The Bócsa-Bugac Forests of the Kiskunság National Park Directorate

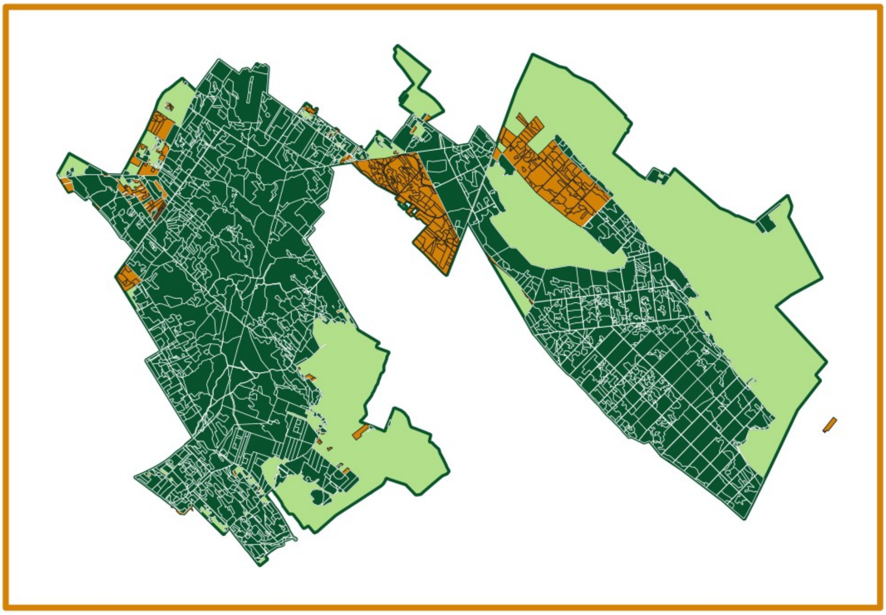
Summary of the Field Demonstration at the International Forestry Students' Association Southern Europe Meeting

Location: Kiskunság National Park
Bócsa-Bugac Core Area
Bugac Great Forest

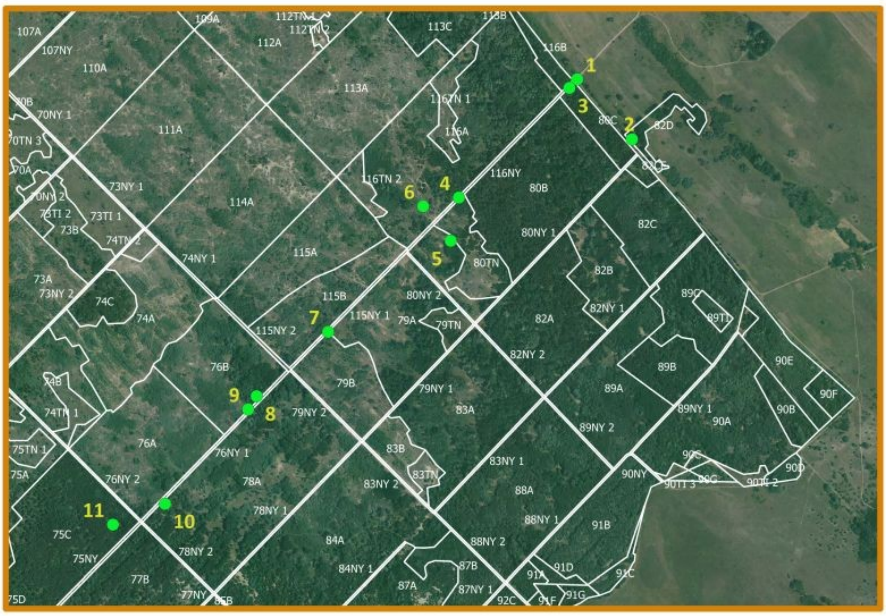
Presented by: Attila Hoksa
Date: 30 May 2026

Disclaimer: This document does not fully reflect the content of the original presentation.

Bócsa-Bugac Core Area, Kiskunság National Park



Location Map of the IFSA-KNPI Study Tour Programme



1. Description of the *Bugac Great Forest*

(We are standing here in Bugac, at the edge of the Bugac Great Forest...)

Our largest forest block is located in the *Bócsa-Bugac* core area of the national park.
The protected *Bócsa-Bugac* core area covers 11,671 hectares and is the most forested of the nine core areas of the national park.
The majority of the core area, 7,143 hectares, is designated as strictly protected, while 4,528 hectares are under standard protection.

The core area also entirely overlaps with the Natura 2000 site called *Bócsa-Bugac* Sandsteppe.
Within the core area, forests extend over approximately 7,500 hectares, of which around 7,000 hectares are under the management of the National Park Directorate.
On the map, the *Bócsa-Bugac* forest lies between the Danube and the Tisza rivers, within the Sand Ridge region. It is located in the driest part of the Danube-Tisza Interfluve, in the heart of the Sand Ridge.

The characteristic native forest communities are juniper-poplar forests on sandy soils. These correspond to Natura 2000 habitat type 91N0, known as *Pannonic inland sand dune thicket* (*Junipero-Populetum albae*).

Other native forest types occur in smaller proportions.
These include, for example, Euro-Siberian steppic woods with pedunculate oak (Quercus robur), as well as forests dominated by Hungarian ash (Fraxinus angustifolia subsp. pannonica).
Non-native forest types are also widespread in the area, particularly non-native pine forests, black locust stands, and hybrid poplar plantations.
The most characteristic non-forest native habitats are open and closed sandy grasslands. These are classified as Natura 2000 habitat type 6260, known as *Pannonic sand steppes*.

Climate change affects the entire area of the national park, and the effects of warming can be observed in all its ecosystems. The largest contiguous forest block of the national park, the *Bócsa-Bugac* forest, including the *Bugac Great Forest*, is no exception.
Forests weakened by extreme weather events become more vulnerable to pathogens and insect pests. At the same time, invasive tree species, which are often more resistant to drought and pests, spread into declining native forest stands.
Climate change is therefore a serious challenge for our forests under nature conservation management.

2. Euro-Siberian steppic woods with Pedunculate oak

(Here we can see a patch of sandy oak woodland consisting of pedunculate oak...)

The pedunculate oak (*Quercus robur*) is commonly known as English oak.

In the *Bugac Great Forest*, the most characteristic forest habitats are the Pannonian sandy juniper-poplar woodlands. Other Natura 2000 habitat types, such as 91I0 *Euro-Siberian steppic woods with Quercus robur*, also occur within the *Bócsa-Bugac* sand steppe Natura area.
(In the territory of our directorate, the most beautiful stands of sandy oak woodland are found in the Upper *Kiskunság* region (*Kunpeszér*).)

The sandy pedunculate oak stand shown here was formerly managed as a wooded pasture under traditional land use practices. This form of use is still visible in the structure of the forest: the typically rich shrub layer characteristic of sandy oak woodlands has become reduced.
We aim to protect the remaining very few patches of pedunculate oak woodland as effectively as possible. Native oak trees are not subject to logging, and we actively suppress invasive tree species.

General characteristics of sandy steppe oak forests

M4 according to the General National Habitat Classification System and 91I0 according to Natura 2000 habitat types.

A biologically diverse forest community is characterized by a wide variety of plant species, complex vertical structure, and varying canopy closure conditions. The old pedunculate oak trees provide habitat for numerous bird and insect species, and in themselves are exemplary models of biodiversity.

The pedunculate oak is the dominant tree species forming the stand, although in transitional types poplar species may also be dominant. Mixed in are wild pear (*Pyrus pyraster*), white poplar (*Populus alba*), grey poplar (*Populus × canescens*), silver birch (*Betula pendula*), and field elm (*Ulmus minor*).

The shrub layer in its natural form is rich and diverse (here it is sparse due to grazing). Characteristic species present here include hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*), privet (*Ligustrum vulgare*), common barberry (*Berberis vulgaris*), and common juniper (*Juniperus communis*). Other shrub species occurring in our sandy oak forests include: dog rose (*Rosa canina*), spindle (*Euonymus europaeus*), purging buckthorn (*Rhamnus cathartica*), common hazel (*Corylus avellana*), elder (*Sambucus nigra*), and dewberry (*Rubus caesius*).

(Located next to point 3)

(Here is a fenced area where we sowed acorns to prevent wildlife damage...)

Pedunculate oak is also regenerating in the area, typically not under existing oak stands, but under pine plantations and other thinning forest stands. Its regeneration is supported by the open, light forest-steppe structure, as well as by animal species that disperse acorns, such as squirrels and jays. (This process is called synzoochory.) The pedunculate oak produces acorns only sporadically every 2-3 years, and heavy mast years occur only rarely (about every 5-7 years). Regeneration is threatened by wildlife damage, invasive pressure, and the drying climate. Among biotic pathogens, powdery mildew fungi negatively affect the regeneration dynamics of pedunculate oak forests. The few existing regeneration patches are often fenced by us and supplemented with acorn sowing.

Birch grove

(Over there you can see a group of birch trees...)

A striking example of climate change is the birch grove, which has begun to decline. It was in good health not long ago, but as a result of last year's severe drought, it has started to deteriorate significantly. Two types of birch trees can be found in our area. One is the common or <u>silver birch</u> (*Betula pendula*), which is the more widespread species and is also the one visible here. The other is the <u>downy birch</u> (*Betula pubescens*), which is protected in Hungary. In more northern regions, downy birch is the more common dominant species, but in Hungary it is rare and considered a relict species. In the Bócsa forest complex, it occurs only in a few small groups.

3. Non-native conifer forest stands

(Here we can see a non-native monoculture pine forest stand that is in severe decline...)

Pine forests found on the Great Hungarian Plain are non-native forest stands. They were planted in the past century as part of afforestation programs aimed at stabilizing sandy soils in the region. They were mostly established as pure monoculture stands and served timber production purposes.

As a result of climate change, pine stands on the Great Hungarian Plain have begun to decline dramatically. Two characteristic pine species were commonly planted: Scots pine and Austrian pine.

Characteristics of Scots pine (*Pinus sylvestris*)

Scots pine has a very wide natural distribution range and can be found across almost all of Europe. It occurs in hilly and mountainous regions as well as on lowland plains, and it is also one of the dominant tree species of the northern taiga. In Hungary, however, it is native only to the western part of the country (*Őrség* and *Fenyőfő*).
It tolerates extreme site conditions remarkably well. It can survive even on barren soils and sandy substrates. It is relatively tolerant of drought and can withstand harsh weather conditions. Scots pine is highly light-demanding. As a pioneer tree species, it regenerates easily from seed on exposed sandy soils and may therefore behave invasively in native juniper woodlands.
It is a two-needle pine species belonging to the Diploxylon group. Its needles are 4-7 cm long and twisted, while its crown is relatively sparse. The bark on the lower trunk is grayish-brown and scaly, whereas the upper part is thin and orange to reddish in color.

Scots pine is affected by numerous pathogens and pests. Among fungal diseases, the most destructive is root and butt rot of conifers, caused by *Heterobasidion annosum*, which can destroy entire forest stands. (The fungus previously had the scientific name Fomes annosus.) In Pinus species, this fungus attacks the sapwood, causing infected trees to die rapidly.
Many insect species attack Scots pine. Needles and buds are damaged by species such as European pine sawfly (*Neodiprion sertifer*), common pine sawfly (*Diprion pini*), and web-spinning pine sawfly (*Acantholyda hieroglyphica*). Shoots are damaged by pine shoot moth (*Rhyacionia buoliana*), whose feeding causes the shoots to develop a characteristic "posthorn" deformation. The trunk is attacked by bark beetles such as the six-toothed bark beetle (*Ips sexdentatus*) and the common pine shoot beetle (*Tomicus piniperda*).

Characteristics of Austrian pine (*Pinus nigra*)

The Austrian pine or black pine is a characteristic tree species of Mediterranean and sub-Mediterranean mountain regions. It comprises several subspecies distributed across Europe. The nominate subspecies, *Pinus nigra subsp. nigra*, occurs in Central Europe, including the Vienna Basin. Another type, *Pinus nigra subsp. pallasiana*, grows on limestone cliffs in the mountains above the Lower Danube in the Southern Carpathians.
The nominate form has been widely introduced in Hungary as a non-native tree species, making it the second most widespread conifer species in the country. It was planted during the afforestation of barren mountainous areas, often replacing the original karst shrub forests. It was also introduced to the Great Hungarian Plain because of its high tolerance to extremely dry calcareous sandy soils.
Like Scots pine, Austrian pine is a two-needle (diploxylon) pine species. It can be distinguished from Scots pine by its longer, sharper, dark green, and less twisted needles, its denser crown, and its brownish-gray bark.

Austrian pine is affected by somewhat fewer pests and pathogens, but in recent years, mass dieback events have also occurred in Austrian pine forests due to various fungal species causing needle reddening and needle blight, including *Sphaeropsis sapinea* and *Dothistroma septosporum*.

Impacts of climate change on pine forests

Both pine species are severely affected by climate change.

Biotic stress factors, including pathogens and insect pests, are becoming increasingly aggressive as a result of climate change, and their impact is further amplified in pure, single-species pine stands.

Abiotic stressors are also causing increasing damage to pine forests under more extreme weather conditions. In our region, storms and wildfires have caused significant destruction in recent decades, and even-aged monoculture pine stands are particularly vulnerable to these disturbances.

During drought periods, accumulated dry needle litter makes pine forests especially prone to fire. Large-scale wildfires in the region have been exacerbated by extensive monoculture pine plantations. These stands facilitate the spread of rapidly advancing crown fires due to the continuous contact between highly flammable, resin-rich tree crowns.

In stands declining due to pests and climate change, invasive tree species often become established.

Positive effects

The coniferous trees present in the area can also have beneficial effects. Gradually thinning, rather than suddenly opened, conifer stands are favourable from a nature conservation perspective, as they often become well grassed over time. In many places, valuable grassland habitats and species of community interest can be found within open conifer stands. On better-quality sites, these stands can serve as good precursor stands for oak forests. On soils covered with conifer litter, under favourable light conditions, pedunculate oak often regenerates well beneath them from acorns sown by Eurasian jays. Conifer forests also provide favourable conditions for the distribution of numerous bird species.

Small groups of conifers, especially Scots pine, which has a relatively broad ecological amplitude and wide distribution, can have a place in the landscape as they increase biodiversity. However, pure, even-aged conifer monocultures are undesirable and not sustainable.

4. Forest site conditions

(Here we are in the "semi-desert" landscape of Bugac...)

The *Bugac Great Forest* is located in the Danube-Tisza Interfluve, one of the most diverse regions of the Hungarian Great Plain. Its microtopography is highly varied: the flat, steppe-like plain is connected to the Great Forest, which is characterized by dune landscapes.

Site conditions, including soil type, groundwater level, aspect, slope, and microclimate, vary considerably across the heterogeneous sandy terrain.
The parent material of the Danube-Tisza Interfluve ridge is sand. The characteristic soil types of the region are calcareous sandy skeletal soils. Under the most extreme site conditions, drifting sand soils occur, whereas more favourable locations are characterized by humic sandy soils and multilayered soil profiles containing buried humus horizons.
The Bugac area is characterized by extreme temperature conditions, very low precipitation, and low relative humidity. Due to climate change, the groundwater table, which is naturally deep in this region, is sinking even further. The drying and erosive effects of wind are also significant.

Between the dunes, a valley effect is present, where site conditions are the most favorable for forest growth. Here, juniper-poplar stands of valley type can be found.
The most extreme site conditions occur on the dune crests, where only pioneer-type juniper stands can survive. In some places, the dunes also contain patches of bare sand, as can be seen in this area. Shown here is a pioneer-type juniper-covered dune crest, where extremely dry soils lacking a true topsoil layer can be clearly observed.

Actively shifting dunes

The dunes themselves constantly change under the influence of wind and migrate. Wind erodes the surface of the sandy landscape and removes the upper sand layer. The wind later deposits the sand, forming dunes of convex and parabolic dune forms. The different shapes of the dunes create a diverse landscape.

The dunes visible today were formed over centuries of long-term, gradual sand movement. Actively shifting dunes are currently rare due to vegetation cover, but they can still be found in some places. A good example can be seen at *Fülöpháza*, where a few larger, unvegetated, mobile dunes occur. This area is often nicknamed the "Hungarian Sahara" due to its extensive bare sand surfaces and active dune forms. Here, wind-formed ripple patterns can be clearly observed.

Fülöpháza, migrating sand dune

Fülöpháza, desert-like active sand dune

5. Presence of invasive species, problems caused by invasive tree species

(We can see a patch of black locust over there...)

One of the consequences of human activity is the spread of invasive alien species. Some tree species introduced for horticultural or timber production purposes have become aggressively spreading invasive species. Invasive spread has intensified in the last decade due to climate change.
These invasive species are causing problems in the *Bugac Great Forest*, but also elsewhere in our national park. In our forest areas, the problem is mainly caused by intensively spreading alien tree species, but in the intermediate grasslands, invasive herbaceous plants also cause a problem.
From a practical conservation perspective, the invasive species threaten the native forest communities, the protected values, the Natura 2000 habitats and the habitats of species of community importance.
From a legal perspective, nature conservation law, forestry law, and European regulations require measures to prevent the spread of invasive species and to control ongoing invasions. The relevant EU legislation is the Regulation of the European Parliament and of the Council concerning the prevention and management of the introduction and spread of invasive alien species. (Regulation (EU) No. 1143/2014).

<u>Typical invasive tree species:</u>

Black locust (*Robinia pseudoacacia*)

One of our oldest non-native and invasive tree species. Black locust is native to the Appalachian region of the eastern US. It is the only one among these species with significant timber production value. Its assessment is controversial: it is an economically valuable tree species, but undesirable in protected natural areas. It sprouts vigorously, its root suckers threaten native habitats and related species.
Under normal conditions, it spreads mainly vegetatively, but can also regenerate from seed after disturbances such as fires.
Control of locust is relatively simple; it is one of the easiest invasive tree species to manage. During targeted control operations, herbicide injected into the trunk is an effective method of control. Thinner individuals can be controlled by bark wounding and herbicide application, while smaller shoots can be controlled by selective herbicide spraying.

We manage the extensive locust plantations using traditional forestry methods. We convert these stands into native forests, usually native poplar stands, by means of clear-cutting and artificial afforestation (so-called forest structure transformation). Locust is also capable of natural aging, so in many places we leave dead, standing trees in place to dry out naturally.

Tree of heaven or ailanthus tree (*Ailanthus altissima*)

Native to China. It was initially planted in parks and later also introduced for forestry purposes.
It is a vigorously spreading, aggressive species that is very difficult to eradicate. It spreads rapidly both by root suckers and by seed.
It strongly degrades forest habitats by increasing weed cover in the soil, preventing the regeneration of native forest stands, reducing the naturalness of forests, and decreasing biodiversity. The tree of heaven has allelopathic properties that suppress the growth of native vegetation in the surrounding area. In more open areas it destroys Pannonian sand steppe communities and, through its aggressive sprouting, displaces native herbaceous species. In sandy forests it is one of the most dangerous invasive tree species.
Control is difficult; it can only be suppressed through repeated, targeted chemical treatments.
For seed-producing trees, herbicide must be injected into the trunk. Larger shoots require bark application of herbicide, while smaller shoots need treatment of the leaf surface, although runoff of the chemical may unfortunately also pollute the environment. A less environmentally harmful option is targeted spraying of apical shoots. In recent years, tree of heaven has been increasingly damaged by *Verticillium* wilt, and although the potential use of this pathogen for biological control is currently being investigated, such an approach may involve ecological risks.

American or common hackberry (*Celtis occidentalis*)

Native to the northeastern part of the United States. In urban areas, it has been widely planted as a street and park tree, and in forests as a admixed tree species. Its seeds are dispersed by birds. It has become increasingly problematic in recent years and is spreading more aggressively. The forest understory is often densely covered by young hackberry seedlings, which displace native plant species. It is important to remove mature, seed-producing trees as soon as possible.

Other invasive species in this area

Russian olive (Elaeagnus angustifolia)

Black cherry (*Prunus serotina*), honey locust (*Gleditsia triacanthos*), boxelder maple (*Acer negundo*), green ash (*Fraxinus pennsylvanica*). These tree species originate from the Atlantic region of North America. The latter two are more to cause problems in floodplains, but they also occur in this area. In grasslands, the Central Asian Russian olive (*Elaeagnus angustifolia*) is a problem. Among shrubs, the american golden currant (*Ribes aureum*) spreads as an invasive plant. The most significant invasive herbaceous plant that threatens sandy grasslands is the common milkweed (*Asclepias syriaca*).

common milkweed (Asclepias syriaca)

Protection against invasive species is a huge expense. We have limited funding for this from our own budget, so we are seeking additional funding from European Union grant sources (such as KEHOP and the LIFE programme). In 2013 and 2020, we carried out invasive eradication in larger contiguous area. Smaller areas are treated annually.

6. Forest fires in the *Kiskunság* National Park area

(Here we are at the site of the major Bugac wildfire of 2012...)

Due to climate change, forest fires have increased in our areas since the 1990s. Three major forest fires devastated our protected areas: in 1993, 2012, and 2015. In addition, several smaller forest fires affected the national park area.

In 1993, a huge fire broke out in the *Bócsa* forest block (about 1800 hectares burned down.) Juniper stands were partially preserved in patches. This was the largest forest fire in our area so far.

In April 2012 (from 29 April to 5 May), 894 hectares of area burned down in *Bugac* (mostly forest, small part grassland approximately 30 ha).
The forest fire raged for a week before firefighters were able to completely contain it. Most of the central, strictly-protected juniper forests (90%) and the entire area of the forest reserve burned down.
The restoration of several hundred hectares of forest became necessary. We mapped the affected forest stands in detail over the following months. With the help of the authorities, we designated several *Pannonian sand steppe* (Natura 2000 habitat type 6260) areas for conservation. We were able to preserve significant natural values through the creation of clearing areas. A significant part of the forest restoration was based on the large proportion of native gray poplar root suckers that appeared. Approximately 80 hectares of artificial restoration took place, mostly in the place of the burned pine plantations, supplemented with natural restorations within the artificial parts.

Thirdly, in addition, in July 2015 (from 24 to 30 July) in the *Bócsa* forest block, 253 hectares of land were burned. (*Bócsa* settlement boundary: 78 hectares; *Kaskantyú* settlement boundary: 175 hectares, overlapping with the area affected by the 1993 forest fire.)

In the future, forest fires are expected to become more frequent due to climate change and longer drought periods, posing increasing challenges for forest management and nature conservation. The adverse effects require adaptive management approaches, including the support of natural regeneration processes.

7. Forest regeneration after the wildfire

(Here we can see an artificially regenerated grey poplar stand,

..and next to it a naturally regenerated native poplar stand...)

The transformation of non-native forest stands is primarily carried out through artificial reconstruction. This involves complete harvesting of the existing stands, followed by site preparation and planting with seedlings of native tree species characteristic of the landscape. We also apply natural regeneration methods, primarily relying on the root suckering of native poplar species.

Following the major forest fire in 2012, an obligation arose to restore several hundred hectares of forest under forestry regulations. We carried out most of this through natural regeneration, but on approximately 80 hectares we implemented artificial forest restoration.

During artificial reforestation, we first harvested the burned stands. After that, we carried out stump removal (uprooting the stumps), followed by deep ploughing on difficult terrain using a crawler tractor and a rigol plough. Planting was done using a special method, placing large seedlings deep into the furrows created during ploughing. This method promotes seedling survival in extremely dry sites. When placed deeper in the soil, seedlings develop new fine roots. These operations were carried out with the help of contractors.

On most of the area, grey poplar regenerated well on its own from root suckers after the fire. Where it was necessary, we took action against invasive tree species. Natural regeneration was based exclusively on native poplar, because juniper requires decades for natural renewal.

8. The role of deadwood in forests

(Here we can observe a tree that has died through natural processes...)

Deadwood plays a very important role in close-to-nature forest management.

The later in its life a tree begins to die, the more diverse a biological community it can support. In other words, the thicker the deadwood, the higher its ecological value. Therefore, in addition to preserving deadwood, it is very important for nature conservation that a large number of older trees are present in the area, meaning that trees should be allowed to reach old age.

The formation of deadwood

Trees in forests gradually weaken due to mechanical impacts from non-living environmental factors, depending on their species and age. Drought can dry them out, wind can break off branches or snap the trunk, and severe storms may uproot them. The weakened parts are then colonized by various insects and beetles. These beetles bore tunnels into the wood, and some species are even capable of digesting the cellulose content of the wood.

At the same time, fungi also settle in the wood and spread through it. The tree gradually starts to decay. As decomposition progresses, additional insect and fungal species appear, feeding on the by-products of decay.

<u>During tree decay, several types of deadwood develop over time and space:</u>

-standing dead trunks, where the bark begins to peel off and the wood structure gradually changes;
-fallen trunks lying on the forest floor, often with loose or partly detached bark, providing habitats for a wide range of decomposer organisms;
-trunks affected by white rot, where fungi primarily break down lignin, followed by the decomposition of cellulose and other wood components;
-trunks affected by brown rot, where cellulose is decomposed while lignin remains largely intact, causing the wood to become brittle and fragmented.

The fauna associated with deadwood (saproxylic fauna) is extremely diverse depending on the condition of the wood, including jewel beetles, bark beetles, longhorn beetles, stag beetles, dung beetles and many others.

One of the Natura 2000 indicator species found in the area, the cinnabar flat bark beetle (*Cucujus cinnaberinus*), is typically found in loose-barked deadwood habitats, where the conditions beneath the bark provide a suitable microclimate. The larvae develop beneath the bark and later pupate there, while adult beetles also overwinter in the same habitat.

Tree cavities

Woodpecker species create cavities and nesting holes in tree trunks by excavating the wood. They often start excavating cavities in weakened, damaged, or decaying trees.
The black woodpecker (*Dryocopus martius*), using its powerful beak, creates large cavities. Depending on the type of wood, excavating a cavity may take several weeks. A completed cavity can be about 50 cm deep, with an entrance about 10 cm wide. These large cavities are later used by secondary cavity-dwelling species such as the European roller (*Coracias garrulus*), little owl (*Athene noctua*), and red squirrel (*Sciurus vulgaris*).
Softer deciduous tree species (such as poplars) become suitable for cavity excavation sooner than harder species (such as oak). Smaller woodpeckers usually excavate cavities in more heavily decayed wood, creating smaller hollows. These smaller cavities are also later used by secondary cavity-dwelling species that do not create their own cavities but depend on existing ones, such as tits, flycatchers, and dormice.
As a result of fungal and insect activity, natural hollows also form in decaying trees. Over time, fungi weaken and decompose the wood, while insects contribute to the breakdown process, gradually creating hollow spaces within the tree. These naturally occurring hollows are readily occupied by owl species, such as the tawny owl (*Strix aluco*), small mammals, and bats.

Deadwood also plays an important role in bird feeding. Insects hiding beneath the bark provide a valuable food source. As trees age, their bark becomes thicker, and more insects can be found underneath it. For nuthatches, woodpeckers, and tits, these dying trees with thick, peeling bark represent an important food source.

(Located at point 2)
Nest boxes

Artificially installed nest boxes can be seen on a few trees. Both natural and artificial cavities provide nesting and living places for cavity-nesting birds and other species. In our forests today there are few old trees, therefore the number of hollow, cavity-bearing trees is also low. As a supplement, we place artificial nest boxes.
Different box types exist according to the needs of each species. The following types can be seen here:

There is a type C nest box over there.
This is a nest box with a rectangular entrance hole. It is used by wagtails, robins, redstarts and spotted flycatchers.

Here you can see a type B nest box.
Its entrance hole is about 3 cm wide. It is used by the sparrows, tits, nuthatches, wrynecks, and flycatchers.

Shown here is a Type A nest box.
Its entrance hole is approximately 2 cm in diameter. It is primarily used by smaller tit species, such as the blue tit.

Over there you can see a treecreeper nest box.
It is a triangular-shaped box, with the entrance hole on the side.

9. Sandy grasslands and Natura 2000 habitats and species

(Here we are standing in a forest glade, where an open sandy grassland can be observed...)

Open sandy grassland

Sandy grasslands are one of the most characteristic and ecologically important habitat types of the *Kiskunság* National Park. Within a forest-steppe landscape, where closed forest stands are naturally restricted, sandy grassland communities occur in different structural forms, ranging from open to closed communities. Besides the extensive grassland areas characteristic of the region, smaller grassland patches occur in a mosaic pattern within the more forested parts of the landscape. The more open sandy grassland forms are typically associated with this mosaic structure, whereas closed grasslands tend to dominate more continuous steppe-like areas.

<u>Priority Natura 2000 habitat types in the *Bócsa-Bugac* Sand Steppe site:</u>
-Pannonic sand steppes (code 6260), covering 36% of the area
-Pannonic inland sand dune thicket (code 91N0) *(Junipero-Populetum albae),* covering 22% of the area
-Pannonic salt steppes (with code 1530)

Pannonic sand steppes are habitat types occurring exclusively in the Pannonian Basin, with their largest continuous stands found in the Sand Ridge. These are species-rich plant communities. This habitat type includes both open and closed sandy grassland forms.

The open forms, typically occurring in a mosaic with forest patches, represent the most natural conditions and are therefore of high conservation value. Their persistence is threatened by invasive tree species and by agricultural and forestry practices involving soil disturbance, which are incompatible with nature conservation objectives.

Approximately one third of the *Bócsa-Bugac* core area consists of steppe-like habitats dominated by closed sandy grasslands. These areas are traditionally managed through grazing; however, overgrazing can occur, particularly under increasing drought stress associated with climate change.

<u>Plant species of Community interest:</u>
-Persistent carnation (*Dianthus diutinus*)* (priority species; occurring in the *Bócsa* forest area)
-Sand autumn crocus (*Colchicum arenarium*)
-Sand iris (*Iris humilis subsp. arenaria*)
-Small-headed thistle (*Cirsium brachycephalum*)

Persistent carnation (Dianthus diutinus) - Photo by Tímea Varga, 2017

Sand autumn crocus (Colchicum arenarium)

Of these, the first three species are typical of our forest areas. The first species occurs in the *Bócsa* block of the forest area, the second in the *Bugac* area. The first two species are strictly protected, the other two are protected.

Sand iris (Iris humilis subsp. arenaria)

Other herbaceous and subshrub species forming characteristic grasslands and occurring in our *Bócsa-Bugac* forest areas

Ephedra distachya, ball-head onion (*Allium sphaerocephalon*), sand feather grass (*Stipa borysthenica*), *Festuca wagneri*, red helleborine (*Cephalanthera rubra*), dark-red helleborine (*Epipactis atrorubens*), *Corispermum canescens*, *Corispermum nitidum*, late carnation (*Dianthus serotinus*), *Sedum hillebrandtii*, sandy cinquefoil (*Potentilla arenaria*), *Astragalus varius*, *Astragalus dasyanthus*, *Euphorbia cyparissias*, *Peucedanum arenarium*, dyer's alkanet (*Alkanna tinctoria*), sand onosma (*Onosma arenaria*), immortelle (*Helichrysum arenarium*), *Centaurea arenaria*, *Echinops ruthenicus*, sand goatsbeard (*Tragopogon floccosus*)

Dyer's alkanet (Alkanna tinctoria)

Sandy cinquefoil (Potentilla arenaria)

Animal species of Community interest:

-Hungarian meadow viper (*Vipera ursinii rakosiensis*)* (priority animal species)
-European ground squirrel (*Spermophilus citellus*)
-Hungarian ground beetle (*Carabus hungaricus*)
-Cinnabar flat bark beetle (*Cucujus cinnaberinus*)

Cinnabar flat bark beetle (Cucujus cinnaberinus) - Photo by Tímea Varga, 2020

The first two species do not occur in forested habitats. The first three species are strictly protected, while the fourth is protected. Particular importance is attached to the conservation of the Hungarian meadow viper, for which we have also implemented a LIFE Programme project. To increase the available habitat for the Hungarian meadow viper, we have cleared forest areas composed of non-native tree species and converted them into grasslands.

Hungarian ground beetle (Carabus hungaricus) - Photo by Tímea Varga, 2020

Cone-headed grasshopper (Acrida ungarica)

Besides the insect species of Community interest, the grasslands are particularly important habitats for numerous protected arthropod species, including the cone-headed grasshopper (*Acrida ungarica*), the oriental meadow brown (*Hyponephele lupina*), the tree grayling (*Hipparchia statilinus*), the predatory bush-cricket (*Saga pedo*) and the black-lobed garden orb-web spider (*Argiope lobata*). In addition, the forests and grasslands provide nesting habitats for numerous protected bird species.

10. Surviving remnants of ancient juniper woodland

(Here we can see a patch of juniper-poplar woodland that remained intact after the forest fire...)

The ancient juniper woodland of *Bugac*, destroyed in a severe forest fire, was one of the most extensive and most beautiful juniper stands in Europe. The fire almost completely devastated the juniper groves in the most valuable, strictly protected areas. The ancient juniper woodland is unlikely to ever recover its original structure. Even partial regeneration after the fire will take decades. Fortunately, small remnants of the ancient juniper woodland have survived in *Bugac*.

The famous ancient juniper woodland of *Bugac* developed over centuries under special conditions. The area was shaped primarily by traditional livestock grazing, but the afforestation programmes on the Great Hungarian Plain during the first half of the last century also played an important role in shaping the landscape. The grazing practices of earlier centuries facilitated the spread of juniper, because grazing animals left the prickly juniper untouched.

When grazing ceased in the *Bugac Great Forest* due to the growing dominance of forestry, the native woody vegetation, together with the open sandy grasslands in a mosaic pattern, gave rise to the natural Pannonian juniper-poplar associations. This is how the *Bugac Great Forest* acquired its distinctive appearance. It was this landscape that was later largely destroyed by the fire.

On the other half of the *Bócsa-Bugac* core area, within the *Bócsa* forest block, larger continuous remnants of the ancient juniper woodland can still be found. The 1993 forest fire also caused devastating destruction here, but in many places larger patches survived. Since the fire, the area has gradually begun to regenerate. Regeneration here is very slow; however, after 33 years, juniper saplings are already present.

Characteristics of the *Pannonic inland sand dune thicket* Natura 2000 habitat

This unique native plant community occurs only in the Pannonian region, typically on the calcareous sandy areas of the Danube-Tisza Interfluve. It never appears in isolation, but is usually found in a mosaic pattern together with sandy grasslands, shrublands, and other sandy forest associations. Under the extreme site conditions characteristic of this habitat, it functions as a pioneer forest association and also represents the final forest stage of sandy succession; on more favorable sites, sandy oak forests replace it.

Depending on the varied microtopography and site conditions, three or four major types can be distinguished.
Pioneer type: Between patches of juniper shrubs of varying sizes, there is sparse vegetation and a few stunted grey poplars.
Typical juniper-poplar type: It occurs between dunes, where denser stands of poplar develop, while juniper is mainly found at the forest edge.
Valley type: It occurs at the base of dunes and in valleys, where poplars form closed stands and the light-demanding juniper is being gradually displaced.

Characteristic species of the sandy juniper-poplar woodland

The dominant species are juniper and native poplars, which together form a loose, open-structured plant community. Due to the extreme site conditions, this forest association is poor in tree species and moderately species-poor in shrubs. Its high biodiversity is maintained by sandy grasslands rich in herbaceous plants that form a mosaic with the forest (already discussed earlier).
The upper canopy layer consists of white poplar (*Populus alba*) and grey poplar (*Populus × canescens*). The latter is a hybrid of white poplar and European aspen; in our region, hybrid grey poplars showing predominantly white poplar characteristics are most common. Individuals resembling European aspen (*Populus tremula*) also occur in the area. Black poplar (*Populus nigra*) is also characteristic of the area. Although it is primarily a floodplain species, it also tolerates dry conditions well and can be easily propagated by cuttings. Adapting to local conditions, very beautiful juniper-black poplar stands have also developed.
The lower layer is dominated by common juniper (*Juniperus communis*). Admixed tree species are rare in typical juniper-poplar woodlands, though wild pear (*Pyrus pyraster*) and field elm (*Ulmus minor*) do occur. In addition to juniper, deciduous shrub species are also characteristic of the shrub layer, including European privet (*Ligustrum vulgare*), common hawthorn (*Crataegus monogyna*), blackthorn or sloe (*Prunus spinosa*), common barberry (*Berberis vulgaris*), and European buckthorn (*Rhamnus cathartica*).
Among the smaller shrubs, rosemary-leaved willow (*Salix rosmarinifolia*) is characteristic of slightly moister sites.

11. Natural forest regeneration, forestry records

Forestry Regulation and Records

In Hungary, forest management is regulated by the Forest Act (Act XXXVII of 2009). Forest management activities are supervised by the forestry authority. Forest areas are registered in the National Forestry Database.

Within municipalities, forests are divided into forest blocks, which are further subdivided into forest compartments. Each forest compartment has its own identification code. Forest compartments are recorded in official forest stand registers. These records contain the identification code and area of the compartment, the forest manager, and the designated primary function of the forest, which may be production, protection, or public welfare purposes.

The records also include the main characteristics of the forest stand, tree species, soil type, naturalness, as well as permitted and prohibited activities within the forest. Trees may only be harvested if harvesting is authorized in the forest management plan. Logging operations may involve clear-cutting or partial harvesting methods such as thinning (the selective removal of trees).
Clear-cutting is subject to restrictions in protected areas. Its maximum size is generally limited to three hectares and it is only permitted in non-native forest stands.

According to the official records, the area of this forest compartment is 15 hectares. Before harvesting, Scots pine and black pine formed a continuous stand, with small groups of native grey poplar also present.

Natural Forest Regeneration and Strip Regeneration

(Here we can see natural forest regeneration…)

Three small patches of the stand were harvested, covering a total area of approximately three hectares. We retained groups of native grey poplar as retention trees. Retention tree groups play an important role in close-to-nature forest management.

The retained tree groups mitigate the negative effects of clear-cutting, serve as habitats, and provide nesting sites for birds.

In the area of the harvested forest, poplar root suckers emerged naturally. As a result, on most of the site there was no need for full soil preparation, and no artificial regeneration was required. This is much more favourable from a nature conservation perspective.

However, on approximately half a hectare, where no poplar suckers appeared, we supplemented regeneration with artificial planting. (This can be seen opposite.)
Before planting, we carried out partial soil preparation by creating strips using a soil milling machine. We then planted the seedlings into these strips using a planting machine. Partial soil preparation is more favourable from a conservation point of view than full soil cultivation because it preserves grassy habitats. Its disadvantage is that the establishment of seedlings is less certain.

The mosaic of naturally regenerating areas, groups of retained poplar trees, artificially reforested sections, and the remaining non-native pine forest ensures habitat diversity.

SPECIES CHECKLIST FOR THE FIELD DEMONSTRATION

Native Tree and Shrub Species

white poplar	Populus alba
grey poplar	Populus × canescens
black poplar	Populus nigra
European aspen	Populus tremula
silver birch	Betula pendula
downy birch	Betula pubescens
pedunculate oak, English oak	Quercus robur
field elm	Ulmus minor
(European) wild pear	Pyrus pyraster
Hungarian ash	Fraxinus angustifolia ssp. pannonica
common juniper	Juniperus communis
(common) hawthorn, single-seeded hawthorn	Crataegus monogyna
blackthorn, sloe	Prunus spinosa
purging buckthorn, European buckthorn	Rhamnus cathartica
(European) privet	Ligustrum vulgare
(common) barberry	Berberis vulgaris
(European) spindle	Euonymus europaeus
(common) hazel	Corylus avellana
dog rose	Rosa canina
(black) elder, European elderberry	Sambucus nigra
rosemary-leaved willow	Salix rosmarinifolia
(European) dewberry	Rubus caesius

Non-native Tree Species in the Area

Scots pine, Baltic pine	Pinus sylvestris
Austrian Pine, black pine	Pinus nigra

Invasive Tree Species of Asian Origin

Russian olive	Elaeagnus angustifolia
tree of heaven, ailanthus tree	Ailanthus altissima

Invasive Species of North American Origin

black locust	Robinia pseudoacacia
honey locust	Gleditsia triacanthos
American hackberry, common hackberry	Celtis occidentalis
(wild) black cherry	Prunus serotina
boxelder maple, box elder, ash-leaved maple	Acer negundo
green ash, red ash	Fraxinus pennsylvanica
golden currant	Ribes aureum
common milkweed	Asclepias syriaca

Protected Herbaceous Plant Species

sand autumn crocus	Colchicum arenarium
sand iris	Iris humilis subsp. arenaria
round-headed leek, ball-head onion	Allium sphaerocephalon
red helleborine	Cephalanthera rubra
dark-red helleborine	Epipactis atrorubens
sand feather grass	Stipa borysthenica
dyer's alkanet	Alkanna tinctoria
sand onosma	Onosma arenaria
persistent carnation	Dianthus diutinus
late-coming pink, late carnation	Dianthus serotinus
small-headed thistle	Cirsium brachycephalum
immortelle, dwarf everlast	Helichrysum arenarium
sand goatsbeard	Tragopogon floccosus

Protected Animal Species

European ground squirrel	Spermophilus citellus
(Eurasian) red squirrel	Sciurus vulgaris
black woodpecker	Dryocopus martius
European roller	Coracias garrulus
little owl	Athene noctua
tawny owl	Strix aluco
Hungarian meadow viper	Vipera ursinii rakosiensis
Hungarian ground beetle	Carabus hungaricus
cinnabar flat bark beetle	Cucujus cinnaberinus
cone-headed grasshopper	Acrida ungarica
oriental meadow brown	Hyponephele lupina
tree grayling	Hipparchia statilinus
predatory bush-cricket	Saga pedo
black-lobed garden orb-web spider	Argiope lobata

Pests and Pathogens

root and butt rot of conifers	Heterobasidion annosum
European pine sawfly	Neodiprion sertifer
common pine sawfly	Diprion pini
web-spinning pine sawfly	Acantholyda hieroglyphica
pine shoot moth	Rhyacionia buoliana
six-toothed bark beetle	Ips sexdentatus
common pine shoot beetle	Tomicus piniperda

Grey poplar (Populus × canescens)

Grey poplar (Populus × canescens)

Common juniper (Juniperus communis)

Common juniper (Juniperus communis)

Pedunculate oak (Quercus robur)

Pedunculate oak (Quercus robur)

Silver birch (Betula pendula)

Silver birch (Betula pendula)

Downy birch (Betula pubescens)

Downy birch (Betula pubescens)

European wild pear (Pyrus pyraster)

Field elm (Ulmus minor)

Common hawthorn (Crataegus monogyna)

European privet (Ligustrum vugare)

Blackthorn or sloe (Prunus spinosa)

Dog rose (Rosa canina)

Common barberry (Berberis vulgaris)

Common hazel (Corylus avellana)

Purging buckthorn (Rhamnus catharctica)

European dewberry (Rubus caesius)

Black elder (Sambucus nigra)

European spindle (Euonymus europaeus)

Rosemary-leaved willow (Salix rosmarinifolia)

Scots pine (Pinus sylvestris)

Scots pine (Pinus sylvestris)

Austrian pine or black pine (Pinus nigra)

Austrian pine or black pine (Pinus nigra)

Black locust (Robinia pseudoacacia)

Black locust (Robinia pseudoacacia)

Tree of heaven (Ailanthus altissima)

Tree of heaven (Ailanthus altissima)

American hackberry (Celtis occidentalis)

Russian olive (Elaeagnus angustifolia)

Boxelder maple (Acer negundo)

Black cherry (Prunus serotina)

Honey locust (Gleditsia triacanthos)

Selected References

This presentation is based primarily on the author's professional work and experience. The references below include selected sources consulted during its preparation.

Photographs by other authors are credited individually; all other photographs are the author's own.

Jereb, O. & Kondor, A. (1995-1996). *Erdőműveléstan I-III.*
Gencsi, L. & Vancsura, R. (1997). *Dendrológia*
Bartha, D. (2004). *Magyarország fa- és cserjefajai*
Csóka, Gy. (2013). *ERDŐKÁROK képes útmutató*
Varga, F. (2001). *Erdővédelemtan*
Babos, I. (1956). *Homoki termőhelyláncok*
Szodfridt, I. (1969). *Borókás nyárasok Bugac környékén*
Merkl, O. (2016). *A szaproxilofág bogarak (Coleoptera) szerepe a holtfa lebontásában*
Kiskunság National Park Directorate. *https://www.knp.hu/en*
MÉTA Program - Magyarország növényzeti öröksége. *https://novenyzetiterkep.hu*
Forest Film Studio. *https://www.youtube.com/@forestfilmstudio*
Virginia Tech Dendrology. *https://dendro.cnre.vt.edu/dendrology*
Sipos, F. (2026). *Personal consultation.*