



SALT MARSHES OF THE DANUBE REGION

*Precious small islands
in the sea of arable land*



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Western pontic

Introduction

Salt marshes are typical for seaside areas; however, occasionally they develop in warm inland areas where evaporation prevails over precipitation in summer and where the supply of salts is assured by underground water.

In Europe, **inland salt marshes** are found in only a few countries. They occur primarily in the Pannonian basin (lowlands surrounded by the Alps, Carpathians and Dinars). They cover the largest area, about 400 thousand hectares, in Hungary.

Salt marshes are rare in Slovakia and cover only small areas. In the Danubian lowland, they comprised about 8,300 hectares at the beginning of the 1960s. However, many of them have been drained, ploughed, forested or otherwise grown over because of the cessation of their use as pasture for livestock. The remnants of the salt marshes are now scattered like “small islands in the sea of arable land” and represent the last havens for a number of rare, protected and endangered species of plants and animals. Unfortunately, these small islands are threatened by disappearance as well. One of the key conditions for preserving the current area of these salt marshes is their restoration as grazing lands.



Bokrošské salt marsh



Salt eyes – the most salinated parts of a salt marsh



Panské lúky meadows – Ráczo's pond (Ráczo's pond)

Salt more precious than gold

What a salt marsh is and types of salt marshes

The name itself suggests that **salt marshes** are connected with salt. Experts define these places as **habitats containing high amounts of soluble salts in soil**. They are typical for seaside areas where salination is caused by the presence of seawater. In our conditions, **inland salt marshes** develop due to the combination of the following factors: the **presence of underground water with a high content of readily soluble salts, a water evaporation regime and a warm climate**. In Slovakia, these conditions can be found mainly in the Podunajská (Danubian) and Východoslovenská (Eastern Slovakian) lowlands.

In spring, **the level of underground water is near the soil surface** and dissolved salts reach the surface through capillary action, occasionally flooding it. Then, in the warm and dry part of the year when **evaporation prevails over precipitation**, salt can precipitate on the soil surface in the form of white crystals called **flowers of salt**. They are crystals of various salts such as **sodium carbonate** (Na_2CO_3), **calcium sulphate** (CaSO_4), **sodium chloride** (NaCl), etc., depending on the composition of the underground water.

For the salination of soils, **fluctuations of the underground water level** are essential. Where these fluctuations are significant and the high level of water in spring dries rapidly, the salination is greater. If this is followed by **a hot, dry summer, the high concentration of salt in the soil is maintained**. Saline soil has a low level of permeability for water and air, is alkaline to strongly alkaline, and is hard and fissured in dry conditions. Salination of the soil can be greatest on the surface or at a certain depth (30 – 70 cm under surface). For example, in the saline marsh Mostové, it was found that the salination at the surface level was 0.31% (3.1 g of salts/l), and at a depth of 35 – 70 cm it was 0.49% (4.9 g of salts/l).

At higher elevations of the northern Slovakian basins, salination happens around mineral water springs. One example is the travertine piles in the Spiš region. Man can cause salination as well, e.g., by excessive use of mineral fertilisers, application of salt on roads in winter, etc.

* Do you know what a biotope or habitat is?

A **biotope** (from Greek bios – life, topos – place), or more commonly in English, a **habitat**, is the set of all factors (both organic and inorganic), which cooperate in creating an environment for the life of a species. Simply said, it is a space for life, or environment for life.



Flower of salt

* Do you know what a salt eye is?

The most salinated parts of a saline habitat, with salt precipitated on the surface, are called **salt eyes**. The conditions for life are especially extreme here, allowing only a very few plant species to grow.



Salt eyes

Adaptable extremists

Plants of salt marshes and their adaptations

A high content of readily soluble salts in soil **worsens a plant's water intake**. The **effect of salination** is, in the end, **equal to the effect of drought**. In these conditions, only specific species of plants called **halophytes** grow. No other plants could survive such extreme conditions.

Halophytes adjust to the high concentration of salts in a number of ways. A common adaptation is the **pulp (succulent) structure** of these plants. Succulents such as the **sea plantain** (*Plantago maritima*) or **saltmarsh sandspurrey** (*Spergularia salina*) can accumulate a great amount of water in their tissues. In this way, the concentration of salts in their cells remains almost unchanged.

A certain group of plants, including, for example, the **sea arrowgrass** (*Triglochin maritime*), have the ability to **excrete salts on the surface of their leaves**, thus maintaining the amount of salts in their cells under a certain limit.

Still another adaptation is the one plants such as the **blackgrass** (*Juncus gerardii*) have, which **shed their old leaves saturated with salts**. In the meantime, new leaves grow, which are again able to take in salts.

The vegetation of salt marshes is not rich in species; however, **most of them are among the endangered species** of our flora. The occurrence of plant species in a salt marsh is predominantly affected by the concentration and the chemical structure of salts in the soil.

Let us walk together through the salt marshes of the Danube region. In some, we can find **salt eyes**, which are the most precious parts of a salt marsh. Due to the high concentration of salts, only a few species can grow here, for example, the critically endangered **Western Pontic** (*Camphorosma annua*) or the endangered **sea plantain** (*Plantago maritima*).

✳ Do you know what halophytes are?

Plants that grow in saline soils – **halophytes** – are divided in two groups. **Obligate halophytes need salt** for their growth; therefore, they do not grow in places without the presence of salt. In Slovakia, there are **only 33 species** of this kind, for example, sea plantain, *Artemisia santonicum*, etc. **Facultative halophytes**, i.e., **salt-enduring plants**, e.g., lotus maritimus or *podospermum canum*, grow in other conditions as well but **can tolerate salination**.

A typical representative of the salt steppes of the Pannonian Plain is *Artemisia santonicum*, which favours sites flooded in spring and dried out in summer.

During its blooming season, you will definitely recognize the **sea aster** (*Tripolium pannonicum*), which grows exclusively in the Pannonian Plain. The number of sites of its occurrence has been significantly reduced.

The largest population of **wall barley** (*Hordeum geniculatum*) in Slovakia grows in the Síky pri Močenku salt marsh, which, until recently, was the only regularly grazed salt marsh in our country. This critically endangered annual grass grows at salinated sites disturbed by the hooves of grazing animals. Due to its sharp caryopses (dry, seed-like fruit), the sheep avoid it and graze on the surrounding plants only. If grazing ceases, the species quickly retreats.



Sea plantain



Sea aster



Western Pontic



Artemisia santonicum



Sea aster



Wall barley



Siberian statice

* Do you know why there are a lot of annual plant species growing in saline habitats?

These plants wait out the adverse period (drought with intensive soil salination) in the form of seeds. The paradox is that the germinating halophytes are sensitive to high salination; therefore, they germinate when the concentration of salts in the soil decreases.

At the end of summer, the salt marshes of Kamenín are decorated by the conspicuous, purple flowers of the critically endangered **Siberian statice** (*Limonium gmelinii*). This plant migrated here from the salt steppes of Hungary, and it does not grow anywhere else in Slovakia.

Salination happens on exposed banks and in the bottoms of ponds and various terrain depressions where the soil is flooded in spring and dries in summer. In these specific conditions, very rare species such as **Crypsis aculeata** and **swamp pricklegress** (*Heleochoa schoenoides*) grow. Both are among the protected and critically endangered species of Slovakia. *Crypsis aculeata* is known to occur at only one site: Ráčzovo jazierko (Ráčz's pond) in Tvrdošovce.

Another critically endangered species of Slovakia is the **saltmarsh sandspurrey** (*Spergularia salina*), which is a typical species along European seacoasts.

These species survive thanks to the supply of seeds in the soil, the so-called *seed bank*. We may not find them at a site for several years, but then, when the conditions allow it, they may occur in quite large populations.

* Do you know what an endemic species is?

An endemic species is one that grows in a certain area and does not occur elsewhere. **A Pannonic endemic species** is a species geographically limited to the Pannonian region. Of the plants of the salt marshes and meadows, for example, sea aster, Siberian statice or *Cirsium brachycephalum*, are among the Pannonic endemic species.



Crypsis aculeata



Swamp pricklegress



Saltmarsh sandspurrey

At places with a lower salt content, the vegetation is thicker because plants that do not need salt but can tolerate it grow there in addition to obligate halophytes.

Among these salt tolerant plants, an exceptionally rare species protected under the Habitats Directive is *Cirsium brachycephalum*, which grows in both wet and salinated meadows and pastures. It is considered endangered in almost all countries of its occurrence; therefore, it has been included on the world's "red list" of threatened species.

During its blooming time, **salt marsh iris** (*Iris spuria*) is a conspicuous plant. It is a critically endangered species of Slovakia, occurring at about 10 sites in the Danube region. It is not a typical halophyte; it grows primarily in alluvial meadows but can tolerate slight salination.

Similarly conspicuous is *Galatella punctata*. At some sites, for example at Kamenínske slaniská (Kamenínske salt marshes), when it blossoms in late summer we can see thousands of individual *Galatella punctata*. Despite that, this species is critically endangered in Slovakia. In addition, this is a species that cannot tolerate intensive mowing or grazing.

There are two habitats in Slovakia (protected under the EU Habitats Directive) bound to strongly salinated soils: **inland salt meadows** (1340*) and **Pannonic salt steppes and marshes** (1530*). They are both in the group of **priority habitats** (those for which there is a particular obligation for protection). **Inland salt meadows** represent both open and covered grass vegetation in salinated soils with the highest concentration of salts at a depth of 25 – 30 cm. In the past, they occurred quite abundantly, mainly in the Danubian Plain; currently, we find them only very rarely. **Pannonic salt steppes and marshes** include pioneer communities, which occupy exposed banks and the bottoms of lakes, fishponds, dead-end river branches and periodically flooded depressions. In dry times, salts precipitate on the soil surface in the form of white coatings. These habitats have always been very rare and have not developed in their typical form in Slovakia. The best preserved examples are in Ráčzovo jazierko (Ráčz's Pond) in Tvrdošovce.



Cirsium brachycephalum



Salt marsh iris



Galatella punctata



Large conehead (Cricket)

* Can you distinguish a cricket from a grasshopper?

A cricket's antennae are usually longer than its body. Most cricket species are **omnivorous**, although they mainly hunt insects and spiders. **A cricket produces sound by rubbing its forewings together** (the wings are hardened and have a protective function). It lives primarily in trees, bushes and taller plants.

A grasshopper's antennae are short and most of the species are **herbivorous**. It produces sound by rubbing its hind leg against its thickened forewing or bottom. It lives in low vegetation, in grass and other plants. Some species, mainly the ones that fly well, reside in bushes and trees.

Tiny and varied

Invertebrates of salt marshes

Unlike plants, there are only a few animal species strictly bound to salt marshes.

Most of the species occurring in salt marshes are those that favour the low vegetation of extensively farmed meadows and pastures, finding enough food there.

Among beetles, for example, the endangered species of **ground beetle** *Dyschirius salinus* is well adapted to high salt concentrations. In low vegetation, we can easily notice the **grasshopper** (*Aiolopus thalassinus*) or the **large conehead** (*Ruspolia nitidula*) cricket, which is of Afro-tropical origin. In dry grass areas, however, the grasshoppers must be vigilant because the **wasp spider** (*Argiope bruennichii*) weaves its nests here, and grasshoppers are among this spider's favourite prey. These spiders have their relatives in tropical areas.



Grasshopper *Aiolopus thalassinus*



Wasp spider

We can see a number of butterflies and moths in a salt marsh. Most of them are not as strictly bound to salt marshes as the moth *Cochylimorpha obliquana*, the caterpillars of which feed only on the stalk of *Artemisia santonicum*. If a salt marsh grows over and *Artemisia* is replaced by other plant species, this moth disappears from the salt marsh.

On the stalks and leaves of salt-marsh plants, even very close to salt eyes, lives the **land snail** (*Euomphalia strigella*). It is a common representative of molluscs at dry and warm sites and frequently occurs in salt marshes.

Artemisia santonicum and the moth *Cochylimorpha obliquana*



Dyschirius salinus



Land snail



Red-backed shrike

✦ Did you know that...?

The warning colouring of the fire-bellied toad's belly protects it against predators?



✦ Did you know that lizards hibernate in winter?

We can observe the sand lizard only from March to September because it spends the rest of the year hibernating in a shelter – in holes abandoned by rodents, or under stones or tree trunks – without eating any food and with limited breathing.



Sand lizard

✦ Did you know that the tawny pipit keeps guard over an area?

The pipit needs open spaces with thin grass cover and a few trees and bushes as its nesting and feeding habitat. There it can keep guard, sing and hunt.

✦ Did you know that the red-backed shrike has its own pantry?

The family name of the red-backed shrike, *Lanius*, means "butcher" in Latin. It refers to its food (insects, tiny vertebrates) but also to the shrike's habit of impaling its prey on thorns or prickly twigs to "carve" it more easily or to store it for later consumption.

Known and unknown

Vertebrates in salt marshes

There are several species of amphibians protected under the European Habitats Directive living in salt marshes. Among the most precious are the **European fire-bellied toad** (*Bombina orientalis*) and the **Danube crested newt** (*Triturus dobrogicus*). For the latter, Slovakia represents the north-west edge of its occurrence. In the summer, these amphibians feed mainly on mosquito larvae.

The **sand lizard** (*Lacerta agilis*) is among the reptile species protected under the European Habitats Directive. We can see it warming up in the sun or watching for insects in the open spaces of a salt marsh. In the more humid parts of a salt marsh, the **grass snake** (*Natrix natrix*) finds its environment for life.

In Slovakia, the **tawny pipit** (*Anthus campestris*) is a rare nester bound to steppe habitats, including salt marshes. In the thorny shrubs on a salt marsh edge we can find nests of the **red-backed shrike** (*Lanius collurio*) and the **Barred warbler** (*Sylvia nisoria*), which are songbirds also protected under the Habitats Directive.

Conspicuously coloured songbirds such as the **western yellow wagtail** (*Motacilla flava*) and the **common stonechat** (*Saxicola torquata*) will definitely capture your attention as they perch on tall grass stalks in salt marshes. Both species prefer open landscapes and build their nests on the ground. They feed mainly on insects; therefore, every autumn they fly thousands of kilometres to spend their winters in the warm south, mainly in Africa.

Tawny pipit

Common stonechat

As a hunting place, the habitats of salt marshes are important for the rare **red-footed falcon** (*Falco tinnunculus*), which feeds on large species of insects, mainly grasshoppers and crickets. The rare **saker falcon** (*Falco cherrug*) and the **western marsh harrier** (*Circus aeruginosus*) hunt rodents and birds here. During winter in the salt marshes, the **Northern harrier** (*Circus cyaneus*) enjoys feeding on voles.

The **short-eared owl** is a winter visitor in salt marshes, having roosting places at a number of sites. All these feathered predators are among the species protected under the Habitats Directive.

Of the mammals, the rare **steppe polecat** (*Mustela eversmannii*) prefers to live in salt marsh habitats, but we know very little about the occurrence of this beast. Its most important food is the **European hamster** (*Cricetus cricetus*). At dusk, the **common noctule** bat (*Nyctalus noctula*) hunts insects in these habitats.

* *Did you know that falcons do not build nests?*

The red-footed falcon, similar to other species of falcons living in Slovakia, is a colonial breeder, reusing the old nests of corvidae (birds of the crow family) – crows, magpies and ravens. Not long ago, the raven colonies near salt marshes were an ideal nesting place for the red-footed falcon. In optimal conditions, this social bird of prey nests in colonies numbering dozens of couples.

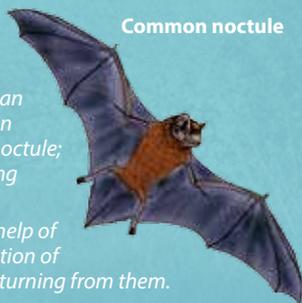
* *Do you know that...?*

Most bats produce sounds we cannot hear because their frequency is higher than human ears can capture. An exception is the common noctule; we can hear its loud chirping even during the day.

Bats get oriented with the help of echolocation – the localisation of objects based on echoes returning from them.

The head-down position is natural and comfortable for bats; it requires no effort. A special closing mechanism in their feet allows the claws to clench while the muscles are relaxed. By stretching the muscles, the claws relax and the bat can soar. The blood circulation in their bodies is also adjusted to this head-down position.

Common noctule



Red-footed falcon



Short-eared owl



Western yellow wagtail



Northern harrier



Western marsh harrier

Will they survive?

Threats to salt marshes

Salt marshes are naturally rare in the Danube region and their existence is determined by a specific interplay of ecological conditions. That is why they are so vulnerable and can quickly disappear if these conditions change.

The most significant problem is **land drainage**. For the existence of salt marshes, it is essential that ground water with a high salt content reaches the surface through capillary action in the wet periods of the year, resulting in salination of the upper most part of soil. However, almost the entire Danubian Lowland is interwoven with a thick network of canals, which has caused the level of ground water to drop far below the soil surface. This intervention has affected the salt marshes, and many of them disappeared or became significantly reduced after the surrounding lands were drained.

Another serious problem is the **absence of regular economic use, mainly grazing**. A few decades ago, livestock grazed on all the Slovak salt marshes. They were mainly cattle, sheep, and goats, but domestic poultry fed there, too. The animals grazed the land and prevented the accumulation of junk vegetation. In addition, they disturbed the soil surface, which benefited several tiny and competitively weak species. However, grazing gradually disappeared, and a few years ago only the Sĺky pri Močenku salt marsh was being grazed. **Where grazing ended, tall grasses and weeds began to grow, junk vegetation started to accumulate, and the soil surface lost contact with the saline ground layers. As a result, the sensitive halophytes disappeared.**

In the introduction to this brochure, we call the salt marshes "small islands in the sea of arable land". It is an appropriate name because today's salt marshes represent only remnants of natural vegetation in the intensively used farmland of the Danube region. The impacts of intensive agriculture, such as **excessive accumulation of nutrients (eutrophication)** and **weeds (ruderalisation)**, are a serious threat. Accumulation of nutrients supports the growth of tall grasses and weeds, which suppress the original salt-marsh vegetation. This new vegetation, in combination with the invasion of weeds from surrounding fields, can support the change of a salt marsh with low vegetation to an area thickly covered with tall weeds.

In addition, the **existing salt marshes are constantly being ploughed-up**; in 2002, for example, the most salinated part of the Mostové salt marsh was disturbed this way. Ploughed lands can support the growth of halophytes for a short time, but after a couple of years, the disturbed soil becomes occupied by weeds, speeding up the disappearance of the salt marsh. Also, the cultivation of salt marshes is not economical because salinated soils have very low productivity.

Last but not least, **forestation or construction activities** can threaten the existence of salt marshes. For example, as a result of forestation projects, some salt marshes near the village of Močenok disappeared, and construction activities seriously damaged the Bokrošské slanisko salt marsh.

At the beginning of **1960s, the area of salt marshes in the Slovak part of the Danube region** was approximately **8,300 ha**. By **2004**, this area decreased to about **500 ha**. In addition, the remaining salt marshes were in a very bad state, on the verge of immediate disappearance. In the last **50 years, we have lost almost 95% of the original area of the salt marshes in this region!**

There is still a chance

Conservation and ecological restoration of salt marshes

Due to a number of remarkable plant and animal species that live in these habitats, salt marshes became a centre of scientists' interest decades ago. Slovak nature conservationists have been trying to save them by declaring salt marshes nature conservation areas. Since as early as 1953, the Kamenínske slanisko salt marsh (probably the most famous salt marsh in Slovakia) has been protected, and today it is a National Nature Reserve. Gradually, other protected areas were declared. After Slovakia entered the European Union, the Slovak legislation regarding nature conservation was extended by the European one, based on which most of the salt marshes of the Danube region were included in the network of **Special Areas of Conservation**. The purpose of the network is to assure conservation of **species and habitats protected under the Habitats Directive**. In addition, they are part of the **Natura 2000 European network of nature protection areas**.

Although the legal protection of salt marshes is substantial, that alone will not save them. Only active interventions, so-called **ecological restoration**, will help.

Within the project LIFE+ *Restoration of endemic Pannonic salt marshes and sand dunes in southern Slovakia*, a number of activities are being implemented with a goal to improve the sad state of the salt marshes in the Danube region.

At several sites, **regular grazing** was restored in cooperation with local people, who provided and managed their own livestock. For areas where there was no local interest in grazing, project money was used to purchase a herd of sheep and goats, and these sites began to be grazed as well. Currently, the animals purchased by the project are rotated among these sites, but the goal is that local farmers will eventually see a benefit, take over and manage the grazing themselves.

Along with regular maintenance, attention is also being given to **restoration of the optimal water regime**, for example, by filling in drainage canals or building shallow depressions where salts can precipitate.

All measures follow the goal of returning the salt marshes of the Danube region to their inhabitants – halophyte plants and animals bound to these habitats.

If you visited the Kamenínske slaniská salt marsh before 2013, only with difficulty could you have found some remnants of halophytic vegetation, retreating under the pressure of tall grasses and weeds. As part of the project, a fence was built around the site in cooperation with a local farmer in 2013. That autumn, a herd of horses, goats, water buffalo, mangalicas, and Hungarian grey cattle started to graze on the area. The site is gradually changing beyond recognition; tall weeds and grasses are disappearing, and halophytic vegetation is recovering. In 2015, the village livestock will also start grazing on the Kamenínske slaniská salt marsh. Since the beginning of the project, grazing has been restored at other salt marshes as well: Mostové, Šurianske slaniská, Pavelské slanisko, Bokrošské slanisko and the Pri Orechovom rade salt marsh. In total, 260 ha of these marshes are now used for grazing.

If you wish to learn more about our salt marshes, we recommend the following materials:

- Dítě, D., Eliáš, P. ml. Melečková, Z. Ohrozené druhy slanísk a ich spoločenstvá na Slovensku/ Endangered types of salt marshes and their communities in Slovakia. *Životné prostredie*, 2011, 45, 5. p. 256 – 259.
- Dítě, D., Melečková, Z., Eliáš, P. ml. & Janák, M. Manažmentový model pre biotopy slaných pôd/ Management model for saline soil habitats. DAPHNE – Institute of Applied Ecology and Botanical Institute of the Slovak Academy of Science, Bratislava, 2011. 28 p. URL: http://www.daphne.sk/sites/daphne.sk/files/uploads/MM01_slaniska_0.pdf
- Chrenková, M., Kráľovičová, A. Svet slanísk pre mladých objaviteľov/The World of Salt Marshes for Young Discoverers. DAPHNE – Institute of Applied Ecology, Bratislava, 2015. 54 p.
- Web page focused on windblown sands and salt marshes of the Danube river region: www.perlypodunajska.sk

Special areas of conservation in the Danube river region with salt marshes

Name and code of SAC*	Area in ha	Cadastre	The most significant halophyte species (plants of saline soils)	Characteristics of the salt marsh
SKUEV0076 Bokrošské slanisko	10,2	Iža	Western pontic, golden ragwort	Remnant of the northern most projections of Hungarian salt puszta
SKUEV0080 Juhásove slance (Bačove slaniská)	59,28	Hájske, Horná Kráľová	Saltmarsh sandspurrey, swamp pricklegrass, Pholirus pannonicus, plantago tenuiflora	Remnants of salt meadows and marshes
SKUEV0068 Jurský Chlm	104,6	Búč, Mužla	Cirsium brachycephalum, salt marsh iris	In the alluvial part of the site – there are salt meadows in a mosaic with marshes
SKUEV0066 Kamenínske slaniská	119,44	Kamenín, Kamenný most	Siberian statice (the only site in Slovakia), western pontic, salt marsh iris, Galatella punctata	The most extensive preserved area of salt meadows in Slovakia
SKUEV0010 Komárňanské slanisko	14,55	Komárno	Pholirus pannonicus	Salinated terrain depression surrounded by arable land
SKUEV0078 Mostové	22,55	Veľké Kosihy	Western pontic, threebract loosestrife (one of two sites in Slovakia)	Halophyte vegetation of steppe character, soil layers typical for undisturbed salt marshes
SKUEV0095 Panské lúky	73,49	Tvrdošove	Crypsis aculeata (the only site in Slovakia), saltmarsh sandspurrey, swamp pricklegrass, goosefoot	Two parts: Panské lúky – well preserved salt marsh habitat and Ráčzovo jazierko – significant habitat with occurrence of rare halophyte species
SKUEV0099 Pavelské slanisko	18,61	Komárno-Nová stráž	Plantago tenuiflora	A preserved remnant of salt marshes of steppe character
SKUEV0017 Pri Orechovom rade	1,69	Komárno	Blackstonia acuminata	A small remnant of salt marshes, a site important for the occurrence of several orchid species
SKUEV0088 Siky	32,51	Močenok	Western pontic, saltmarsh sandspurrey, plantago tenuiflora, wall barley – largest population in Slovakia	Until recently, it was the only regularly grazed salt marsh in Slovakia
SKUEV0096 Šurianke slaniská	188,72	Šurany	Western pontic, Cirsium brachycephalum, wall barley	A salt marsh complex consisting of a mosaic of salt steppes, meadows and marshes; it has two parts – Akomáň and Číky

*SAC – Special Area of Conservation of the Natura 2000 network

Special areas of conservation in the Danube river region with salt marshes

