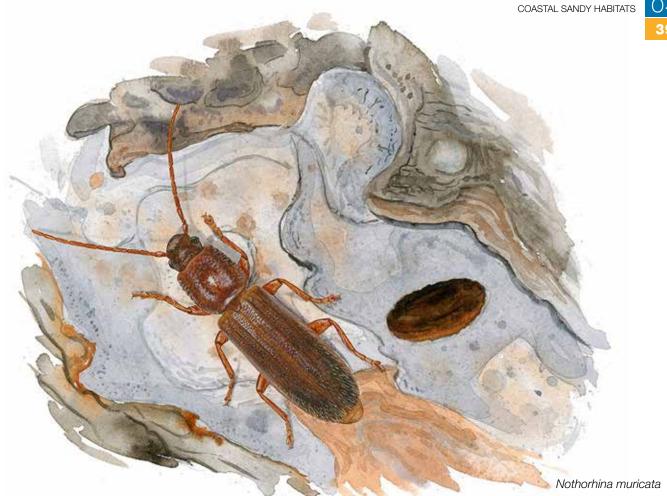
Major initiatives began in the mid-19th-century in order to replant the forests and bind the sand again. More than 7 million pine and spruce seedlings were planted between 1860 and 1890 in what is now Ekopark Böda. Foreign tree varieties such as Austrian pine and eastern white pine were also planted. As the newly planted forest grew, sand drift diminished and the sand dunes stopped migrating. The forests have gradually closed up over time.





Aerial photos from the 1940s show that there was still open sand along the coast and in the forests. Compared with modern aerial photo (below), it is clear just how much the landscape has changed since the forests have grown denser and small seeded pines have started to close areas of open sand.





SPARSE FORESTS WITH SUNNY GLADES **AND SOLITARY TREES**

The sand heaths in the Byrum project area are located inside the Böda Västra nature reserve and cover an area of 75 hectares. A forest containing several pine generations grows here. Coarse trees several hundred years old, are surrounded by a younger generation of planted pines, as well as a number of self-sown pine seedlings. This area reaches all the way out west to the coast, where the pine forest gives way to a narrow belt of white and grey dunes.

Bödakusten Östra is located beyond Bödabukten. This nature reserve is 200 hectares in area and extends over a site some 400 metres wide and 5 km long along the coast between Fagerrör to the north and Lyckesand to the south. Just like the Byrum sand heath, there are several pine generations here with some really old trees, pines planted in the mid-19th century onwards and younger self-rejuvenation. The row of white and grey dunes at Bödabukten is considerably wider than at Byrum.

The major natural value in the pine forests of both areas is mainly linked with an unusually wide variety of soil fungi and fungi that live on wood. Phellinus pini, Tricholoma apium, Bankera fuligineoalba and Tricholoma focale are just some of them. The pines are also home to insects that live on wood, such as Nothorhina muricata and Cerylon impressum. The coastal dunes are where the open sandy soil specialists can be found, with species such as sea holly and the bee known as Megachile dorsalis.

Felling has taken place in the pine forests of both areas, with the aim of releasing old solitary trees and providing the area with great variation in tree cover. A number of younger trees with the potential to succeed the old pines have been saved. Straight-trunked pines have been removed in favour of crooked characteristic trees. Trees have also been damaged in order to increase the proportion of dead and dying wood. Deciduous trees were generally spared. The stumps left over after felling have been dug up in parts of these areas, and ground cover has been cleared to create open sandy areas. The objective was to develop a forest with a large proportion of open, sunlit ground with a mosaic of bare sand, lichen carpets and other vegetation.

Pine trees have been felled and the stumps removed in order to recreate grey dunes in Böda Östra. In the white dunes, Japanese rose has been dug up in Böda Östra, and in Böda Västra the invasive balsam poplar needed to be combated in the same way. Prescribed burning have taken place in the white dunes in Böda Östra to get rid of litter, moss and old dune grass. Beach pea and other flowering plants increased considerably after these burns.



HALLAND - HÖKAFÄLTET

Laholmsbukten in southern Halland is edged by almost 30 kilometres of wide sandy shores, dunes and old, wooded driftsand fields. In the middle of the bay, covering 8 km, is the "Laholmsbukten sand dune reserve" Natura 2000 site, a Sand Life project area. From north to south, this covers the nature reserves of Gullbranna, Tönnersa and Hökafältet.

Hökafältet, 366 hectares in area, was a common outfield area for three villages for a long time. A new law passed in 1826, which aimed to prevent problems with sand drift, prohibited grazing, peat extraction and tree felling in the driftsand fields. These new restrictions, together with failed attempts to prevent sand drift over the years, lead to that the villages eventually gave up and donated Hökafältet to the state in 1851.

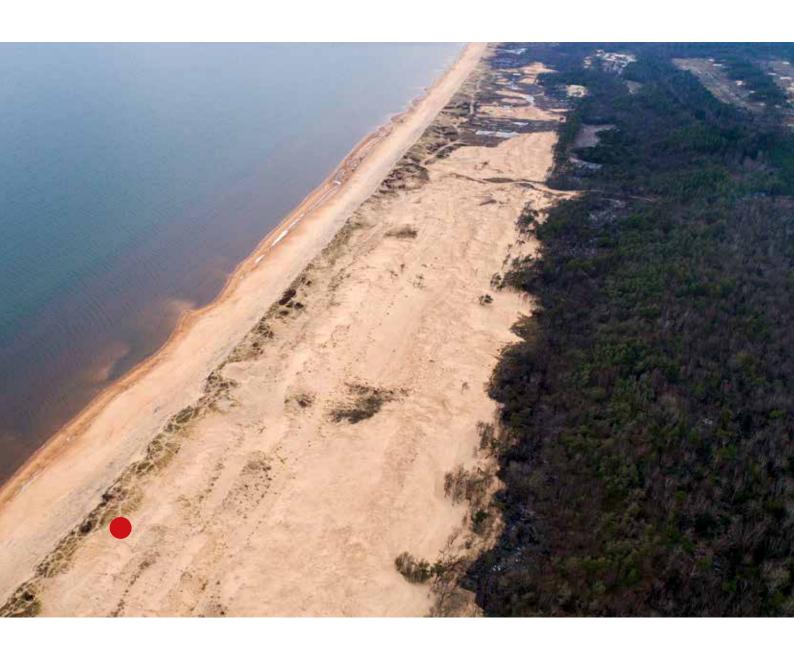
In 1827, J O Bruhn of Denmark was appointed by the County Governor of Halland. Bruhn's job was to bind the sand in the driftsand fields of Halland, and his speciality was dune grass. In 1852 he began grass planting operations at Hökafältet, which he described at the time as: "...a completely whirling sea of sand, presenting a mortal danger to anyone within it in strong winds".

Over a period of seven years, more than 8 million Leymus arenarius and Ammophila arenaria seedlings were planted in the field, and after that Bruhn was able to note that he had succeeded in his task. When the dune grasses had stabilised the sand, regular pine trees were planted but with less successful results. Hence more than 3 million more robust mountain pine seedlings were planted instead. These mountain pine seedlings became denser in the 20th century, turning into impenetrable stands covering large parts of the field until the Sand Life project began.





Hökafältet in the Bay of Laholm's sandy dune reserve before and after the removal of mountain pine. The red point shows the same place in both pictures.



OPEN SAND DUNES AND GRAZED HEATHLAND

When restoring Hökafältet, most emphasis was placed on large-scale felling of mountain pine. The outermost belt of grey and white dunes was covered with mountain pines over a distance of 2 kilometres. The pine in this windblown location were low and grew closely together in impassible bush areas. The mountain pines have been removed in their entirety over an area of around 20 hectares as part of the project, and clean new sand has then been dug out in large parts of the cleared area. This has allowed us to turn back time by more than a century, to when the original open dune landscape was restored in all its magnificence. The dunes are once more open to low grasses, flowering plants and various insects. The natural dynamic, allowing the sand to be moved around by the winds, has once more been put into play and it is hoped that this will maintain the valuable open dune environments for many years to come.

In the northern part of the field, the dunes to the east give way to a damp area with humid dune slacks and marsh forests, followed by flat driftsand fields. There are also low, parallel dune systems here, aligned with the coast, which is essentially made up of old sandbreaks covered in sand. In these parts, 30 hectares of mountain pine seedlings have been cleared and the roots pulled up. The newly opened sand heaths are now part of a grazing area covering 100 hectares, together with humid dune slacks and semi-open pine and mixed forests. A further 15 hectares of mountain pine has been cleared in adjacent areas to the south-west, creating open sandy soils alternating with sparse pine forests.

SKÅNE - GROPAHÅLET

The long, sandy coast of Hanöbukten runs from Åhus in the north and a further 20 kilometres to the south, with a dune system mainly built up during periods of sand drift between the 18th century and early 19th century. This dune belt extends up to one kilometre in towards land and comprises a variety of flat sand heath, low dunes and steep dune systems where the highest dunes reach heights of more than 20 metres above sea level. Approximately in the centre of the bay and east of the community of Yngsjö lies the Gropahålet Natura 2000 site, which comprises two nature reserves, Gropahålet and Lillesjö.

The sandy areas along Hanöbukten have been open and grazed outfields and also cultivated at times, at least since the end of the 17th century. What the landscape looked like before the dune systems were built up from the 18th century onwards and which forests grew along the coast up until that time is unclear, but it is likely that both oak and pine both formed part of this coastal landscape. In this particular site pine was planted from the 1820s onwards in order to prevent driftsand. Initially pine cones were dug down into the sand along with seaweed, and after that seedlings were set out on a number of occasions over the years.

The 20th century also saw the planting of mountain pine in a couple of the areas that were completely open in the 1940s. It took a long time for the forests to start to grow, and aerial photos from as late as the 1940s show us that the tree cover was still sparse at that time and the area was full of open, sandy spaces, but the trees have taken over at an increasing pace ever since.

LARGE GLADES, DEAD WOOD AND SUNLIT SLOPES

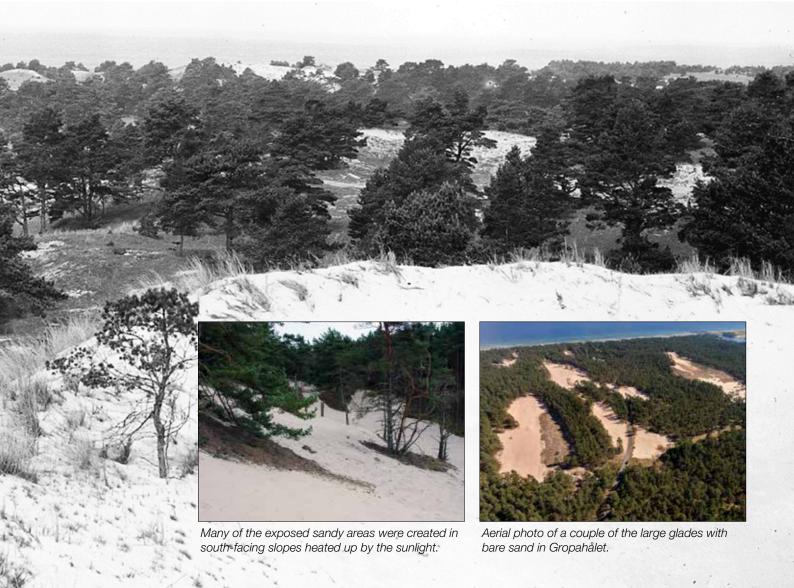
The aim of the Gropahålet measures was to restore the semi-open dune landscape of the 1940s, with its large, sunlit glades and a sparse forest with split pines growing alone and lots of dead wood. This will benefit the animals and plants living in the open sandy soil, which found themselves being crowded out as the forests expanded. At the start of the project, large parts of the area were covered by a mature, dense pine forest containing two generations of pine. This was made up of older, coarse, split pines that had grown in an open dune landscape and the straight, younger trees that were planted later. There were also younger, dense mountain pine stands in places throughout the area that had been planted in open dune depressions in the 20th century.



Dunes in the area are up to 16 metres high and have been built up by the winds in a system running east to west. This means in turn that the area is rich in south-facing dune slopes. A number of the steepest slopes have been kept open naturally until today thanks to the dry, warm conditions with moving sand, which prevented pine seedlings growing. These glades provided the starting point for the felling and clearing efforts that were focused on opening up and enlarging the glades, thinning out solitary trees, clearing mountain pine and creating sunlit dead wood.

Throughout the area, 13 large glades and clearings have been created covering areas of between 2000 and 20,000 square metres. Trees and planted mountain pine have been felled and the stumps have been pulled up, except in one mountain pine area where the stumps had to be left due to some ancient remains. Extensive excavation and earthmoving efforts have removed thick layers of moss and litter, bringing clean sand up to the surface. As patches of calciphilous flora – including species such as sand pink, rock violet and small pasque flower – can be found in Gropahålet, samples of the lime content in the sand were taken in the area in order to focus specifically on bringing calcareous sand to the surface.

Photo from 1927 of the south dune area east of Yngsjö where the Natura 2000 area Gropahålet is situated.



SKÅNE - FLOMMEN

The Falsterbo peninsula can be found at the far end of the south-western corner of Skåne. This area has a brief history. The peninsula began to form just 4 000 years ago with sand brought with currents from the east. Three low moraine ridges that formed during the last ice age stop the sand and form a basis for the peninsula. The sand from the sea currents has built up the peninsula along the south and west coasts, meter by meter. These processes are on-going even today, helping to bring about the sand dynamic that forms a basis for the outstanding natural value of the area.

On the western coast of the Falsterbo peninsula, sand and water work together to create a unique complex of sandbanks, lagoons, sand dunes and coastal meadows. The Flommen nature reserve is situated here, part of the larger Natura 2000 site of the Falsterbo peninsula. This reserve was named after the "Flommar", the old word for the cut-off lagoons which give the area its character. The mosaic of valuable natural environments at Flommen also provide enormous species variation. The coastal meadows are nesting grounds for waders such as the common redshank. Eurasian ovstercatcher and pied avocet. The natterjack toad and European green toad live here. Sand lizards, rare sea holly and insects such as Osmia maritima and large carder bee thrive in the dry, sandy soil. The Falsterbo peninsula is also one of Sweden's most important migration routes and resting places for migratory birds. This is particularly true in autumn, when hundreds of thousands of birds pass Nabben, the south-western tip of the reserve, as they fly south.

In the Middle Ages, Europe's biggest herring market can be found in Skanör-Falsterbo, which was also an important trading area. At Skanör Castle, which was situated in the northern part of the reserve, the Danish bailiff made sure that everyone paid tax for their fishing, and there were fishing huts along the beach. There was a beacon at the far south, at Kolabacken. Fires were lit here to guide ships in the treacherous waters along the tip of the peninsula. Skanör and Falsterbo have become increasingly popular resorts since the late 19th century. The fishing huts of the Middle Ages disappeared long ago and were replaced by a long row of bathing huts along the beach.

DUNES FREE OF JAPANESE ROSE

The expansion of the Japanese rose in the sand dunes along the west coast of Flommen has been a familiar problem for a long time. It was originally planted to keep the sand under control. Over the years, the Japanese rose has increasingly taken over the dune area despite a number of attempts to combat it. The Sand Life project provided the opportunity to stamp out the Japanese rose once and for all.

Dense Japanese rose plants were dug up extensively, roots and all, in dunes, on sandbanks and between bathing huts. The parts of the plant was sorted out from the sand, and clean sand was dugged upp from below. This clean sand was then placed on top after the sorted sand had been returned to the bottom of the excavation pits. These areas can be accessed again, and the plants and animals native to these sandy soils can once again return.

FALSTERBOHALVÖNS HAVSOMRÅDE SE 0430095

Area: 43 327 ha

Managed by: County Administrative Board

Other types of protection: Nature reserve

Habitat types according to The Habitats Directive in project Sand Life: 2110, 2120, 2130, 2140, 2180, 4030, 6230





5.INLAND SANDY AREAS

Undulating hills with blossoming heather. Broad, sandy heaths where sand lizards warm themselves on the bare sand. Pine-clad sand dunes with warm, sunny glades. Nature involving sand can be found in places other than on the coast. Inland Sweden offers sandy soils with very high biological values.

Sandy soils in inland of southern Sweden were formed towards the end of the last ice age. When the huge glaciers of the inland ice melted, lots of material was carried along in the ice rivers that formed. Stone, gravel and – eventually – sand were deposited as the water began to move less quickly. Eskers and sand heaths remain in the landscape. The wind has since redeposited the sand and formed large sand dune fields and areas of loess-like deposits, fine sandy particles like shallow layers of sand.

Inland sandy soils can be found all over the country; along major waterways and next to lakes, or in places where former ice lakes once lay. Brattforsheden in Värmland, Slättö sand in Småland, the slopes of Brösarp in Skåne and the areas around the uplift along the coasts of Norrbotten are a few examples of sandy areas in inland Sweden.

Large parts of inland sandy areas are wooded nowadays, often with sparse pine forest. There are inland sandy areas in Skåne as well where just deciduous forest can be found. Areas that are still without trees are almost always the result of a human presence. These may be areas subjected to extensive grazing, where the feet of the animals create patches of bare sand and keep trails open. Sandpits, motocross trails, military shooting ranges and embankments are other areas where people have helped to stave off overgrowth and allow the sand to emerge. In southern Sweden, primarily in Skåne, sandy areas were used for agricultural purposes until well into the 20th century. The largest expanse of inland sandy areas that still remain open can now be found in Skåne.

DRY SAND HEATHS AND GRASS-COVERED SANDY SOILS

Large parts of the ground in open sand dunes and on sand heaths in inland areas are covered by grasses, plants and heath vegetation. This vegetation is relatively species-poor, and grasses such as grey hair-grass, *Corynephorus canescens* and common bent, *Agrostis capillaris*, grow alongside many annual plants. The land cover is not entirely closed; there are areas of exposed sand. The shapes of the fossil sand dunes can still be seen in some areas. There is no tree layer, or a very sparse tree layer, and even bush vegetation is scant. The proportion of brushwood, primarily heather, *Calluna vulgaris*, and crowberry, *Empetrum nigrum*, affects whether the land is to be classified as dry sand heath or grass-covered sandy soil. Grass-covered sandy soils often have less than 10 per cent brushwood vegetation.

Open pasturelands in inland areas are often a mosaic of different habitat types. Grass-covered inland sandy areas and sand heaths in lime-poor areas are reminiscent of the grey dunes of the coastline, with grey hair-grass and sand sedge, *Carex arenaria* as characteristic species as long as disturbance prevents the vegetation closing up. Dry heaths may have similar vegetation to the sandy soils of the inland areas but be situated on silicate-rich podzol soils. Flowering plants are more common in more calcareous environments inland, and here grass-covered sandy soils resemble the dry meadows on silicate soils habitat type in terms of vegetation. Areas with a high lime content offer conditions for the sandy grasslands habitat type.

There are also great similarities in terms of vegetation between inland open sandy habitats with brushwood vegetation and the brushwood-covered dunes of the coast. In general, there are greater amounts of bare sand in inland sandy grasslands than in inland sandy areas with brushwood vegetation.

The diversity of plants, animals and fungi in inland sandy areas varies, depending on a range of factors such as the lime content in the soil, land use and climate. Grazing paves the way for a great deal of species diversity. Dung beetles are directly dependent on a mix of grazing and areas of exposed sand. Grazing animals also help to keep the grass short, create disturbance and prevent overgrowth. However, there is a risk of extensive grazing reducing the number of flowering plants, which affects the availability of food for many insects.

OPEN SANDY AREAS WILL DISAPPEAR WITHOUT DISTURBANCE

Inland sand dunes and sand heaths are entirely dependent on disturbance to prevent them becoming overgrown and turning into forests. Disturbances in the vegetation cover are considerably more important in inland sandy areas than along the coast, where the wind helps to move the sand Large parts of inland sandy areas are wooded nowadays, while other areas are now natural pasturelands and heather heaths. Most areas in Skåne are now cultivated or pastureland.



INLAND SAND DUNES BECOMING MILITARY TRAINING GROUNDS

The Armed Forces' need for open land for military exercises has preserved species diversity in large areas of inland sandy soil in southern Sweden. The large inland sand heaths was not viewed as profitable as regards agriculture, and the Armed Forces have taken over large areas in Halland and Skåne. Military training grounds are now some of the most species-rich sandy habitats. The Revingehed armoured vehicle training ground is located on the large sand heath in Vombsänkan and has a unique insect fauna. But other training grounds in Skåne, such as Kabusa, Rinkaby and Ravlunda, have large areas of grass-covered sandy soil as well. These three training grounds are located by the sea in south-eastern and eastern Skåne, but their grassy sand dunes and dry meadows are the result of ice river deposits and sand drift rather than part of the dynamic of the coastal dune landscape.

OTHER SANDY AREAS INLAND

The Sand Life project works within Natura 2000 sites and their habitat types. However, there are also important environments outside the Natura 2000 network, and other protected countryside that is home to the structures that are important to plant and animal life in sandy soils.

Gravel pits and sandpits may be important environments that supplement natural sandy areas for species associated with sand. There is plenty of bare sand here, and often a warm, dry microclimate. Many pits are currently home to species in danger of extinction, and it is important to ensure that pits are maintained in a way that benefits the species that live in sandy soils. It is particularly important to plan the restoration of pits so that they can continue to accommodate important environments for species that thrive in sandy soils.

It is also important to work with the sandy areas found along the edges of roads, embankments and developed areas in order to link together sandy soils with high natural values and make it possible for plants and animals to spread between areas.



SOME OF THE PROJECT'S INLAND SANDY AREAS

Sand Life has worked with restoration measures involving grass-covered sandy soils and brushwood heaths in Skåne in particular. Two areas with different characters and conditions are presented here; the extensive sand heath in Vombsänkan and the undulating hilly landscape around Brösarp in eastern Skåne.

VOMBSÄNKAN AND THE REVINGE FIELD

Inland Skåne is home to Vombsänkan, one of southern Sweden's inland sand heaths. The sand and gravel come from the huge ice lake that once covered a large area between Lund, Sjöbo and Eslöv. Nowadays there are two considerably smaller lakes here, Vombsjön and Krankesjön, which are surrounded by large, expansive sand heaths.

THE REVINGE FIELD

The military armoured vehicle training ground of Revingehed is located in the western part of Vombsänkan and covers 4500 hectares. Most of the training ground used to be agricultural land which was sown with grass and became pastureland in the late 1960s. There is a great deal of variation in terms of vegetation types on the training ground nowadays as the soil type, moisture and intensity of the military exercises vary from area to area. The sandy soils have developed into dry meadow environments with high natural values. Besides the open pastureland, there are wet meadows, wetlands, smaller, broad-leaved deciduous forest sections and – not least – Krankesjön, one of the most important lakes for bird life in Skåne.

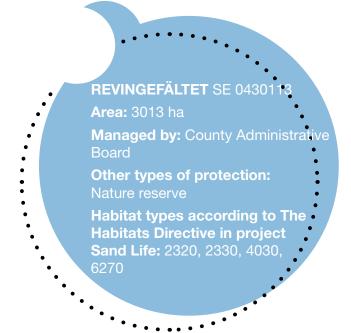
allowed to lie fallow for many years, sometimes up to 18 years. This created a variation of areas in various stages of overgrowth, a patchwork of environments that provided good conditions for species diversity. Besides the rich insect fauna, this field is still home to a fine flora of arable weeds, including lamb succory, *Arnoseris minima*, field madder, *Sherardia arvensis* and smooth cat's ear, *Hypochaeris glabra*, all of which are in danger of extinction.

The Armed Forces' use of Revingehed as a training ground means that the sandy environments have avoided the change that took place in similar environments in southern Sweden in the 20th century. Few other places now have the ground disturbance required to allow species that live in sand to thrive. At Revingehed, cattle grazing keeps the fields open, while tanks and other vehicles create disturbance in the soil cover.

NATURAL ASSETS

Nowadays, the Revinge field is deemed to be one of Sweden's top locations as regards insects in sandy soils. This area is the most species-rich in Sweden when it comes to wild bees, with more than 45 red-listed species. Most of these species are linked with dry habitats, with exposed sand and flowering plants. *Harpalus* beetles and dung beetles are other groups of species that have a strong foothold in the sandy soils of the Revinge field. This area is home to many different kinds of flowers that benefit lots of insects; including dwarf everlast, *Helichrysum arenarium*, sheep's bit scabious, *Jasione montana*, flatweed, Hypochaeris radicata and fragrant scabiosa, *Scabiosa canescens*.

The old farming system, where the soil was allowed to lie fallow between harvests, is the reason for the fantastic diversity of plants and, above all, animals. This system was used until the early 20th century in the Revinge field. The meadows in the Revinge field were lean, so they were





A new patch of open sand at Revingefältet.

THREATS AND MEASURES

One thing most of the endangered species in the Revinge field have in common is the fact that they benefit from exposed sand and are disadvantaged by overgrowth. Conditions for the flora and fauna of Revingehed have slowly but surely worsened over the past two decades. The proportion of bare sand has fallen drastically, primarily due to changes in the intensity of military activity. The transition from tracked vehicles to wheeled vehicles, together with a reduction in the number of exercises, has resulted in disturbance of the ground almost ceasing completely.

Sand Life measures have led to an increase in the proportion of exposed sand and flowering plants. Areas of bare sand have been created throughout the entire area thanks to ploughing, harrowing, excavation and trenching. In pasturelands with agricultural subsidies from EU, patches of bare sand have to be less than $500 \, \text{m}^2$.

The most extensive measures have been implemented in areas where there is currently no agricultural subsidies, which permits large-scale disturbances. Overgrowth has been stopped in the ungrazed areas north-east and north of Krankesjön by removing bushes and brushwood. Annual nature conservation burns have taken place in the ungrazed areas throughout the project in order to reduce the litter layer and remove last year's grass.

Sand Life has set up an outdoor museum along the road between Silvåkra and Harlösa, not far from the birdwatching tower, explaining about local assets and their maintenance.





CULTURAL HISTORY AND SPECIES DIVERSITY IN THE HILLY LANDSCAPE OF EASTERN SKÅNE

The thick, sandy and easily eroded sediments that make up the beautiful, hilly landscape around Brösarp in eastern Skåne are unique in terms of both cultural history and the high natural values of the area. These sandy, dry soils so dependent on custom and tradition are home to a rich variety of species, such as sand pink, *Dianthus arenarius*, various *Tulostoma fungi* and dung-living beetles.

The magnificent hills north of Brösarp are home to a rich and varied flora. There are layers of calcareous sand here, paving the way for xeric sand calcareous grasslands (also called sandy grasslands), a rare type of vegetation with species such as sand pink and St Bernard's lily, *Anthericum liliago*. There used to be agriculture with periods of fallow on these hills, but since the 1920s, the area has been used for grazing. Grasslands on calcareous sand are now found mostly on south-facing sides, where erosion takes place and rabbits flick calcareous sand out of their holes.

The sothern slopes of Brösarp are known most widely for the beautiful display of spring flowers, with lots of cowslips, *Primula veris*. The valleys are home to a number of ancient remains and buildings dating back a long way, including Hallamölla mill dating back to the 15th century, Glimmebodagården north of the northern slopes of Brösarp, and Andrarums Alunbruk, dated 1637. The dry meadows on both the southern and the northern slopes of Brösarp are now a mosaic of dry heath habitat types, with elements of heather heath, grass-covered sandy soils, calcareous grasslands and smaller areas of sandy grassland.

Large areas were planted with pine in the first half of the 20th century, changing the almost entirely treeless land-scape up to that time. Parts of the northern slopes have now been returned to pasture at new nature reserves. Restoration measures have taken place in many parts of the Natura 2000 areas of Verkeåns dalgång and Möllegården, which are adjacent to one another. Here are examples from two different areas.

BOSARP

A smaller area north of Brösarp had prior to the project been cleared of trees and there were plans to convert the area to pastureland. The pine stumps were removed and the area was fenced in as part of the project. There are small fragments of sandy grasslands in adjacent areas, so large patches of exposed sand were made. As there was no agricultural subsidies for the area at that time, large patches of exposed sand covering up to 1 000 square meters could be uncovered. Calcareous sand was unearthed.

At the edge of the forest, a firebreak was also dug so that a nature conservation burn could potentially be carried out in the grasslands. Cattle have grazed the area since 2015.

DRAKAMÖLLAN AND THE NORTHERN SLOPES OF BRÖSARP

Soft hills with heath vegetation and deciduous groves are characteristic of the Drakamöllan nature reserve. There used to be agriculture with long periods of fallow. Patches of arable land on the hills were cultivated for two years and then left fallow for nine years in a pattern that had been used since the Middle Ages.

A combination of measures has been implemented in the area in order to increase the proportion of bare sand and reduce overgrowth and the dominance of the heather vegetation. Nature conservation burns have taken place in various areas in the spring seasons. Smaller areas have been ploughed up, while in other areas the sand has been dug up. Heather, which had grown tall and woody, was harvested prior to ploughing in Drakamöllan. (See chapter 8 for more information about maintenance measures.) There was overgrowth of juniper and birch, primarily on the northern slopes of Brösarp. The clearing of juniper bushes and birch has been combined with the creation of patches of exposed sand. Patches of exposed sand have been created in the hills to the south by means of deep excavation, digging out clean sand. Smaller fenced-in areas have been set up around sand steppe fragments in order to protect St Bernard's lily and other flowering plants from grazing.



6.SANDY GRASSLANDS

Warm and sunny, with not much rain. Add to that calcareous sand, and you have the opportunity to find xeric sand calcareous grasslands, also called sandy grasslands - an unusual type of habitat. Few places in Sweden are able to boast the right climate and geology for sandy grasslands. Eastern Skåne and the island of Öland are home to smaller natural areas that are fragments of the flowery sandy grassland areas that could once be found in these places.

Sandy grasslands one of the rarest types of habitat in Europe, so Swedish sandy grasslands are important from a European perspective as well. Sandy grassland areas have declined drastically over the past 20 years, and large parts of sandy grasslands are now about to disappear. The main threats to sandy grasslands, as for other sandy areas, are overgrowth and changes in land use.

AN ENVIRONMENT WHERE SPECIALISTS DOMINATE

Sandy grasslands are an extreme environment, not only because they are warm and dry in summer. A high pH also means that nutrients such as phosphorus are chemically bonded in the soil. Sandy grassland plants therefore adapted to both limited nutrition and a warm, dry climate. Specialists among plants and fungi benefit here as special characteristics are needed for any plant aiming to live in this harsh environment.

Leaching of lime on the surface causes the pH to fall, which together with nitrogen precipitation radically changes the habitat for these species. Other plants can drive out sandy grassland specialists in this new environment. Species that benefit from more nutrition in turn change the environment by making the soil wetter, for example, which further places sandy grassland species at a disadvantage. Leaching is a natural process, but it has been accelerated by acid precipitation and coniferous forest growth over the past few decades.

Constant agitation and soil disturbance are the secret behind the existence of sandy grasslands. Viewed over a wider area, there must be a mosaic of different phases for the unique plants of sandy grasslands to survive.

THE THREE PHASES OF SANDY GRASSLANDS

In the first phase, after disturbance, most of the soil is bare sand (> 60%). Annual plants start to establish themselves, and as yet there is no litter or humus. After a time, the sandy grasslands make the transition to the optimum phase. The vegetation is now species-rich, with many flowering plants, both annuals and perennials. However, there is still a lot of bare sand between the plants, up to about half of the area. Finally, the area makes the transition into the overgrowth phase. The vegetation cover is now closed, and a layer of litter starts to build up. Leaching, particularly in the Skåne areas, causes the pH to fall.

To be stable, about half of the sandy grassland area should be in the optimum phase, a tenth in the initial phase and the rest (40%) should be in the overgrowth phase. If we review the entire area, 20 to 30% of the area should be open sand.

How long it takes for an area to go through the various phases is dependent on the lime content in the sand, which can buffer against leaching and the climate. Nitrogen precipitation has helped to increase the pace of overgrowth.

CHARACTERISTICS OF SANDY GRASSLANDS

The grass Koeleria glauca is one species characteristic of sandy grasslands. If dense tufts of Koeleria glaucaens with their blueishgreen, narrow blades can be seen, you can be sure there is lime in the soil. The fragrant white sand pink (Dianthus arenarius ssp. arenarius) is also common in eastern Skåne. Fungi that are able to withstand desiccation, primarily gasteroid fungi, are another group of organisms typical of sandy grasslands (see page 61 for more information on gasteroid fungi)



At Vitemölla strandbackar, St Bernad's lily was flowering extensively after precribed burning.

AN ENVIRONMENT CREATED BY MANKIND

So how can sandy grasslands go on existing in an area if they are constantly developing towards overgrowth and making the transition to other habitat types? New sand can be added by means of landslides and erosion on scree slopes, but in Sweden mankind is primarily responsible for creation of the relatively large areas of sandy grassland. Feet, hooves and wheels have moved over this dry land and created bare sand. When walking through the sand has proven to be heavy going, people have taken a step to the side and started to make new trails. Low-intensity farming, where the sandy soil was ploughed up and cultivated at 10 to 20-year intervals, has been important to development in the sandy grassland areas of eastern Skåne. Grazing animals have made sure that vegetation was kept short and patches of exposed sand were kept open while the land was allowed to lie fallow. On the island of Öland, grazing is the primary reason why this land has remained open.

In Sweden's report to the EU Commission in 2013, it is estimated that sandy grasslands on Öland cover 30 hectares, and 80 hectares in Skåne. Large areas of sandy grassland can now be found in protected areas (67% on Öland and 88% in Skåne). Besides the management taking place in protected areas, the Swedish Environmental Protection Agency is working within Action programmes for endangered species to preserve sandy grasslands and their characteristic species *Koeleria glauca*, sand pink, *Dianthus arenarius*, and sand milkvetch, *Astragalus arenarius*. The Sand Life project has worked on improving the status of

areas classified as sandy grasslands and implemented restoration measures in nearby areas that hopefully will be able to increase the extent of sandy grasslands.

SANDY GRASSLANDS AND CLIMATE CHANGE

It is easy to believe that sandy grasslands would benefit from the climate change that is expected to bring a warmer climate. However, this warmth will also include more cloudbursts in summer and milder winters, which will place sandy grasslands at a disadvantage and increase the rate of overgrowth of plants and

WHAT WILL HAPPEN WHEN SANDY GRASS-LANDS BECOME OVERGROWN?

When the vegetation cover closes over and/or the pH of the soil falls, sandy grasslands will turn into other habitat types such as grey dunes or grass-covered sandy soil. In areas with finer soil particles, sandy grasslands me instead turn into calcareous grasslands, dry heaths or species-rich silicate grasslands. As with other open areas, bushes and trees will then migrate in unless these areas are kept open.

TWO OF THE PROJECT'S SANDY GRASSLANDS AREAS

HAVÄNG AND THE BEACH SLOPES OF VITEMÖLLA

Haväng nature reserve and the beach slopes of Vitemölla comprise two Natura 2000 sites; Klammersbäck and parts of Verkeåns dalgång. The reserve extends along Hanöbukten, from Vitemölla in the south to the mouth of the Verkeån river at Haväng in the north. Inland, we see the hills created with immense sand deposits when the inland ice melted 13,000 years ago. In the middle of the area, Klammersbäck has eroded a deep ravine through the sand, which is now covered in deciduous trees. Pine forest grows in long, narrow areas on both sides of the brook, while most of the reserve is made up of open sand heaths.

The unique thing about Vitemölla is the large area of sandy grassland intermixed with the dry sand heaths. This is one of the most important locations for sandy grasslands in Sweden, with species such as sand pink, sand milkvetch and St Bernard's lily, *Anthericum liliago*. Almost a third of Sweden's designated sandy grassland area can be found at this nature reserve.

The area's high natural values are linked with human use of the land. The original oak forest that used to stand in the northern part of the reserve was chopped down in the 17th and 18th centuries and the lean, open sandy soils were then grazed by animals from nearby villages. Small fields sown with buckwheat and rye could be used for a couple of years before then being left fallow. Many people also travelled along the coast, both on foot and with carts, which created sandy trails in the landscape. 19th century maps show that the landscape was entirely without trees. Pine trees began to be planted north of Klammersbäck in the early 19th century due to the risk of sand drift. These trees have been felled, and the two large pine groves that can now be found at the brow of the hill date back to the 1920s and 1930s.

Although there are plenty of sand pink and St Bernard's lily on the hills, the quality of the sandy grassland is slowly but surely being compromised. There is not enough disturbance of the soil to maintain the dynamic, with the constant exposure of calcareous sand needed to promote sandy grassland vegetation and fungus variety. Small pines grow on the open land, false oat-grass has taken over some areas completely, and a base layer of moss is continuing to develop.

MEASURES

The project was planning to extend the sandy grassland area. However, the new maintenance plan that came into

being when the project began did not permit felling of the southern pine grove in order to create more sandy grassland area. This is why the restoration measures in the reserve have focused on improving the status of the dry, open land and thinning out the pine forest on the slope in the northern section, and also creating larger glades in this area. Nature conservation burns have been used to remove the full layer of litter.

In the northern part, a number of large glades have been created by removing pines with stumps and digging out the light, nutrient-poor sand. Along the shoreline, the pine grove has also been thinned out by removing straight pines and clearing space for the old, knotty pines.

The entire area between Havang and Vitemölla is loved by local residents and tourists alike. This is why there has been a lot of interest and concern with regard to measures in this area. The section on information explains how we worked with maintenance advice, working days and field tours so that we could maintain lines of communication with the general public as effectively and as openly as possible. We have also had the opportunity to view a survey done by Kristianstad University, which studied how the general public has been monitoring the project in Vitemölla and what they thought about our information initiative. More information on this can be found in chapter 9.





GÅRDBY SANDHED,ÖLAND

MEDIAEVAL PASTURELAND AT THE EDGE OF BARE LIMESTONE SOIL

Gårdby sandhed has been part of the common pastureland for the village of Övre Ålebäck since the Middle Ages. The area was grazed so thoroughly up until the 1950s that the sand whirled around on windy days. However, the land has become overgrown over the last 20 years, even though it is still grazed. An old, sandy embankment and an older sandpit area are situated outside the pastureland.

This is now one of the most important sandy grassland areas on the island of Öland. However, much of the sandy grassland at Gårdby is in the overgrown sandy grassland phase. The sand is no longer agitated, and there are few areas of bare sand. The vegetation cover is closed. Much of the open, grazed area has turned into grey hair-grass heath, which in turn has given way to heather heath in places.

That said, Gårdby sandhed is still home to a wide variety of rare and endangered species. There is a rich fungus flora here, with species linked with sandy grasslands. There is plenty of insect life, with many redlisted *Hymenoptera* and dung-living beetles.

MEASURES

The soil was analysed before the restoration work began. Samples were taken at sites evenly distributed over the area to measure pH, lime content and available phosphorus and nitrogen down to a depth of 80 cm. Essentially, the test results from Gårdby sandhed show that there is calcareous sand throughout most of the project area.

Juniper bushes and younger pine and birch were cleared manually in order to remove overgrowth and increase insolation. After that, more than 130 patches of exposed sand were dug, varying in size between 15 m² and 300 m². The turf and upper layer of soil were transported away, and the light sand beneath was turned up. Around 30 of the patches of exposed sand were dug deeply in order to bring up the calcareous sand.





GASTEROID FUNGI - WITH SPORES INSIDE THEIR BODIES

Gasteroid fungi include our "common" puffballs. These round balls – white initially, gradually turning brown and containing spores – can be found in various places in the countryside. Gasteroid fungi also include *Geastrales*, *Tulostoma* and *Disciseda* – fungi that thrive in open, calcareous sand with sparse plant cover.

Sandy pasturelands, old pits and paths, roads and embankments are all examples of places where gasteroid fungi may be found. Sandy grasslands, an unusual habitat found only in a few locations in eastern Skåne and on the island of Öland, is the most valuable and species-Rich environment for gasteroid fungi.

SUPREME SURVIVORS IN HOT, DRY CONDITIONS

Sandy soil is dry and poor in nutrients. It also becomes very hot. One thing gasteroid fungi all have in common is the fact that they are experts when it comes to surviving these harsh conditions. The round fruitbodies start to develop down in the ground during the driest and hottest time of the year, emerging only in the rainy weather of late summer and autumn. The tiny balls then contain millions of spores that are ready to burst out. A cloud of spores is dispersed if anyone treads on them. Sometimes a heavy downpour or a strong gust of wind is enough to release the spores. The balls then rapidly regain their shape so that the procedure can be repeated. The balls break down slowly and may continue to survive until well into the following season. This gives the fungus plenty of time to distribute its spores.

THREAT TO GASTEROID FUNGI

Many of the gasteroid fungi varieties found in sandy soils are endangered as hot, open sandy environments are becoming less and less common. Species that thrive in calcareous sand are particularly vulnerable as they are dependent on movement of the sand so that the calcareous sand is constantly brought up to the surface.

HELP THE GASTEROID FUNGI

Grazing is by far the most important initiative if we are to save our gasteroid fungi. Ideally, we need to use horses or a combination of horses and cattle – large animals that graze evenly. Their hooves turn over the sand as well. Custom measures are often needed to encourage gasteroid fungi to grow. This may involve uprooting bushes and small trees, small-scale nature conservation burns and turnover of sand. People and animals walking by, off road driving and other wear and tear causing areas of open sand, are also of benefit to the residents of sandy soils. Leaving this land unused and allowing it to become overgrown poses the biggest threat to gasteroid fungi.



Six gasteroid fungi of the Tulostoma genus can be found in Sweden. Tulostoma fimbriatum is endangered and is only known to grow in a small number of locations in calcareous sand environments on the islands of Öland and Gotland and in Skåne, Halland and Bohuslän. The fruitbody is just 7–17 mm wide and 6–12 mm high.



There are two rare Disciseda varieties in Sweden that are almost identical. The only way of telling Disciseda bovista and Disciseda candida apart is by studying their spores under a microscope. Both can be found in calcareous sand environments. Disciseda fungi are made up of a grey/grey-brown fruitbody 10–25 mm wide that is flattened and round. Above ground, the fruitbody lies loosely on the ground with an opening (ostiole) facing upwards.



There are some twenty Geastrum varieties in Sweden. Most of them grow in open, calcareous environments, but some species also grow in calcareous forests. Geastrum schmidelii lives in calcareous open environments, ideally on sandy soil. It is known to grow in around 70 locations around Sweden, primarily in eastern Skåne and on the islands of Öland and Gotland. The fruitbody of Geastrum schmidelii, like in all Geastrum varieties, is initially enclosed by a thick shell. Above ground, this shell cracks open to create a star-like pattern with 6–9 segments, 10–30 mm in size.

WE NEED HELP TO SAVE SPECIES IN SANDY HABITATS

WE CAN ALL PLAY A PART

Everything that helps to create bare sand is important, no matter how great or small the action. The County Administrative Board is implementing major actions in protected areas, but whatever you can do in your garden or on your land is also valuable.

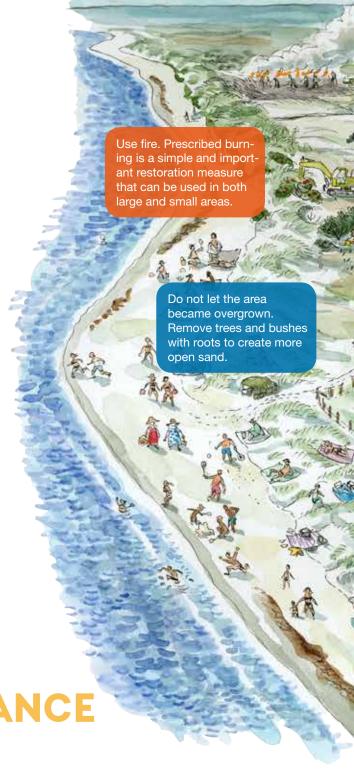
ALL SANDY HABITATS ARE POTENTIAL ENVIRONMENTS

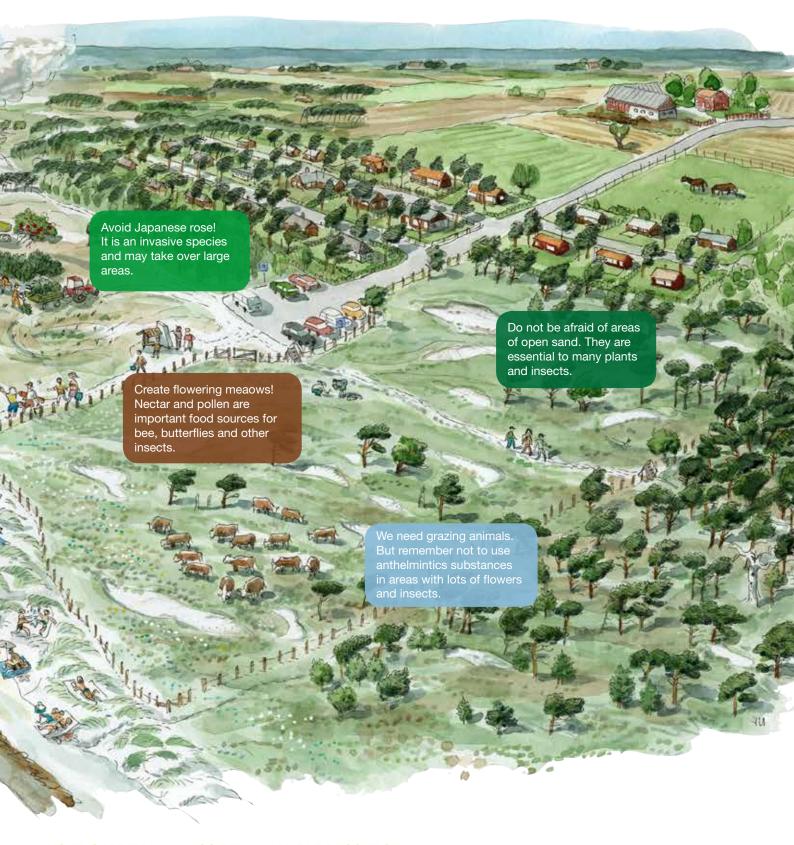
It has become clear over the last few years that sandpits and gravel pits offer major potential as important habitats for species that thrive in sandy soils. Planning the restoration of such pits is very important. The edges of roads, old gravel tracks and motocross tracks are other important refuges for species that thrive in sand. This land also needs to be used and maintained if we are to maintain bare sand in these environments.

TIPS FOR MAINTENANCE OF SANDY SOIL

SANDY SOIL AREAS:

- Let the flowers grow! Rotate grazing and mowing during the season so that there are always flowers in meadows and pastures. Mow pastures that are not being cultivated or grazed (verges, arable outcrops and other edges) late in the season when plants have stopped flowering.
- Grazing livestock prevents the land becoming overgrown. Grazing a variety of animals on the same land is a good idea. Bear in mind that anthelmintics may kill tiny creatures that live in animal droppings.
- Use fire to help you! Burning off last year's grass and old heather will give young plants a chance to grow.
- If you have a household pit, make sure it is kept open. Remove the little sand occasionally to ensure that there is always bare sand there.
- If you use chemical pesticides, choose ones that will not harm pollinating insects. Information on toxicity to bees can normally be found in the instructions for use of the preparation.
- Prevent overgrowth, but nurture willows and sallows as well as flowering trees and bushes when clearing your land.





YOUR GARDEN MAY ALSO BE A VALUABLE RESOURCE:

- Plant flowering plants, ideally ones that are rich in pollen and nectar. Avoid Japanese rose it spreads rapidly in the wild!
- Create a "bee bed". Pile up sand or dig out a couple of cubic metres of soil and replace it with sand that is all you have to do.





in the Sand Life project, or work done as part of the on-

going maintenance of protected areas. We also need to

work on the landscape in general, in a variety of ways.

Many people can make contributions of all sizes if we

increase awareness, focus attention and change work

procedures.

of sand may be of major significance to the survival of

In nature, open sand can be created by wind, running

certain species, but most species require more than that.

water, waves, landslides, fire or animals that root and dig.

However, humans have made by far the biggest contribu-

tion to open sandy areas in the landscape for several thou-

sand years. This history is described in greater detail in the

chapter on history of sandy soils.

SUCCESSION OF SANDY AREAS

Overgrowth of sandy areas normally increases the total number of plants and animals, but species that thrive exclusively in sandy soils disappear as the vegetation becomes ever more en-closed and verdant. Open sandy soil specialists include by far the greatest number of red-listed species. A large number of other species worthy of protection live in sandy areas with a high proportion of exposed sand. Many of the species that turn up when the land becomes over-grown are common species, known as generalists. The biological value of a sandy area is therefore determined not by the total number of species, but by the quality of the species there.

The following schematic model is used to show what happens when a sandy area becomes overgrown. This is used primarily to describe the various phases of calcareous sandy grass-lands, but it is applicable to most other sandy areas as well.

1. Initial phase (with more than 50% bare sand).

The proportion of open sand is large and the sand is so mobile that only very scant vegetation has developed. Plant and animal life is relatively species-poor, but there are a number of specialised species here that are entirely or partly de-pendent on a high proportion of open sand.

2. Optimum phase (30-50% bare sand).

There is a mosaic of various habitat types here; grassy heaths, brushwood heaths, humid dune slacks and – on calcareous land – sandy grasslands or steppe-like terrain. There are plenty of patches of exposed sand. There is often plenty of variation in plant and animal life, with a number of exclusive sandy soil species. This stage usually has by far the greatest biological value, with many red-listed species. Continuous disturbance of the soil is needed in order to retain the optimum phase.

3. Overgrowth phase (more or less entire vegetation cover).

The areas of exposed sand disappear as closed vegetation covers the sand. Grasses and mosses take over and the proportion of flowering plants declines more and more. Bushes and trees begin to migrate to the area in the late part of the phase. Species diversity has declined and there are few exclusive sandy soil species, while competitive species that disperse easily dominate. Species that require warmth and dry land are gradually replaced by species that thrive in chillier, moist, humus-rich environments. When this phase dominates, major restoration initiatives are needed in order to recreate the open sandy areas' mosaic and species diversity in their entirety.

The two first phases dominate in sandy areas with optimum conditions for species diversity and red-listed species, often in combination with one another. The overgrowth faces taken over, restoration measures are necessary to be able to maintain the high natural values. Prior to the resto-ration work done by the Sand Life project, the starting point in a number of areas was essentially a fourth phase, that is to say, a situation in which planting or natural overgrowth has entirely transformed open sandy areas into enclosed bush areas or forests.

RESTORATION AND MAINTENANCE – WHAT'S THE DIFFERENCE?

In a strict sense, restoration involves restoring the natural area to an earlier, more advantageous state for the natural values that you want to promote. These are often major, costly measures. Maintenance refers to activities with a view to maintaining already good conditions in a natural area. As regards sandy areas, restoration initiatives essentially always have a direct effect. The seed bank in the soil can help to result in flowering plants that same year, and insects still living in the local area or even further away find their way to the restored area. If we compare the same way measures in sandy areas with the restoration of old tree environments, the "delivery time" for high natural values can differ by more than a century.



THINGS TO BEAR IN MIND BEFORE GETTING STARTED

Restoring an overgrown sandy area can be a very creative and rewarding task. Rewarding, be-cause species frequently return quickly, and creative because the restoration work frequently involves problem-solving and a creative process. Having the opportunity to go back in time and be able to recreate environments that may have existed more than a century ago is very good reason to feel humble.

Regardless of the initial situation, a number of factors and issues have to be decided upon. This is true when planning either major restoration initiatives or regular maintenance. The questions in the list below, in no particular order, are important to bear in mind before you start work.

- What is the aim of the restoration work?
- Can knowing about the history of the use of the land in the area narrow down the target scenario?
- When was the area last open sandy land?
- What do we know about the previous natural assets/ species in the area?
- Do we need to know more about existing natural assets/ species in the area?
- What are the conditions for distribution of species from the local area?
- Is the aim to achieve a sand dynamic with small-scale or large-scale disturbance, or both?
- Are there any ancient remains or other valuable historical remains that need to be taken into account?
- Are there any species that need to be considered?
- At what time of year would it be most appropriate to implement these measures?

- Are any permits required?
- Do any outdoor recreation activities take place in the area that need to be considered?
- What residents/property owners/relevant members of the general public/authorities, etc. need to be kept informed, and who do we need to maintain communication with?
- What is the situation as regards transport accessibility to and from the area?
- In what order should measures be implemented?
- Are there any benefits to be had due to coordination?
 In other words, can several different measures be coordinated while machinery is on site?
- How is the area to be maintained in the long term, and are any arrangements needed for this; such as transport routes and access to drinking water for grazing animals?
- Has anything already been done on similar projects in Sweden or other countries that we can learn from?
- How large is the budget, and what elements do we need to prioritise based on this? Planning in stages is an advantage if annual but limited funding is available.

The most important, most comprehensive methods used in the restoration of sandy soil areas as part of the Sand Life project are described below. A lot of large-scale initiatives have been implemented as part of the project, but the same principles and methods as those described here can of course be implemented for considerably smaller areas as well, and they can be used for restoration and regular maintenance work as well.

CONTROLLING JAPANESE ROSE

Japanese rose, Rosa rugosa, comes originally from East Asia. It was introduced to Europe in the late 18th century, and since then it has been used as a garden plant and subsequently began to grow wild. Japanese rose has been planted in a number of sandy coastal areas both in Sweden and elsewhere in Europe with a view to binding the sand. It causes major problems nowa-days as it grows at a constant rate into large and full-cover stands. It also disperses successfully with the help of birds and thanks to its hips, which are capable of floating far and wide before being washed up on a beach. The bushes can withstand salt and have deep root systems that reach all the way down to the groundwater. This is why they are capable of growing a long way out in dune areas that a dry, windblown and poor in nutrients.

Methods for eradicating Japanese rose can be applied to species that grow in similar ways and have invasive tendencies, such as Japanese knotweed, giant knotweed, balsam poplar, blackberry and sea buckthorn.

CLEARING AND GRAZING

A lot of time and a great deal of persistence are needed to eradicate Japanese rose by clearing it. It may take many years of repeated clearing or cutting to get rid of it entirely. If you nevertheless wish to try, blunt blades that fray the stalks when cutting can accelerate its depletion. Further seed spread can be prevented if you take care to make sure that the bushes are unable to form hips between clearing operations. It is important to collect up, remove or incinerate all cleared material. Goats can develop a taste for Japanese rose, as can cattle, and they then trample the bushes while they graze. However, grazing is not possible in many sand dune areas and there is no guarantee that the animals will graze on the Japanese rose.



At Flommen nature reserve, attempts were made using a built-in rotating drum to sift away the Japanese rose and its roots from the sand directly in the bucket. The method worked well except the bearings became full of sand and needed to be replaced at regular intervals, which meant that it stood still so much that we had to abandon the method.

Annual clearing operations are generally far too costly and ineffective. This is why other, more final methods are frequently needed.



The Flommen nature reserve, in the Falsterbo peninsula marine area, bathing huts in a row along the beach. Since it is not possible to dig near the huts, the rugosa rose is cut instead using a four-wheeler. The cutting cannot entirely remove the rugosa rose but it prevents it spreading over greater areas.

DIGGING UP THE ROOTS

The Sand Life project has implemented, on a large scale, the most effective way of getting rid of Japanese rose in areas where it grows in sand. This involves digging up the bushes with their entire root systems. During digging, it is also possible to pull up clean, new sand to place on the top of the excavated area. When working on a really large scale, the most cost-effective method usually involves using an excavator, a wheel loader and a screener simultaneously. When digging in dune areas, it is best in most cases to use tracked excavators to provide the best accessibility. Major initiatives require large machines with a long reach, giving the best efficiency. The excavator digs up bushes and roots, which are then placed in a pile which the wheel loader then transports to the screener. Roots and bushes are sorted into one pile there, and the sand trans-ported with them is sorted into another. When the bushes have been dug out, a few more bucketloads are taken out of the pit in order to bring up clean sand. The sand, which is rich in nutrients from earth and various plant parts, is taken back to the pit and placed at the bottom of it before being covered with the clean sand. Finally, all Japanese rose material is transported to landfill or incinerated on site.



Removing Japanese rose at Haversdal nature reserve in Halland using a wheel loader, excavator and sorting machine. Here, the deepest roots were several metres deep in the sand since the bushes established themselves in tandem with being covered by drifting sand.

A preceding burn is a very good way of getting rid of organic material before starting to dig. This saves on expensive machine time and helps to create higher natural values if the Japanese rose bushes can be burned together with a larger sand dune area.

If you have fewer and smaller bushes to dig out, it may be sufficient to use just one excavator with a screening bucket or a combination of an excavator and a wheel loader with a screening bucket. The screening bucket needs to be shaken in order to separate sand from bushes and roots, and this may place a strain on both operator and excavator, but doing this with the wheel loader is gentler. When machines are on site, coordinating the work with other excavating operations that may need to take place on site is a cost-effective approach; digging firebreaks, making patches of sand or digging wind holes in the fronts of dunes, for instance.

No matter how thorough you are, bits of Japanese rose root may remain in the sand after your excavations. This is why it is necessary to monitor the area for at least one year after the excavation operation in order to remove any seedlings that may subsequently grow. If a small number of new plants grows, these can be pulled up by hand; otherwise it may be necessary to return with the machinery.

FELLING AND CLEARING OF TREES AND BUSHES

Both the nutrient levels and moisture in the soil increase as grasses, pine seedlings and brushwood grow in an open sandy area. This acts as a kind of self-reinforcing system, where accumulated nutrients gradually cause the rate of overgrowth to accelerate. Pine, birch, rowan and aspen frequently dominate when sandy areas overgrow naturally. Deciduous trees are responsible for overgrowth in the slightly damper soils. There has been a great deal of overgrowth in many of the sandy areas restored as part of the Sand Life project. Some of the areas restored became naturally overgrown with trees and bushes, others have been covered by ordinary pine seedlings or seedlings of non-indigenous species such as Austrian pine, mountain pine or bal-sam poplar which have grown into dense, full-cover bush and forest areas.

In Hagestad, Skåne large glades were created in the wooded dune. The pine trees were first felled. Then the stumps were pulled up and new sand dug out using reversal digging.

REMOVE AS MUCH AS POSSIBLE

If roots, litter and humus are left in place after felling and clearing, this will result in fertilisation which will trigger more overgrowth straight away. Lots of birch seeds can grow in the litter, birch stumps produce new shoots quickly and aspen root systems can send up thousands of root shoots. For a truly successful restoration operation with long-term effects, it is therefore important to remove as much organic material as possible and bring clean, new sand up to the surface. Ancient remains, in this case settlement remains, were found in two areas handled by project Sand Life. It was possible to fell the mountain pines here, but not allowed to pull up stumps or dig to produce open sand. Removing the full-cover mountain pines was nevertheless a better alternative from a nature conservation standpoint than leaving then where they were. With subsequent clearing of birch and pine seedlings, an area containing ancient remains in the Friseboda nature reserve has now been developed to form a fine sand heath with sparse pines.

One effective way of getting rid of trees and bushes and their roots can be to pull them up using an excavator or forestry machine. Grapples of various kinds are used to pull them up. It is possible to use a grabber bucket (on excavator) or a forest grapple mounted with a tiltrotator, which is a rotating device that allows the trunks to be accessed and grabbed from various angles. Trees with a chest height diameter of up to 35 cm normally be pulled up. In some cases, it is more appropriate to fell the trees first and then pull/dig up the stumps in a second procedure. First-stage felling can also be carried out manually, and this may sometimes be a simpler, more cost-effective method. The dimensions of the trees, access to chipping machines of various types, the size of the area and the state of the market as regards the ability to sell different chip variants to heating plants are



Pulling up of mountain pine by the roots at Hökafältet in Halland.



Splintering of mountain pine at Hökafältet in Halland.

crucial to the alternative or combination of methods that should be selected.

PLANNING WELL AND BEING FLEXIBLE

A number of different methods and machines are available to choose from when planning your work. Here, it is necessary to work on the basis of what different conditions and limitations are in place. Accessibility, the scope of the measures and the need for consideration are just some of them. It is also important to work out at an early stage how you will be getting rid of the remains of the cleared trees. Small volumes can be burnt in situ, while larger volumes need to be collected together, placed in a heap and chipped. Chipping is often carried out on site, and in this case it is necessary to know in advance how the buyers want the material to be laid out and where before executing the chipping operation. At the same time, it is necessary to choose storage/work areas with both natural and cultural assets and the general public in mind. It is also necessary to agree with the buyers at an early stage on how chipping is to take place. Sometimes it is possible to chip the remains of trees with their stumps in place, and at other times you have to chip these separately. It is sometimes possible to chip the trees directly after they have been felled ("new wood chipping"), while at other times the heaps need to be left for several months so that they can dry out and the sand can be removed from them.

When procuring major initiatives, it is important to think through and clearly formulate your requirements in terms of implementation, consideration and results. Although it is then largely up to the contractor to choose machinery and procedures for getting the job done, it is nevertheless necessary to maintain close contact with them as work progresses as unforeseen questions or alternative solutions that you may not have considered may arise.



Mia Severinsson is one of the talented operators who helped the Sand Life project execute all measures.



In Brösarp's northern slopes in the Verkeån Valley Natura 2000 area, smaller machines were used to clear away juniper and birch.

In other words, thinking along creative lines and focusing on the solution is important; as is the case for all types of restoration project, in fact.

CLEARING UP AND CREATING OPEN SAND

After felling trees and removing the remains, you will be left with a task that may be a little like clearing up after a party. Twigs, branches, pieces of root, cones, and deciduous and coniferous litter are left behind, along with an upper layer of sand that is often leached and rich in humus. If you are aiming to restore open sandy areas to their natural dynamic, your work is not complete yet. Now you need to remove as much organic material as possible. One rule of thumb for creating optimum conditions is that at least one-third of the area in a fully open sandy area should comprise bare sand. Work has often been done using an excavator with a grading bucket as part of the Sand Life project. The organic material is gathered together and either removed from the site or folded down into the sand together with the uppermost layer of sand by means of inversion excavation. This involves pulling clean, new sand up to the surface, allowing it to swap places with the organically saturated sand, which ends up at the bottom according to the same principle as when digging up Japanese rose. If it is not possible to work over the entire area, it is necessary to give priority to digging up clean sand in south-facing, warm locations that are protected from the wind. It is also possible to dig in exposed areas where the wind can help to keep the sand dynamic moving. What you have to remember is to make the open sandy so areas large that overgrowth is slow. Here, conditions in the location in guestion must be the deciding factor. Local ground vegetation and remaining trees that cast shadows, exposure to the sun and wind, the nature of the sand, hydrology and the local climate are all factors that determine how quickly overgrowth can take place. That said, one rule of thumb is that excavated open sandy areas need to be at least 100 square metres in area, but ideally they should be considerably larger.



By burning in a headwind, it is possible to burn further into the organic debris and achieve a slower combustion process. The beach slopes of Vitemölla in the Verkeån Valley Natura 2000 area in Skåne.

When sandy grasslands and moorlands become overgrown with grass, moss and brushwood, the plant cover becomes enclosed, dead plant material accumulates, soil nutrient levels increase and the soil becomes cooler and damper. In this situation, prescribed burning is one of the fastest, most effective ways of clearing the land for sand, flowers and insects to return. If excavation work is planned in order to create open sand or remove Japanese rose bushes, an initial prescribed burn can help by burning lots of organic material rather than having to dispose of it. This gives a better result and saves on expensive machine time as well.

Burning can be used as a restoration measure, and also as a regular maintenance measure. Regular burning of grasslands and moorlands thins out the soil, adversely affects broadleaved grasses and increases floral diversity. Therefore, burning as a maintenance measure is an important complement to grazing and mowing or can be used to replace it.

GOOD PLANNING FOR GOOD RESULTS

The best time for burning is in March and April, when the sun has dried up the soil and the litter and grass have not yet put forth green shoots. Insects are not yet active at this time, either. It may also be possible to burn in the late summer or early autumn, if the grass is dry. One possible advantage of this is that it gives you more time until the next growth season, and the wind and frost can help to loosen the sand.

A number of factors have a part to play in a successful burn. If you want to have a major impact on vegetation and litter, it has to be sufficiently dry. Weather factors such as ambient humidity and wind are important so that you can control the burn safely. It is also necessary to check what consideration has to be shown, e.g. whether there are any areas containing species that may be adversely affected by a fire. Your preparations will also include maintaining good procedures when contacting the local emergency services and any other affected parties. If the area to be burned is near to a public road, you may need to apply for a permit from the County Administrative Board. It may also be a good idea to maintain contact with traffic announcement teams in such locations.



In the Drakamöllan nature reserve in the Verkeån Valley Natura 2000 area in Skåne, the heather is burned every year. A special machine has been developed by the tenant farmer Niels Lund so as to be able to burn areas with patchy heather.





Excavated firebreaks have double functions. They prevent the fire from spreading, while creating areas of bare sand. Bosarp in the Verkeån Valley Natura 2000 area in Skåne.

MAKING THINGS SAFE WITH FIREBREAKS **AND WATER**

To be able to execute a safe burn, you need to review what firebreaks and other fire restrictions are already available on site. This may include paths, roads, ditches or waterways, for example. New firebreaks can be created by cutting or digging an area at least one metre wide. Firebreaks retain their moisture more effectively if they are cut in the autumn, prior to the burning season. Coniferous bushes within a few metres on either side of the firebreak need to be removed (or watered) in order to prevent the risk of the fire "jumping" the firebreak. Digging firebreaks may have a number of positive effects as this also creates open sand and new paths. When burning smaller areas, it is possible to water boundary lines for the fire instead of using firebreaks. This is done using watering cans, or a pump and hose, and in this case you water the area directly prior to lighting the fire. No matter how the burn is being executed, you must always have water on hand and you must make sure a lot of water is available in plenty of time beforehand. You will need to transport water to the site if there are no brooks, dams or areas of open water that are sufficiently deep. If you return to an area to execute burns at regular intervals, it may be worthwhile digging a waterhole if possible.

DEEP BURNING, AND BURNING WITH CONTROL

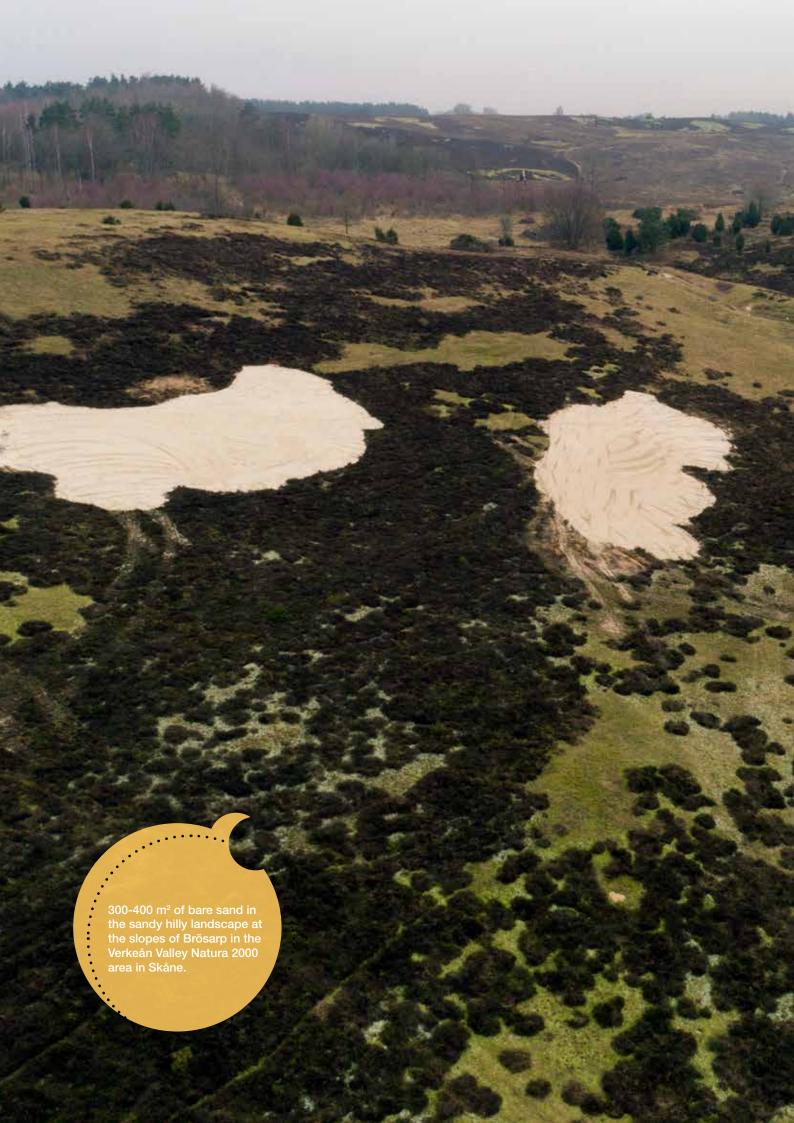
When everything is prepared and the weather is on your side, it is time to light your fire. If you have had sunshine for a couple of days beforehand, drying out the soil properly, and light winds of less than 5 metres per second, this is ideal. If you want to avoid the smoke affecting nearby buildings or roads, you may need to avoid certain wind directions.

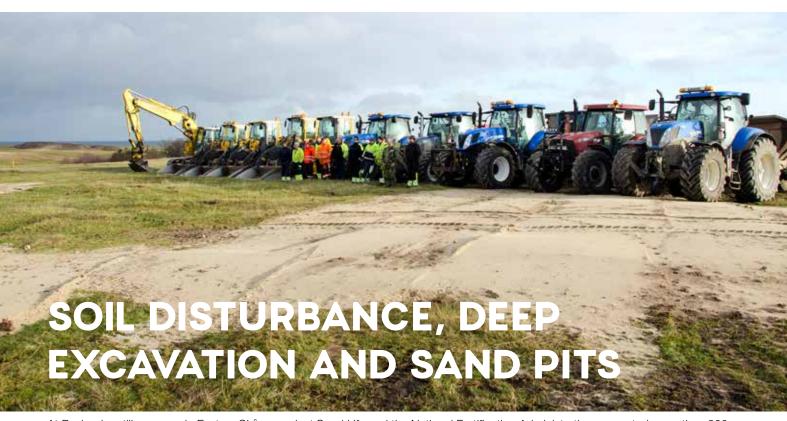
You must not be in too much of a hurry to light your fire. Waiting until the cool of the morning and the moisture have gone and the litter and vegetation are really dry may make a big impact on the results. You light your fire into the wind, working from the location where the risk of spread and hence the need for full control is greatest. From the edge to the firebreak where you light the fire, the fire is allowed to creep into the wind and into the unburned area until it has left a burnt zone a few metres wide behind it. After that, you can gradually go on lighting fires along the firebreaks and in towards the unburnt area. Burning into the wind is always recommended. The fire then generally gets deeper down into the litter than when burning with the wind, which is often what you are aiming to achieve. Burning into the wind and allowing the fire to determine the pace also gives you more control. This also gives animals in the ground vegetation the op-portunity to run away when the fire approaches slowly. Another alternative is to gradually burn with the wind, particularly if you are going to burn large areas.

When burning is complete, you need to keep an eye on the area and damp down until everything has stopped smouldering. You should be prepared for a long and entertaining working day when carrying out prescribed burning. Plenty of drinks and snacks are recommended.



By thoroughly watering around trees and bushes, junipers and other trees can be saved from the fire. Skedeås on Öland.





At Ravlunda artillery range in Eastern Skåne, project Sand Life and the National Fortification Administration excavated more than 300 patches of bare sand of 250-400 m². The majority of patches of sand were created by excavation and the excavated masses were used as shooting embankments in the training ground. But reversal digging and ploughing have also been used at the field to create bare sand.

In most places, nature itself is unable to achieve the disturbance it needs to maintain good access to open sand. In this case, you need to resort to soil disturbance as a regular maintenance measure. There are many different ways of doing this. You have to adapt your actions according to the needs and specific conditions in each area. The degree of overgrowth, the thickness of the litter layer, the lime content of the sand and the proximity of groundwater are some of the factors that influence how various kinds of soil disturbance should be planned and implemented. The methods described so far in this chapter (Japanese rose excavation, clearing, felling and burning) all indirectly help to create open sand in various ways, even though their main purpose is to remove overgrowth. Creating clean, new areas of sand is a second step in these cases when the overgrowth has been removed. After digging up Japanese rose, clean sand is lifted to the surface and placed on top. After pulling up and felling mountain pines, sandy areas can be created by means of inversion excavation when litter is removed. After a successful burn to remove grass, moss and litter, patches of sand with sparse vegetation may result.

A basic rule of thumb as regards optimum conditions for sandy natural assets is for at least one-third of the area to be made up of open sand and areas with sparse and low-growing vegetation. In most sandy areas, a considerably higher proportion than this is beneficial to diversity. For example, the best territories for the tawny pipit are found in areas where there is more than 50 per cent exposed sand.

COASTAL DUNES, WINDS AND SAND DYNAMIC

The wind was able to blow more freely before the dune grasses lyme-grass, *Leymus arenarius*, and marram, *Ammophila arenaria* were planted and protective fencing was built in order to stabilise the sand along our coasts. The dune grasses have long, stiff blades that prevent the sand blowing around, and deep root systems that bind it. As a result, they have helped tall coastal dunes to form closest to the shore. It is possible to dig wind holes in the front parts of dunes in order to open the dunes up to the wind again. This gives the wind the opportunity to blow the sand around again. The sanddrift caused in this way covers the vegetation behind the front of the dune in a thin layer of sand and helps to keep the valuable sand dynamic moving.



In Friseboda, Skåne a large area with mountain pine was cleared. Tree stumps were removed and inversion excavation made areas of open sand. Already the next year, the tawny pipit was found in the area.

Sanddrift may still be a cause for concern, but it is possible to alleviate these concerns by working at a safe distance from populated areas and providing plenty of information on what is being done. As part of the Sand Life project, it has been possible to work in large natural areas at a safe distance away from fields, roads and buildings, and in areas where there are safe buffer zones that stop the sand. Openings have been created for the wind in the outermost dunes in areas where Japanese rose has been dug up and mountain pines have been removed on a large scale. Sand has also been loosened to such an extent that a natural dynamic has commenced once again. As a result, this means that the measures will continue to have an impact over a long time in terms of the proportion of open sand.



Removing the upper layer of vegetation and organic debris is a quick way of producing exposed sand. But if a great deal of organic debris if present in the open sand, this area may quickly become overgrown again. Excavation at the military training ground, Revingehed, in Skåne.



At the sandy heath of Gårdby on Öland, the top layer was dug away and removed for landfill.

WARM GLADES AND SUNNY FOREST EDGES

Forests have been opened up in wooded dune areas as part of the Sand Life project. This has created an ancient landscape with sparse pine forests, split pines, dead wood and, closest to the sea, low and windswept dwarf pines. There are now warm, sandy glades between the trees again. Sandy glades are excavated in the forest in the same way as in the open sand dunes. After felling and clearing, litter and the remains of cleared trees are removed and new sand is brought up to the surface by means of inversion excavation. However, there are a few other factors to bear in mind in the forest as well.

Just as in open dune areas, it is necessary to study the existing conditions. Of course, it is necessary to plan where to position glades when felling and clearing trees. Sun and shade are im-portant factors to bear in mind. If the forest is growing on an old dune area, topography has a major part to play. South-facing, steep dune slopes are kept open for longer as they do not become overgrown all that easily due to the sand sliding and the sun beating down. The presence of old trees, sunlit groves and dead and dying wood is of major importance to insects.

The glades must be made large enough to allow parts of the area to be lit by the sun throughout as much of the day as possible. Here, south-facing slopes that are already open provide a good starting point. If it is possible to extend the glade south of the slope, that is a good thing. It is also possible to create glades by making openings in the forest on the basis of sunny forest edges.

Digging patches of exposed sand and sandy paths along the sunny forest edges is also an effective way of creating warm sand environments that are hugely important to insect life.

EXPOSED SAND, SAND PITS AND SANDY PATHS

Coastal grey dunes, sand heaths and inland sand dunes were all part of the old outfield land-scape, where grazing, driving seaweed and other activities kept the land open and rich in open sand. New patches of exposed sand are constantly needed in order to recreate the effects that keep the dynamic moving at various stages of overgrowth. It can take anything from a few years to many years for the sand to close up again, depending on conditions in the location in question and the size of the exposed patch of sand.

INVERSION EXCAVATION

If a lot of organic material has to be removed, it can either be dug up and then transported away, or it can be burnt. It is also possible to invert the sand so that the clean, non-acidified sand is brought up to the surface by means of inversion excavation. There are four stages to inversion excavation. The top layer of vegetation and leached, nutrientrich sand is dug up and placed to one side. Clean, new sand is lifted from the pit. The vegetation and the sand that is richer in nutrients are then placed at the bottom of the pit and finally covered with the new sand.



In sandy grassland it is important to get lime-rich sand up to the surface. In Vitemölla strandbackar, the removal of Japanese rose with its long roots served dual purpose, removing an invasive species and bringing new sand to the surface.

CALCAREOUS SAND IS IMPORTANT TO SANDY GRASSLANDS

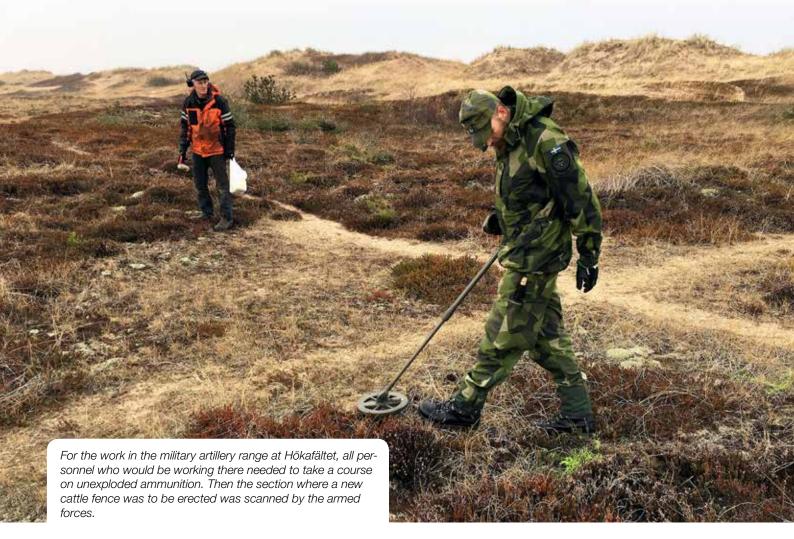
If we are to restore sandy grasslands, we need to do more than just dig out exposed sand. It is important to know whether the area has just overgrown or whether lime has leached out. Sand can be taken from various depths down to at least one metre by simply sampling it using an auger. The lime content and pH can then be analysed by a laboratory. However, the pH can also be determined directly in the field using a pH meter, which provides a handy indication of where the lime can be found. When you know how far down the lime is in the soil, it is possible to determine whether excavation of the topmost layer is sufficient or whether it is necessary to dig deeper and perform inversion excavation.

FALLOW FIELDS, SAND NOTCHES AND SAND PITS

Ploughing creates fallow areas where a new succession of overgrowth can commence. In pasture lands, they need to be fenced in if you want to protect them from grazing and trampling. This benefits flowering plants and allows insects to dig their nests in peace. If you avoid harrowing after ploughing, this creates better microstructures for digging insects. Starting ploughing along a south-facing long side creates a long, sunny sand notch in which insects can dig.

Ploughing inverts the topmost layer of soil. If you want to dig up completely clean sand free of earth and grass roots, you need to dig deeper. Patches of exposed sand can be created by means of inversion excavation or by digging up and removing vegetation and the topmost layer of sand. The material dug up can be used to make embankments or heaps that in themselves can form valuable structures by providing protection from the wind and creating dry microenvironments. South-facing, sunlit areas are the best places in which to position these heaps.





WORKING IN MILITARY TRAINING SITES



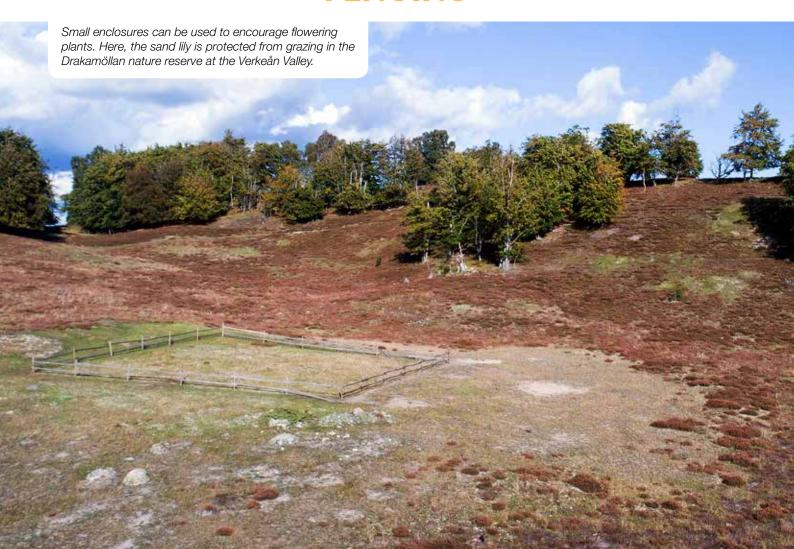


One difficulty experienced by the project has involved conflicts between the need for open sand and restrictions in the environmental compensation regulations as part of state agricultural aid. The rules on the sizes of areas and the proportion of a requested area allowed to remain as bare soil was more restricted at the start of the project, but these rules have been relaxed as the project has continued. At the time of writing, no area of bare soil/wasteland in pastureland may exceed 500 square metres in area. However, there is still contradiction between how environmental compensation in pastureland is structured and how the optimal environment in sandy habitat types should be. The recommendations from the Swedish Environmental Protection Agency for the sandy grassland habitat type state, for example, that 30 per cent is the minimum level for how much open sand a sandy grassland area needs in order to have a favourable conservation status. As things stand at present, it is not possible to implement this in areas with environmental aid, not even in designated Natura 2000 sandy grassland areas. This is also applicable to other sandy area types such as grassy heaths and grey dunes, which also occur in pastureland with environmental compensation.

Therefore, nature conservation maintenance with soil disturbance stands in contrast to the demand for feeding value in pastures receiving aid. Feeding value is the guideline for aid for this pastureland, and this means that areas where patches of exposed sand are ploughed, harrowed or excavated cannot be included until vegetation has covered the surface once more. A system of recurring soil disturbance, where some of the land is either ploughed or harrowed every year, would have been optimal in many sandy areas. However, this is not compatible with environmental aid for pastureland as things stand at present. Overgrowth of areas of bare sand takes at least a couple of years, and in this case the total area without feeding value is large even if you only cultivate a small part of the area every year. It is important to consider right from the outset whether there are any alternatives to environmental aid when forming a nature reserve where grazing is necessary in order to maintain high biological value in sandy areas, or where areas are restored in order to create open sandy areas.



FENCING





SOIL SAMPLING





CHOOSING MACHINERY

Machinery you choose to work with should be adapted according to what you need and local conditions. You will need a tracked excavator if there is a lot of loose sand. Extensive excavation requires larger excavators with a long reach. A wheel excavator or wheel loader may work well in flat, grass-covered dunes. If you have to sort the sand to remove roots and bushes, you might need anything from a wheel loader with a screening bucket to a large screener. In this respect, you have to be efficient in terms of both time and cost. A smaller machine that is cheaper per hour may be more expensive in the long run than a larger, more efficient machine. Long transport distances also cost time. In any case, coordination, good planning and effective use of the machine time are the be-all and end-all. You need to be on site when work begins and turn up regularly as the process continues so that you can clarify your target scenarios, follow up on progress, make adjustments and help to resolve any issues that may arise.

Opportunities to return regularly in order to create new patches of exposed sand may to an ex-tent determine your choice of methods and the size of these patches. If it is not possible to get to the site frequently, you will have to create a few larger patches of exposed sand interspersed with a few smaller ones. The October to March period is an appropriate time for excavation. You may need to explore the area in summer in order to choose the best areas for excavation. And here is some more good advice on what to bear in mind during planning and implementa-tion:

- Get to know the area before you excavate. Study where natural wind holes occur and where natural assets such as flowering plants, fungi and insects are concentrated and their locations in the topography.
- Open new patches of exposed sand near to areas where flowering plants are found in order to promote seed dispersal.
- Do not forget variation in terms of size, location and shape
- Choose locations where you can dig patches that face the south. Warm, dry places benefit insects and stay open for longer than shaded, damp areas.
- Overgrowth of grass, moss, brushwood and bushes often takes place in dune depressions where excavation can recreate warm sand pits.
- Create warm notches and edges in a south-facing position, protected from the wind, creating patches of exposed sand where insects can dig their nests.
- Dig in exposed areas where sand drift can be improved or started safely.

- Long paths a couple of metres wide can act as dispersal routes for insects and flowering plants, as well as being used as paths and firebreaks.
- Follow up your results and learn from your experiences.



WIND HOLES











8.MONITORING THE RESTORATION WORK

One day, the restoration of the area will be complete and the machines will leave the site. Will the objectives have been accomplished? Unfortunately, monitoring of such measures are frequently inadequate due to a lack of time and resources, but EU projects such as Sand Life provide an opportunity to carry out fundamental surveys in order to see how plants and animals are responding to the restoration measures.

Sand Life carried out surveys of species and structures before and after the restoration work in order to find out what effects the measures have had on biodiversity. When restoring an environment, you paint a picture of the land-scape and structures – exposed sand, in our case – that you are aiming to achieve. When the work is done, the next step is to document how it was carried out. The exposed sand is relatively easy to map, but it takes time for plants, fungi and animals to establish themselves in an area. Moreover, Sand Life has turned the clock back and recreated the earliest succession stages, which means that the rapid colonisers are generally the first to appear in the newly restored areas.

As part of Sand Life, we have used methods for restoration of sandy soils that have been tried and tested throughout the EU. Despite this, for future maintenance of sandy soils it is necessary to find out how things have gone. And there is always a need to refine the methods that have already been used.

The monitoring has been coordinated by Lund University, which has also selected and designed methods, carried out remote analysis and performed the various field surveys. Besides the bird life survey, the results were not yet compiled by the time this document was produced, but these will be presented in a separate report.

SURVEY ACCORDING TO THE BASE INVENTORY

Methods established by the Swedish Environmental Protection Agency for the ongoing base inventory of Natura 2000 and other protected areas have been used to monitor vegetation and the percentage of exposed sand. Three parallel lines (grid systems) have been laid out in the sand dunes or sandy grasslands included in the project, and sample areas have been positioned along these lines. The length of these lines and the sizes and positions of the sample areas differ in the sandy habitats and the grasslands, but otherwise the methods are the same. The grid systems were documented both before and after measures were implemented. Habitat type, percentage of bare sand and coverage of vascular plants, grasses, litter, mosses, lichens, ferns, brushwood, trees and bushes are the parameters surveyed in each of the grids. Coverage of eight different vascular plant families that are considered to be particularly important as sources of nectar and pollen has also been documented.

SURVEY OF RESTORATION MEASURES AND CONTROL AREAS

The direct effects of the various restoration measures have been monitored in eight grassland and sand dune areas covered by the project. Burning, removal of Japanese rose, measures to create exposed sand and removal of mountain pine are the maintenance measures followed up. Survey boxes have been laid out in both restored areas and untouched control areas. The boxes used in sand dunes and grasslands are of differing sizes and differing numbers were used, but the various factors that were surveyed are the same and match those included in the survey according to the base inventory above.

INSECT SURVEYS

Hymenoptera, beetles, butterflies and moths have also been surveyed using various methods both before and after the restoration measures, working along the same lines as those established for the base inventory, as well as in a number of the sample areas involved in the surveying of maintenance measures.

SURVEYING BREEDING BIRDS

The territories of three different bird species were mapped both before and after measures were implemented. The tawny pipit, *Anthus campestris*, the characteristic bird of open sandy habitats, was used to represent the open sandy habitats in the survey. The woodlark, *Lullula arborea*, and European nightjar, *Caprimulgus europaeus*, are the other two species that we chose to monitor throughout the project. They both prefer environments with a combination

of semi-open and wooded forests on dry ground comprising a varied mosaic of elements, with coarse trees and glades with bare soil.

The 2013 survey of the tawny pipit noted a total of 33 territories, all of which were concentrated in sandy habitats in eastern Skåne. Most of the Sand Life measures were completed by the time of the follow-up survey in 2017, and it was pleasing to see that the number of territories had increased to 42. The distribution area in eastern Skåne had increased, but unfortunately none of these birds were found in western Skåne or Halland. Nevertheless, it is hoped that the newly opened areas will be able to attract new birds in years to come.

AERIAL SURVEY

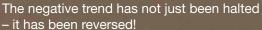
Aerial photos taken before and after the restoration work have helped us to map the changes in the distribution of various habitat types in all 23 project areas. These results will be presented in a separate report.

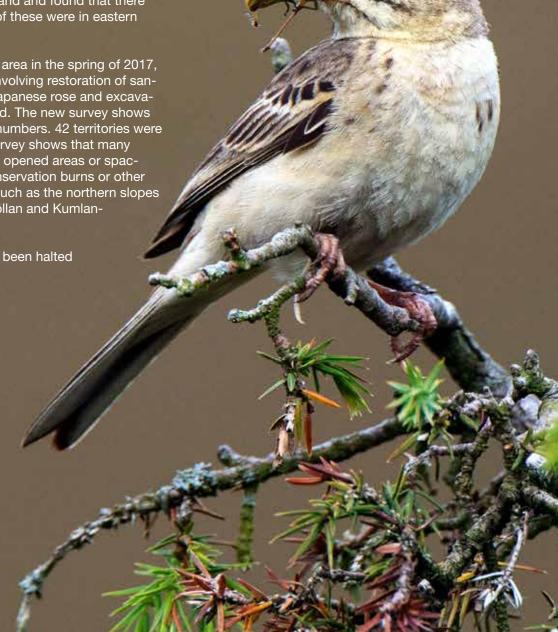
NEGATIVE TREND REVERSED — TAWNY PIPIT NUMBERS INCREASING

Monitoring of the tawny pipit, *Anthus campestris*, the characteristic bird of sandy habitats, shows that species exist that can respond quickly when their environment is improved. A survey carried out following action in 2017 shows that the number of territories has increased by 20 per cent since 2013.

The tawny pipit was common in Skåne in the early 20th century and bred throughout much of southern Sweden, but it has become increasingly rare as areas of sandy soil have declined. The tawny pipit is very much dependent on larger areas of open, bare sand where there are plenty of insects. The number of breeding birds has declined rapidly since the 1980s, and a national action programme has been implemented for the species. According to the Swedish Species Information Centre, there were 210 territories in Skåne and 50 in Halland in 1983. In 2013, ornithologist Patrik Olofsson carried out a survey of all known nesting sites in Skåne and Halland and found that there were just 33 territories left. All of these were in eastern Skåne.

Patrik Olofsson returned to the area in the spring of 2017, following Sand Life initiatives involving restoration of sandy soils, removal of pine and Japanese rose and excavation of patches of exposed sand. The new survey shows a clear increase in tawny pipit numbers. 42 territories were found in eastern Skåne. The survey shows that many birds lived in and around newly opened areas or spaces where ploughing, nature conservation burns or other measures were implemented (such as the northern slopes of Brösarp, Ravlunda, Drakamöllan and Kumlan-Möllegården).





9.INFORMATION WITH RESTORATION AND MAINTENANCE

Better late than never. A proverb that is certainly true, but best avoided when referring to information on major nature conservation projects. "The earlier, the better" provides more scope for success.

There may be a huge difference in how biologists and the general public perceive natural areas. Areas that are important for recreation purposes may sometimes be of no major biological value. This is sometimes because the area is overgrown, or because the forest has been planted and the trees are of the same age. Discovering, as a visitor, that the places where you like to roam are to be changed may arouse strong emotions. It is common for people to believe that nature reserves and Natura 2000 areas will be spared felling operations, major excavations and damage caused by vehicles. Therefore, it may come as a shock to anyone who is unaware that maintenance measures are in progress when they encounter excavators and forestry equipment on their morning walks.

Overgrowth results in slow changes. People who have visited areas for a long time have often forgot how things looked just 10 to 30 years ago and are sometimes not prepared to accept major changes. It is also important to remember that there have been major changes in how people working with nature conservation view the maintenance of sandy soils. Persuading visitors and landowners to take on board the relatively new approaches to the restoration and maintenance of sandy natural areas may present an educational challenge for conservationists.

This is why it is important for visitors, residents and non-profit organisations to feel they are playing a part in the planning of major nature conservation projects. Participation can take many forms, but one of the most important starting points by far is to provide good information on what will be happening, and making sure that this information is received well in advance of the restoration or maintenance measures. This gives landowners, tenants and the general public the opportunity to familiarise themselves with the maintenance measures. It is also important to give them the opportunity to ask questions and mention any concerns well in advance of implementation of the measures.

Communicating clearly and openly is always worthwhile. Not everyone can get their own way, and in the majority of cases stopping the maintenance measures or major restoration efforts is not an option. That said, it is possible to adapt the measures in order to address concerns. Perhaps progress could be a little slower initially, work could begin in a less frequently visited area, or work could be done in stages. This may help to ensure that the changes are not too overwhelming.

It is important to use various channels to distribute information in order to reach out to as many people as possible. Some of the methods we have used as part of the Sand Life project in order to raise awareness and pass on information are described below.

FACE-TO-FACE MEETINGS IMPORTANT

The Sand Life project has had the opportunity to invest both time and money in providing information about the project and the restoration measures implemented as part of it. We have attempted to reach out to people directly affected, such as landowners and tenants, and to the general public who hear people talking about the project or see what is going on when they visit the areas in question.

In total, more than 200 meetings and field tours have been held as part of the project. These include everything from meetings with individual landowners to popular tours involving the general public. It is hoped that this has helped to increase interest in sandy habitats and enhance understanding of disturbing the soil and other maintenance measures among people who work with nature conservation and other people with a general interest in nature.

WORKSHOPS

The project began with a workshop held in Halmstad in March 2013. This was aimed at people who work with the restoration and maintenance of sandy soils or who are interested in preservation of diversity in sandy habitats. Experiences from work with sandy soils in Halland and Denmark and the measures planned as part of the Sand Life project were discussed here.

A second workshop will close the project in Kristianstad in spring 2018. The results from the project's six years of efforts to restore sandy soils will be presented at this workshop.

MAINTENANCE COUNCILS

Meeting up with landowners, tenants and representatives of various interest groups to discuss maintenance issues may facilitate communication among various stakeholders. This is an excellent way of distributing information about planned activities. It also provides an opportunity for administrators to learn from local knowledge and find out more about local history.







In Tönnersa, Halland, Kill Persson, a biologist, tells us of the history and animal life of the sandy soils during a field trip in August 2013.

The Sand Life project has worked with maintenance councils in a number of Natura 2000 areas. The reasons why these maintenance councils exist and their backgrounds may vary, but they frequently originate from local commitment to the area. In this case, it was necessary to meet local residents and other interested parties in order to hold discussions and provide information.

Maintenance measures can be discussed at regular meetings, and the area administrator can deal with any concerns arising prior to planned measures. However, it is important for the members of the maintenance council to be aware that they are an advisory body and that it may sometimes be impossible to accommodate all opinions on what should be done and how. That said, it has been found by members of the Sand Life project that these meetings may frequently provide a consensus on how things should proceed. Members of maintenance councils are incredibly important as they can pass on information to local residents and other interested parties. The frequency of maintenance council meetings is dependent on both the interest demonstrated by members and how much administration and maintenance is planned for the area.

FIELD TOURS

It is possible in the field to show people in a direct and educational way what work is being planned as part of the project. This is also an excellent opportunity to show visitors the elements of biodiversity that are not as easy to see as fields of flowers and fluttering butterflies.

We have often engaged experts that can provide more indepth information on insect fauna, bird life or cultural history. The insect fauna of sandy habitats is both unique and endangered, so many of our field tours have focused on insects. We have dug for dung beetles in cowpats and asked children to help us catch insects in the grass, but we have also opened people's eyes to the importance of the old cultural landscape. We are often asked about maintenance and measures, and that is why it is important to be able to answer these questions while we are there. Combining an expert and an administrator when running field tours helps people to understand the measures being implemented in the area.







One way of visualising changes following restoration actions is to have specific photographic points that are documented at regular intervals. As part of the project, we have tested having photographic points where the public can be involved in documentation. A sign where you can position your camera/mobile and take a picture to later send to the County Administrative Board has monitored the changes at different places in Hagestad nature reserve. January 2016 (left foto: Erik Norregård), May 2016 (middle, foto: Erik Norregårdd) och August 2017 (right, foto: Håkan Nordqvist).

SIGNAGE AND OUTDOOR MUSEUMS

Information signs relating to the Sand Life have been placed in all areas where the project has worked. These signs will remain in place for five years after the project comes to an end and provide information on the natural assets of the area and the measures implemented by Sand Life.

The project has set up permanent outdoor museums in selected locations visited by large numbers of people. These museums include both general information on sandy habitats and the location in which the museum is sited. The aim of the outdoor museums for the project is to arouse curiosity and – hopefully – answer any questions that visitors may have. These outdoor museums can be found in six locations in Skåne (Rinkaby, Friseboda, Hagestad, Revingehed, Falsterbo firing range and the Ängelholm beach forest), two locations on the island of Öland (to the east and west of the Böda coast), and Halland (three outdoor museums in the Laholmsbukten sand dune landscape and one in Haverdal).

PRINTED MATERIAL

We have produced nine folders as part of the project, describing the project, habitat types and species. The aim of this is to provide information on the biological assets in these sandy habitats, and we also hope that they can be used to provide information on the maintenance of sandy soil outside the project area.

The county of Halland has worked on digital folders as a complement to printed matter and produced digital folders that can be accessed via the County Administrative Board's website or by scanning QR codes on signs in the area.













One of the competitors in the world's biggest orienteering competitions, O-ringen, held in the Friseboda nature reserve in summer 2014. On a warm, sunny day, 40,000 feet helped to create a disturbance in the sand. The project was also on site and many people were curious about the project and its measures.

NEWSLETTERS - HAVERDAL

Digital newsletters are another way of reaching out to the general public and local residents. Allowing people to subscribe to the newsletter makes it possible to provide regular information on activities and plans within a specific area. The Halland County Administrative Board has published more than 20 newsletters on the Haverdal nature reserve. These focus on the nature reserve and provide people with news about the long-term work on a new maintenance plan, restoration of the environment as part of the Sand Life project and other news such as field tours and new information relating to outdoor recreation.

WEBSITE

One requirement of the EU's LIFE Programme is that projects founded must have their own websites. We launched our website, www.sandlife.se, in our first year and the plan is to keep this website online for at least five years after the project has come to an end. The website includes information, downloadable material, a calendar and contact details.



THE BATTLE FOR THE PINE GROVE

- a socio-economic survey on attitude changes

How do people outlooks change over time with regard to major restoration projects? Can information help to reduce public concern ahead of major projects such as Sand Life?

Sebastian Ivarsson, a student at Kristianstad University, developed an interest in events taking place at the Haväng and Vitemöllla strandbackar nature reserve at the start of the Sand Life project. As part of his landscape science course, he has carried out a survey of visitors and local residents living near to Vitemölla. One of the strengths of his work is that he has been able to carry out an independent study in his capacity as an independent third party not involved with the project.

Sebastian provides a brief account of his study here. It will eventually be available to download from the Kristianstad University website. The Sand Life project has included his study in an interim report that will be available from the project website at the end of the project.

WHY WERE YOU INTERESTED IN WAS HAPPENING AROUND VITEMÖLLA?

The starting point was my interest in the problems that can occur when working with protected nature – work that is intended to benefit us all! Given this fact, it seemed like a really good idea to study the course of events relating to the nature reserve.

HOW WAS YOUR SURVEY CARRIED OUT?

I started off with a pilot study, which involved initial interviews with three relevant staff members from the County Administrative Board in Skåne. My aim was to find out more about the Sand Life process in Vitemölla. In summer, I carried out a questionnaire survey in Vitemölla and its surrounding area with a view to finding out what local people thought of the Sand Life process. I received responses from 80 participants. Finally, I supplemented the questionnaire with ten depth interviews focusing on the core issues of the questionnaire survey.

WHAT ARE THE MOST IMPORTANT RESULTS FROM YOUR STUDY?

My results indicate that the local people as a group initially had a negative opinion of the County Administrative Board and Sand Life. The comments relating to the issue seem to indicate that they believed the plans were far too brutal and not established sufficiently from a local perspective. A lack of information was also cited frequently. Nowadays,



Sebastian Ivarsson

local residents seem to be neutral or cautiously positive in their perception of Sand Life. In the majority, these changes of attitude seemed to be due to the fact that they had been notified of the results of the actions, and they were also relieved that the initiatives were not as extensive as the County Administrative Board had initially indicated.dessutom lättad över att ingrepp-

en inte blivit så omfattande som länsstyrelsen först hade tillkännagivit.

WHAT ADVICE WOULD YOU GIVE TO ANY ORGANI-SATION INITIATING A PROJECT LIKE SAND LIFE?

Get in touch with the village committee or some other appropriate association at an early stage. Tell them what you want to achieve and why, but without presenting a complete plan. Be open to different views and suggestions. Be particularly clear about who wants to achieve what and when. Presenting a variety of plans and projects as things progress may make people think the organisation has a hidden agenda. It takes a great deal of time and resources to "turn people around" once they have started to mistrust your motives. Give people space so that they can let any changes sink in. Plans and decisions implemented too quickly tend to be perceived as brutal. The above advice is not provided with a view to telling people how to do their jobs! Like so many other things in society, you have to have the time and resources to do things properly. However, I realise that this is not always the case!



APPENDIX 1.

List of species mentioned in the book with Swedish, English and scientific name.

Swedish name	English name	Latin	
INSEKTER			
Bibagge		Apalus bimaculatus	
Bivarg	European beewolve	Philanthus triangulum	
Brun sandjägare	Northern dune tiger beetle	Cicindela hybrida	
Fältmaltörtsrotvecklare		Pelochrista infidana	
Ginstplattmal		Agonopterix atomella	
Ginstsäckmal		Coleophora genistae	
Gråmyra		Formica cinerea	
Grön sandjägare	Green tiger beetle	Cicindela campestris	
Gul frölöpare		Harpalus flavescensOs	
Havsmurarbi	Mason bee	Osmia maritima	
Havstapetserarbi		Megachile leachella	
Läppstekel		Bembix rostrata	
Mjölfly	Scarce marbled	Eublemma minutata	
Mosshumla	Large carder-bee	Bombus muscorum	
Myrlejonslända	Antlions	Antlions Myrmeleontidae	
Månhornsbagge		Corpus lunaris	
Praktbyxbi		Dasypoda hirtipes	
Reliktbock		Nothorhina muricata	
Sandnejlikegallmal		Caryocolum schleichi	
Strandsandjägare	Dune tiger beetle	Cicindela maritima	
Streckhedspinnare	Feathered footman	Spiris striata	
Svartfläckig blåvinge	Large blue	Maculinea arion	
Sälgsandbi		Andrena vaga	
Tallgångbagge		Cerylon impressum	
Vårsidenbi	Mining bee	Colletes cunicularis	
Väddgökbi		Nomada armata	
Väddsandbi		Andrena hattorfiana	
Ängsmetallvinge	The forester	Adscita statices	
VÄXTER			
Backtimjan	Breckland thyme	Thymus serpyllum	
Blåmonke	Sheep's-bit	Jasione montana	
Borsttåtel	Grey hair grass	Corynephorus canescens	
Flockfibbla		Hieracium umbellatum	
Fältsippa		Pulsatilla pratensis	
Getväppling	Kidney Vetch	Anthyllis vulneraria	
Gul fetknopp	Biting stonecrop	Sedum acre	
Hedblomster	Dwarf everlast	Helichrysum arenarium	
Hårginst	Gold-flash broom	Genista pilosa	
Klubbfibbla	Hawkweed	Hieracium pachycranum	
Knärot	Creeping Lady's-tresses	Goodyera repens	
Krypvide	Creeping willow	Salix repens	
Kråkbär	Crowberry	Empetrum nigrum	
Käringtand	Common bird's foot	Lotus corniculatus	
Ljung	Heather	Calluna vulgaris	
Luktvädd	Fragrant Scabiosa	Scabiosa canescens	

	Ta	Γ=	
Martorn	Sea-holly	Eryngium maritimum	
Marviol	Sea rocket	Cakile maritima	
Rotfibbla	Cat's-ear	Hypochaeris radicata	
Ryl	Umbellate wintergreen	Chimaphila umbellata	
Rödven	Common bent	Agrostis capillaris	
Saltarv	Sea sandwort	Honckenya peploides	
Sandnejlika	Sand pink	Dianthus arenarius ssp. Arrenarius	
Sandrör	Marram	Ammophila arenaria	
Sandstarr	Sand sedge	Carex arenaria	
Sandvedel		Astragalus arenarius	
Sandvide	Creeping willow	Salix repens ssp. Repens var. Argentea	
Sandviol	Teesdale violet	Viola rupestris	
Sandvita	Hoary alison	Berteroa incana	
Skogsknipprot	Broad-leaved helleborine	Epipactis heleborine	
Sodaört	Prickly saltwort	Salsola kali	
Stor sandlilja	St Bernad's lily	Anthericum liliago	
Strandråg	Lyme grass	Leymus arenarius	
Strandvial	Sea pea	Lathyrus japonicus	
Tofsäxing		Koeleria glauca	
Trift	Thrift	Armeria maritima	
Vresros	Japanes rose	Rosa rugosa	
Åkerfibbla	Smooth Cat's ear	Hypochaeris glabra	
Åkermadd	Field madder	Sherardia arvensis	
Åkervädd	Field scabious	Knautia arvensis	
KRÄLDJUR			
Grönfläckig padda	European green toad	Bufotes variabilis	
Sandödla	Sand lizard	Lacerta agilis	
Strandpadda	Natterjack toad	Epidalea calamita	
FÅGLAR			
Fältpiplärka	Tawny pipit	Anthus campestris	
Nattskärra	European nightjar	Caprimulgus europaeus	
Rödbena	Redshank	Tringa totanus	
Skärfläcka	Avocet	Recurvirostra avosetta	
Strandskata	European oystercatcher	Haematopus ostralegus	
Större sandpipare	Ringed plover	Charadrius hiaticula	
Trädlärka	Woodlark	Lullula arborea	
SVAMPAR			
Dropptaggsvamp	Reddish-brown corky spine fungus	Hydnellum ferrugineum	
Dynhätta	3 1 3	Mycena chlorantha	
Dvärgjordstjärna	Dwarf earthstar	Geastrum schmidelii	
Dynstinksvamp	Sand stinkhorn	Phallus hadriani	
Fransig stjälkröksvamp		Tulostoma fimbriatum	
Hedfingersvamp	Moor club	Clavaria argillacea	
Kråsmusseron	Booted knight	Tricholoma focale	
Lakritsmusseron	Scented knight	Tricholoma apium	
Liten diskröksvamp	Coorted Wilgitt	Disciseda candida	
Motaggsvamp		Sarcodon squamosus	
motaggovarip	T.	- Car Soudin oquaniosus	
Sandjordtunga		Sahulodossum aranarium	
Sandjordtunga	Mosaic nuffhall	Sabuloglossum arenarium	
Skålröksvamp	Mosaic puffball	Lycoperdon utriforme	
Skålröksvamp Stor diskröksvamp	Mosaic puffball	Lycoperdon utriforme Disciseda bovista	
Skålröksvamp Stor diskröksvamp Strimmig slätskivling		Lycoperdon utriforme Disciseda bovista Deconica montana	
Skålröksvamp Stor diskröksvamp	Mosaic puffball Drab tooth Pine bracket	Lycoperdon utriforme Disciseda bovista	

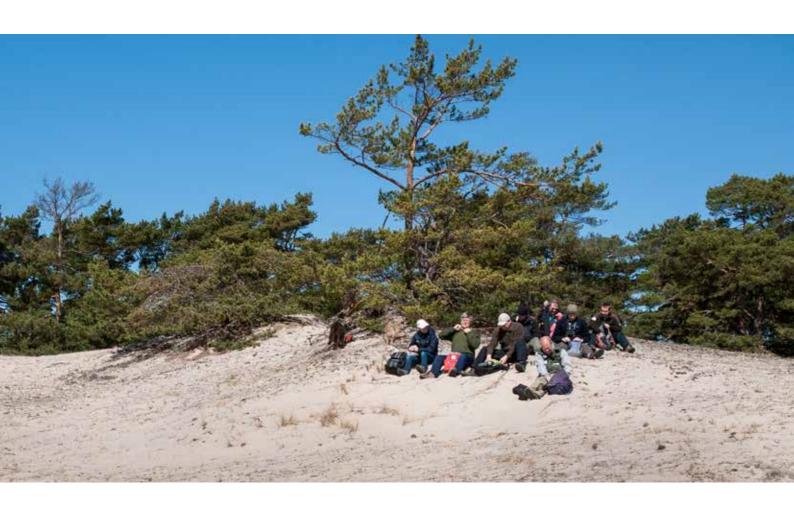
APPENDIX 2.

Restoration measures in Sand Life. Data are collected from the latest Progress Report (October 2017). However, in some sites the areas will be larger since restoration work continues during winter 2017/2018.

Natura 2000-område	Removal of trees and bushes (hectar)	Creating areas of open sand (hectar)	Removal of Japanese rose (hectar)	Prescribed burning - small	Prescribed burning - large	Fire breakers (meter)
Verkeåns dalgång	62,3	8,72	0,78		16	474
Kiviks marknadsplats	10,4	0,3			1	
Friseboda	23,7	5,8	0,7		1	986
Gropahålet	20,6	12,9				
Möllegården	2,46	1,03				
Klammersbäck		0,3				
Bjärekusten			5,73			
Ängelholms strandskog	9,65	4,03	4,43		1	
Lyngby						
Rinkaby	2,33	6,05		1	1	
Ravlunda	8,92	11,4	0,23		1	1920
Falsterbohalvön		0,05	16,2		1	
Sandhammaren - Kåseberga	39,5	11,7		1	2	500
Falsterbo skjutfält	10,4	0,27				
Kabusa		5,03			1	130
Revingefältet		34,2	0,07		20	14900
Åby sandbackar		10,9				
Gårdby sandstäpp		17,4				
Skedeås	3,8	12,5			9	5466
Bödakusten västra						
Bödakusten östra	71,7	3,26	1		8	
"Laholmsbuktens sanddynsreservat"	87,1	43,5	3,6		8	
Haverdal	26	10,3	5		7	
Summa	379	200	37,7	2	77	24376

Removal of encroachment (hectar)	Fencing (meter)	Investments in grazing	Restoration heath (hectar)	Reimbursement for grazing (hectar)	Road (meter)
5,21	1723	5 stiles			
24,7					
	1615	1 stile			
3					
5,26					
2,84					
	1026	4 stiles, 30 meter waterpipe			
			8		
3			15		
8,55	1748	1 gate		18	
0,2					
63,7					
41,3	5400	9 gates			800
11,8					
170	11512		23	18	800



















LIFE is the EU's financial instrument for supporting environmental, nature protection and climate measures throughout the EU. Since 1992, LIFE has co-financed more than 4,500 projects.

During 2012-2018, the County Administrative Boards in Skåne, Halland and Kalmar counties worked together with Lund University and the Kristianstads Vattenrike Biosphere Reserve on the Sand Life project on the restoration and management of sandy habitats in 23 Natura 2000 areas. The project, which was led by Skåne County Administrative Board, received half of its funding from the EU's Life fund. The Swedish Environmental Protection Agency and the Scanian Landscape Foundation have co-financed the project.



