

# The occurrence and conservation status of *Convolvulus persicus* L. (Solanales: Convolvulaceae) on the western Black Sea coast – Romania

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**Abstract:** *Convolvulus persicus* L. is one of the coastal plant species which is endemic for the sandy habitats from the Caspian Sea and Black Sea coastal regions. Due to increasing of the antropogenic pressures, *C. persicus* has become a threatened species all around of its geographical area. Nowadays, on the Black Sea coast, *C. persicus* population have survived only in protected areas from Romania, Bulgaria and Turkey. The biggest populations are in the Danube Delta Biosphere Reserve, on the sandy shore which lie between mouths of the Sulina and Sfântu Gheorghe arms of the Danube River. *C. persicus* is a pioneer plant species, a valuable sand dune builder within the beach foredune system, an ecological function which has to be taken into consideration not only for sand dunes conservation but also for biodiversity conservation management activities. This paper assesses the conservation status of *C. persicus* on the Romanian coastal area of the Black Sea, main threats, and the strategies that are approached in order to protect and preserve it.

**Key words:** Ponto-Caspian endemic, Danube Delta, *in-situ* conservation

## Introduction

Diminishing biodiversity and accelerating rates of extinction is one of the human “signatures” on the Earth that define the Anthropocene epoch (WATERS et al. 2016). At the global level, based on IUCN criteria, more than one in five of plant species assessed are threatened with extinction (BRUMMITT et al. 2015). Coastal zones are heterogeneous habitats with high species biodiversity, and plant species living in sandy shores are characterized by different functional adaptations. Some of them are rare or endemic, strictly dependent by particular habitats. *Convolvulus persicus* L. is a regional coastal endemic plant species that occurs sparsely only on the sandy shores from Caspian Sea and Black Sea coasts.

*C. persicus* is one of the few species belonging to *Convolvulus* genus that is outstandingly distinct (WOOD et al. 2015). *C. persicus* (Persian bindweed) was described by CARL LINNÉ in 1753 as “*Convolvulus foliis ovalibus tomentosis, pedunculis*

*unifloris*” (LINNÉ 1753: 158). The name of the species is related with the place where it was first time found: “Habitat in Persia, ad maris Caspici littus” (LINNÉ 1753: 158). However, the Linnaean name of this plant species was newly typified (STAPLES & JARVIS 2006) because the specimen belonging to the Linnean Herbarium post-dates 1753 and it is not original material eligible as a lectotype (SA’AD 1967, STAPLES & JARVIS 2006) in accordance with article 9.2 and article 9.8 of the International Code of Nomenclature of Algae, Fungi and Plants (MCNEILL et al. 2012). The neotype that was designed for the new typification is a specimen collected from Black Sea coast, Turkey (“Constantinopol. In arenosis maritimis prope “Kila”, Julio 1899” Herbarium Normale ed. I. DÖRFLER, no. 3865, G.V. Aznavour s.n. (BM)”) (STAPLES & JARVIS 2006). Furthermore, STAPLES & JARVIS (2006) state that the taxonomic concept for *C. persicus* as is understood today was

effectively established by SA'AD (1967). However, in the "The Plant List" data base, *Convolvulus persicus* L. is mentioned as an unresolved name (<http://www.theplantlist.org/tp1.1/record/tro-8502220>).

The habitat of *C. persicus* is naturally fragmented. A possible explanation of disjunct distribution of *C. persicus* could be related with the paleogeographic evolution of East Parathethis basin during Miocene toward two separate marine basins - Black Sea and Caspian Sea (VASILIEV et al. 2010) but which were connected each other during Quaternary transgressions (ABREU & NUMMEDAL 2011). *C. persicus* is a pioneer perennial plant species of sandy shore (embryo dunes), the patch level process of its habitat is linked with the oscillations of sea level in the last 2000 years and with the genesis of beach ridge plains, sand barriers and coastal dunes.

Coastal areas with suitable habitats for *C. persicus* have been modified, destroyed and reduced by increasing of human pressures in the last century as well as by the natural processes as coastal erosion and dramatically changes of the shorelines along the Caspian Sea coast due to sea level oscillations (GOLUBTSOV & LEE 1997, GOLITSYN et al. 1998, IGNATOV et al. 1983, BENI et al. 2013).

Consequently, the species has become critically endangered and nowadays the majority of the sites with *C. persicus* populations are inside of different categories of protected areas types from Iran (EJTEHADI et al. 2003, NAQINEZHAD et al. 2006, TAJALI & KHAZAEIPOOL 2012, GHORBANLI et al. 2010, RAVANBAKHSI et al. 2015), Azerbaijan (TEGETMEYER et al. 2007), Romania (DIHORU & NEGREAN 1976, CIOCÂRLAN 1994, STRAT 2005, 2007, 2009, 2016, SÂRBU et al. 2007, DIHORU & NEGREAN 2009), Bulgaria (PETROVA 2011) and Turkey (OZTURK et al. 2012, ÖZHATAY & YÜZBAŞIOĞLU 2014). This plant species is nominated on the national Red Lists in Bulgaria (PETROVA 2011) and Romania (OLTEAN et al. 1994). In Georgia, this taxon is cited as extinct in the wild (MATCHUTADZE et al. 2015) although, it is mentioned as characteristic species for the "Embryonic shifting dunes" habitat type (AKHALKATSI 2010). It is not included into Black Sea Red Data Book (DUMONT et al. 1999).

*C. persicus* is a valuable medicinal plant. Local people from Danube delta used to use aerial parts of *C. persicus*, named "Fisherman's tea" for treating cough (BUTURĂ 1979). Twenty constituents were described in *C. persicus* and the extract of Persian bindweed showed significant antioxidant activities (DEHGHAN et al. 2015, 2016). Active products from aerial parts were tested for the treatment Alzheimer's disease (GHOLAMHOSEININ et al. 2009). The aim of

this paper is to present the actual chorology of *C. persicus* along the Romanian Black Sea Coast, its conservative status, the methods of conservation and main threats.

## Material and methods

A critical review of the literature regarding geographical distribution, biology, ecology, protection and conservation of *C. persicus* was carried on with special attention for it in Romania. In addition, original data and observations that were collected during the field works on the Danube delta shore over the last 10 years. The occurrence of *C. persicus* in the sites that are quoted according to Romanian Flora (GRINȚESCU 1960) and national Red Book (DIHORU & NEGREAN 2009) were checked as follows: Agigea (2009, 2013), Sfântu Gheorghe (2003 and every year since 2005), Cardon (2000, 2005) and Sulina (2000, 2001, 2008, 2014, and 2016). Also, field observations were carried out regarding the size of populations, types of habitats, accompanying species along the deltaic shore, type methods of active *in situ* conservation.

## Results

### General description of the study site

The Romanian Black Sea coastline has 256 km length subdivided into two major sections: the Northern part of sandy shores, in the area of deltaic and lagoonal littora l, and the Southern part, mainly composed by a soft sea-cliff coast, small lagoon barriers and pocket beaches. The boundary between the North and South Romanian Black Sea coast is marked by Midia Headland.

The climate is temperate continental with pontic influences. Mean multiannual air temperatures are around 11 °C but has increased with 1°C in the first decade of 21<sup>st</sup> century (STRAT 2010, 2015). In the summer season, mean air temperature are higher than 25 °C around 60 days, but rarely more than 30 °C (STRAT 2010). Mean annual precipitations range from around 350 mm, in North side, at Sulina, to 460 mm, in Southern side, at Mangalia. Based on the RIVAS-MARTINEZ et al. (1999), for the last two decades the bioclimate of this coastal area was assessed as mediterranean xeric continental (STRAT 2010). The mean length of thermal growing season is around 270 days and it has increased with around 30 days in the last six decades (STRAT 2015).

The human pressure has increased dramatically in the Southern part of the Romanian Black being most pronounced within the metropolitan region of

Constanța, the genuine morphology of shore was irreversibly changed and natural habitats have been lost. In contrast, the Northern area of Romanian Black Sea coast, Danube delta coast, is still well preserved, with a high degree of natural state, despite of tourism activities. Biodiversity assessment of the coastal zone from Romania, based on Mean Species Abundance index, which is a composite index of 'naturalness' of ecosystems, reveals the highest values from Europe (LAVALLE et al. 2011).

### Biology and ecology of *Convolvulus persicus* L.

*C. persicus* is a clonal species from the genus *Convolvulus*. Its elongated rhizomes have many shoot buds and one clone often has many branched aerial shoots that make clumps around the nodes (ramets). Long and branched roots are deeply buried in sand. Older individuals of *C. persicus* may form large clusters with several branched and unbranched stems. Slender rhizomes intermingle with each other under the ground when two or more clones coexist (GRINȚESCU 1960, BURDUJA et al. 1966). Plant is tomentose (Fig 1), with petiolate leaves of 1–3.5 cm wide, not markedly hastate or sagittate at base. The high hairs density is plant response to sand blasting, salt-spray, and high sunlight. It produces white, bisexual, funnel-shaped, herkogamous flowers with delicate fragrance in leaf axils that are pollinated by insects. Single flowers open sequentially from the bottom to the top of their shoot, the corolla is undulate to 5-lobed, and on the exterior, there are five pink-purple hirsute bands which terminate at the apex of each corolla lobe. The fruit is a capsule with 2-4 brown dormant seeds. During field surveys on Danube delta shore no *C. persicus* germinated seeds were observed. Vegetative reproduction is prevalent, stimulated by moderate sand burial. The growth pattern is intermediate between the guerilla and phalanx strategies. It spreads laterally by using foraging rhizomes that grow through the sand. Wave eroded features and dune sand deflation may expose and fragment rhizomes (Fig 1). At the end of the vegetation period as drought proceeds, epigeal parts of the plant gradually shrink, lose their leaves, but underground rhizomes remain firm and viable over the winter, and respond to the arrival of new growing season by sprouting new ramets in early April.

On the shore dunes, the landward extent of *C. persicus* is influenced by clonal dispersal and competition from taller plants. It does not naturally invade inland sites but is able to survive in sites that are far away from the present seashore, if the mobile sandy habitats are still preserved (STRAT 2009). In this case, it is a valuable additional indicator of



**Fig. 1.** *Convolvulus persicus* on the shifting dunes from Sulina (A). Exposed rhizomes of *C. persicus* caused by sand deflation on the fore dunes from Sf. Gheorghe shore (B).

the past shoreline positions, a storyteller of coastal morphodynamics. The seaward extent is regulated by the physical environment through the movement of rhizomes away from the drift line, the mortality in the back shore caused by episodically seawater flooding, and by the wave erosion of shore dunes. *C. persicus* is an early successional plant on the sandy shore and needs low competition and an important colonizing species on sandy high beaches where it promotes embryonic dune formation and serves to stabilize topographically important primary dune systems. Growing rhizomes and long roots trap shifting sand. In that way, *C. persicus* stabilizes the sand, and therefore it is a bio-constructor geomorphological agent. The only one potential competitor, in terms of more efficient sand binder perennial plant species, is *Leymus sabulosus* but this species occurs very sparsely. Along the Danube delta shore, *C. persicus* is associated with: *Aeluropus littoralis* (Gouan) Parl., *Artemisia tschernieviana* Besser, *Atriplex littoralis* L., *Cakile maritima* subsp. *euxina* (Pobed.) Nyár, *Centaurea arenaria* M.Bieb. ex Willd., *Corispermum nitidum* Kit., *Cuscuta* sp. *Cynodon*

*dactylon* (L.) Pers., *Elymus farctus* subsp. *bessari-bicus*, *Ephedra distachya* L., *Eryngium maritimum* L., *Euphorbia seguieriana* Neck., *Hippophae rhamnoides* L., *Leymus sabulosus* (Bieb.) Tzelev., *Linaria genistifolia* subsp. *euxina* (Velen.) D.A.Sutton, *Petasites spurius* (Retz.) Rchb, *Polygonum arenarium* Waldst. & Kit., *Salsola kali* subsp. *ruthenica* (Iljin) Soó, *Scolymus hispanicus* L., *Secale sylvestre* Host., *Tournefortia sibirica* L., *Xanthium strumarium* L. (STRAT 2005, 2016).

## Discussion

### Occurrence of *Convolvulus persicus* L. on the western Black Sea coast – Romania

Most probably, on the Black Sea coast, for the first time, the occurrence of *C. persicus* was noticed by the English botanist JOHN SIBTHORP (SMITH 1832). In August 1794, during his journey to Greece, he collected *C. persicus* seeds of from Domusderi sands, close to Bosphorus (SMITH 1832). In Romania, *C. persicus* was discovered in 1915 (SĂVULESCU 1915, PETRESCU 1915) at Agigea, on sand dunes, no longer connected to the sea. Later, this taxon was noticed in other sandy sites along the coastline. Thus, in “Flora României” (GRINȚESCU 1960) are mentioned four sites: three in the Southern part of the littoral, at North and South of Constanta city, and one within Danube Delta, on the sea shore, near the mouth of Sf. Gheorghe arm of the Danube River. Later, several other sites have been discovered within Danube Delta. DIHORU & NEGREAN 2009 cited 14 occurrence sites, of which two are on the barrier lagoon Razelm-Sinoe, and 8 sites in Danube delta. Nowadays, the occurrence of *C. persicus* in Romanian is certified in five sites (Fig. 2): Agigea (44°05'18" N, 28 38'33" E), Sf. Gheorghe beach (Sărăturile beach) (44°53'29" N, 29 37'22" E), Sacalin Island (44°46'21" N, 29 30'13" E), Sulina beach (45° 08'456" N, 29° 41'28" E) and Cardon (45°14'28" N, 29 37'40"E). The last four sites are located in Danube delta.

### Conservative status and main threats of *Convolvulus persicus* in Romania

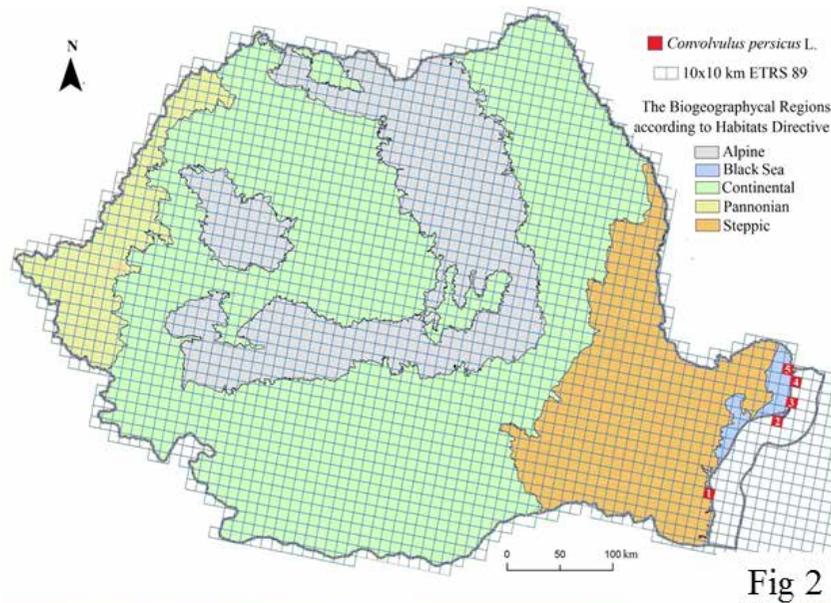
Since it was discovered at Agigea, botanists has treated *C. persicus* as a “privileged” species. Its floristic importance was highlighted as follows: “This plant species gained a particular interest not only for our country, but also for the European flora, because until present it was known only for Constantinople region” (SĂVULESCU 1915: 70).

On the National Red List of vascular plants (OLTEAN et al. 1994) *C. persicus* is considered as rare species (Red Book of vascular plants from

Romania), later being considered as critically endangered species (DIHORU & NEGREAN 2009).

On the inter-distributary sandy shore Sulina – Sf. Gheorghe, there are the biggest populations of *C. persicus* from Romania, developed along almost 3 km length, on the Sulina beach, and along almost 10 km length, North of the Sf. Gheorghe mouth. The plant species forms patches on the high beaches and fore-dunes and the area of occupancy of populations has been increased in the last two decades (STRAT 2016). We believe that the positive trend of the area of occupancy is positively correlated with the dynamic and morphology of the shore. In both shore sectors with *C. persicus* populations in the last decades sand accumulation and surface aggradation occurred (PREOTEASA & VESPREMEANU-STROE 2017). Morphologically, these coastal processes formed wide beaches, embryo dunes and perennial fore dunes which mean suitable habitats for *C. persicus*. Progressively, as fore dunes were developed, *C. persicus* has colonized them. Another example is Sacalin Island, a sand barrier spit formed at the South side of Sf. Gheorghe arm mouth in the last 120 years by constant southward elongation, having around 20 km length. *C. persicus* colonized the Southern part of Sacalin Island, which is the youngest part of it, with mobile sand dunes. On the contrary, the populations from Agigea are the smallest from Romania, covering only about 100 m<sup>2</sup> and in order to ensure the survival and to maintain a suitable habitat, managing activities are required. The site from Cardon is located inland of Danube delta, in area of the marine delta, within the Letea beach ridge plain, which represents former shorelines alignments, dated around 1 000 years old (VESPREMEANU-STROE et al. 2017). Nowadays, these dunes are around 10 km away from sea, and from ecological point of view they are in a transitional stage between white dunes and grey dunes, still providing a suitable habitat for *C. persicus*.

The threats to the survival of rare plant species *C. persicus* along the Romanian Black Sea coast are both natural and anthropogenic. To preserve rare species in a dynamic environment as are the coastal dunes, it is imperative to account for temporal and spatial shifts in the distribution of suitable habitat. Based on current habitat suitability, on the long-term, the survival of populations from two occurrence sites – Agigea and Cardon – is vulnerable to ecological succession. Due to the main required abiotic condition (mobile sand dunes), the species is at risk from the spread of scrubs and trees, and even to perennial grass vegetation. The general trend from an ecological and geomorphological perspective of



**Fig. 2.** Distribution of *Convolvulus persicus* L. in Romania in ETRS 10x10 km grid cells. The number indicates the occurrence sites of *Convolvulus persicus* inside of grid cell: 1 – Agigea, 2 - Sacalin Island, 3 – Sf. Gheorghe, 4 – Sulina, 5 – Cardon.

**Fig. 3.** The suitable habitat for *Convolvulus persicus* along the deltaic shore Sărăturile, north to Sf. Gheorghe arm mouth of the Danube River.

these coastal dunes is towards increasing stabilization and succession towards rank grasslands, scrub and woodland, especially in the Cardon area. During the successional phase from white dunes to grey dunes it is expected that *C. persicus* to be replaced by other plant species according to local bioclimatic conditions, without the possibility of migration to another available habitat area.

Along the deltaic shore Sulina-Sf. Gheorghe, the vulnerability of *C. persicus* needs to be assessed taking into account the impact of climate change, sea level rise trend on the western Black Sea coast and

changes in Danube River sediment discharges that control the ratio between accretions and erosion processes. Sea level rise is the principal forcing function in shoreline retreat along sandy coasts worldwide and significantly retreat results from erosion that is the main effect on low-lying sandy coasts (ASHTON et al.2011). Based on positive trend of global sea level rise (BINDOFF et al. 2007), beach erosion prediction for the entire Black Sea coast suggests a dramatic impact on beaches (VELEGRAKIS et al. 2009), but particular studies within Danube Delta area are required. In order to predict if *C. persicus* will loss

the suitable current habitat in the region due to sea level rise effects and climate changes, species distribution model have to be developed and included in management plans of conservation of dune habitats. As long as the shoreline is under prevalent accretionary processes, it will be suitable habitat for *C. persicus*.

Within Danube delta, the main anthropogenic stressors are touristic activities and local land use. Because both beaches, Sulina and Sf. Gheorghe, have become very popular in the last two decades, human pressure has increased. In Sulina area, the dune habitats with *C. persicus* populations are exposed to human trampling, all-terrain vehicle rides, urbanization and infrastructure development. Cattle overgrazing and cattle trampling are main sources of habitat degradation in the neighborhood of Sf. Gheorghe village. Spread of bushes species (*Hippophaë rhamnoides* L.), ruderal species and invasion of non-indigenous plant species are other threats.

### Protection and conservation of *Convolvulus persicus* L. in Romania

At the national level, in order to protect *C. persicus*, both *in situ* and *ex situ* strategies have been adopted. All extant populations of *C. persicus* are located in protected areas: the botanical reserve “Dunele marine de la Agigea” and Danube Delta Biosphere Reserve. Due to *C. persicus* is naturally rare, the protection of its habitat was taking into account in the years following its discovery (SĂVULESCU 1915), by the biologist ION BORCEA, in 1928 at the first Congress of Romanian Naturalists. At that moment, unofficially, in the area of coastal dunes from Agigea, ca. 600 m<sup>2</sup> area populated with *C. persicus* and other rare plants (the endemic *Alyssum borzaeanum* E. I. Nyarady, *Ephedra distachya* L.) was fenced (<http://www.bio.uaic.ro/agigea/rezervatie.html>). In 1939, the botanical reserve “Dunele marine de la Agigea” was legally established. Later, owing to the exceptionally rich flora and presence of threatened plant species, the area was designed as Important Plant Area (SÂRBU et al. 2007) and Natura 2000 site (ROSCI0073), in order to protect “2130 Fixed coastal dunes with herbaceous vegetation (grey dunes)” habitat type. These coastal dunes are protected against wind action and far away from sea and waves attack. They look like relict dunes, a sample of the former wild Black Sea coast that evolved in isolation to coastal processes. For this reason, in the area where there is *C. persicus* populations, dunes are weeded and the sand is kept loose by manual works to restore open dune conditions with mobile sand. Therefore, only the small patches of bare

sand generated by artificial reworking of sand dunes help to conserve the habitat in the dynamic dune type in order to provide a niche for *C. persicus*.

Considering typical zonation of the biosphere reserves, at the moment of designation of DDBR, in 1993, the sites with *C. persicus* populations were not included into strict protected areas. On the other hand, the Danube delta was designed site of community importance (ROSCI0065), and although *C. persicus* is not listed as species of community importance, it occurs in two habitats of community importance: “1210 Annual vegetation of drift lines and „2110 Embryonic shifting dunes”. Thus, along the Sulina - Sf. Gheorghe shore, *C. persicus* is one of the characteristic species of “2110 Embryonic shifting dunes” habitat type (FĂGĂRAȘ 2013). Also, it occurs on the high beaches, in drift line communities (Fig. 3), among the earliest perennials species of future embryo dunes (STRAT 2016).

To reduce the exposure of *C. persicus* to human impacts, an active management of its habitats from the Danube delta shore was approached. On the Sulina shore area, in the middle of the public beach, a special area with *C. persicus* was protected with a reed fence with a prohibited access of people inside. Although the fence is less 1 meter in height and is not visually intrusive but attracts excessive attention, it acts as a trap for the sand moved by wind, affecting not only the local geomorphology of area but also the pattern of distribution of the *C. persicus* populations. Because the fence interacts with the sand drift driven by characteristic dominant winds from area, sand has accumulated along the fence and in the middle of the enclosure sand deflation has created a depression. The fencing changed general topography of designed area and abiotic habitat conditions. Consequently, the plant has migrated to dunes formed along the reed fence and outside of it. The “escaping” of *C. persicus* from the area that was special designed for its protection, is a valuable lesson about how works the nature. The development of appropriate conservation *in situ* methods for plant dune species needs an integrative approach: apart from a fuller understanding of the biology and ecology of that species, a basic understanding of processes that control coastal dune systems is required.

As *ex-situ* conservation strategy for *C. persicus*, *in vitro* approach was also carried out. Germinated seeds were used as starting plant material for an *in vitro* preservation optimized protocol, plant vegetative organs being highly contaminated with fungi (HOLOBIUC et al. 2015). Tissues cultures have been preserved in the collection of the Institute of Biology from Bucharest (<http://www.ibiol.ro/>). Regarding

the genetic stability of individuals belonging to different clones regenerated through direct morphogenesis, biochemical analysis showed no genetic alterations (HOLOBIUC et al. 2015).

Preliminary studies concerning the variability in *C. persicus* natural population from Sulina, based on the analysis of catalase pattern showed a certain level of polymorphism (VOICHIȚĂ et al. 2013).

## Conclusions

In Romania all populations of *C. persicus* are located in protected areas. At the moment, on the Black

Sea coast, the Danube delta shore is the optimal habitat of *C. persicus*, and a suitable refuge at the western limit of its geographic range. The deltaic shore Sulina-Sf. Gheorghe, as well as Sacalin Island, are reference systems, regionally representative, for a typical suitable habitat of *C. persicus*. The future conservation management measures need to take into account the evolution of the coastal area under sea level rise and climate change conditions. Owing to the biodiversity value of this taxon for Black Sea biogeographical region, both countries, Bulgaria and Romania, have to propose adding of *C. persicus* in Annex II of the Habitats Directive.

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