

# BIODIVERSITY OF CROATIA

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## **Biodiversity of Croatia**

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WILD  
&  
DOMESTICATED TAXA

# INTRODUCTION

Due to its specific geographical position on the dividing line between several biogeographic regions and due to its characteristic ecological, climatic and geomorphologic conditions, **Croatia is one of the richest European countries in terms of biodiversity.** The great diversity of land, marine and underground habitats has resulted in a wealth of species and subspecies, including a significant number of endemics.

Unfortunately, there is still not a comprehensive inventory of Croatian biodiversity, particularly of the invertebrate taxa. **New species and subspecies are being discovered each year.** Over the past five years, 198 new taxa of terrestrial invertebrates, 146 taxa of freshwater invertebrates and 20 taxa of marine invertebrates have been registered in Croatia. In 2005, an endemic fish species new to science was discovered and described in the small Norin River in the Neretva Delta area. This indicates that the true biodiversity in Croatia is even greater than the existing data present.

The number of known species in Croatia is around 37,000 though the estimated number is far higher – from 50,000 to over 100,000. This is a very significant number for a relatively small country.

One of the reasons for the **large number of endemics** in Croatia, and especially tertiary relics, is the fact that this area was not greatly affected by glaciation. The main centres for endemism of flora are the Velebit and Biokovo mountains while endemic fauna is most represented in underground habitats (cave invertebrates, the olm), the islands (lizards, snails) and the karst rivers of the Adriatic drainage basin (minnows and gobies).

Croatia contains significant populations of many **species that are threatened at the European level.** These are connected to preserved large areas of their habitats. Vast mountain beech and fir forests are rich in bear, wolf and lynx populations. Large wetland complexes with alluvial forests are important breeding, migration and wintering sites for European waterbirds and for wetland birds nesting in forests, such as the white-tailed eagle, black stork and lesser spotted eagle. The wealth of marine biodiversity, in combination with the immense diversity of islands and cliffs with endemic life forms, gives the Croatian coastal area international significance.

Although Croatian nature is of high value, many of its components are **threatened.** The Red List of Threatened Species, within the analysed groups (vertebrates, butterflies, dragonflies, cave fauna, vascular plants and fungi) lists 1131 threatened taxa. All these taxa are **strictly protected** by the Regulation on Protection of Wild Taxa enacted in January 2006. This Regulation divides species of conservation interest into strictly protected and protected, in accordance with relevant inter-



Endemic genus and species - Velebit degenia (*Degenia velebitica*) has been registered only on three sites in Croatia and nowhere else in the world (photo: S. Bogdanović)

national legislation (the Bern Convention, Birds and Habitats directives).

The most significant **threat to wild species** is habitat loss and degradation. Even today, there is great pressure to convert natural habitats into building or intensive agricultural land. Additionally there is significant habitat fragmentation occurring, especially through construction of roads and other traffic corridors. Besides these threats, excessive exploitation through hunting, fishing and forestry, intensive agriculture, pollution of water, soil and air as well as introduction of allochthonous species are also of great concern.

*Radović's goby (Knipowitschia radovici)* was discovered in the Neretva drainage basin in Croatia and described in 2005. There are nine species of this genus in the Mediterranean area, most are endemic. They live in isolated freshwater habitats vulnerable to human threats and therefore need protection of their habitats.



Photo: M. Kovačić



	Total no. of known taxa	No. of endemic taxa	Endemic taxa / %
Plants	8,582	485	5.65
Fungi	3,800	0	0.00
Lichens	930	82	8.82
Mammals	101	5	4.95
Birds breeding/total	234/375	0	0.00
Reptiles	38	9	23.68
Amphibians	20	6	30.00
Freshwater fish	150	18	12.00
Marine fish	433	6	1.39
Terrestrial invertebrates	15,474	351	2.27
Freshwater invertebrates	1,780	172	9.66
Marine invertebrates	5,647	1	0.02
<b>TOTAL</b>	<b>36,955</b>	<b>1,135</b>	

	Total no. of taxa	Threatened taxa (RE/CR/EN/VU/DD)	Threatened taxa (RE/CR/EN/VU/DD)/%
Vascular plants	5,347	574	10.73
Fungi	3,800	314	8.26
Mammals	101	19	18.81
Birds breeding/total	234/375	86	22.93
Reptiles	38	10	26.32
Amphibians	20	6	30.00
Freshwater fish	150	76	50.67
Marine fish	433	73	16.86
Butterflies	180	28	15.56
Dragonflies	71	31	43.66
<b>TOTAL</b>	<b>13,375</b>	<b>1,131</b>	

Data on total number of known taxa, endemic taxa and threatened taxa in Croatia - for threatened taxa numbers for five main IUCN categories (out of seven) are given. IUCN categories - EX-extinct; RE-regionally extinct; CR-critically endangered; EN-endangered; VU-vulnerable; NT-near threatened; LC-least concern, DD-data deficient



Polyps of *Parazoanthus axinellae* - a cnidarian representative of rich biodiversity of the Adriatic Sea (photo: NP Telašćica, D. Petricoli)

# PLANTS

According to the available data, Croatian flora consists of **8,582 known taxa**, while certain estimates put this number at almost 10,000 taxa. The ratio of plant species to territory puts Croatia amongst the three European countries richest in flora (with Slovenia and Albania).

## No. of taxa in main groups of plants

group	no. of known taxa	estimated no. of taxa	known (%)
algae	2,597	3,717	69.87
mosses	638	700	91.14
vascular plants	5,347	5,500	97.22
<b>TOTAL</b>	<b>8,582</b>	<b>9,917</b>	<b>86.54</b>

It is presumed that up to 14% of the plant taxa in Croatia has not yet been registered. While the list of vascular plants is mostly complete, the mosses have not yet been inventoried due to a lack of specialised researchers. Algae are well known in certain areas while in others, there is virtually no data (central Adriatic, watercourses, caves, etc).

## No. of taxa in main groups of vascular plants

GROUP		No. of TAXA	
ferns		86	
spermatophytes (seed plants)	gymno- sperms	<i>Cycadophytina</i>	7
		<i>Coniferophytina</i>	40
		<b>total</b>	47
	angio- sperms	<i>Magnoliopsida</i>	4,277
		<i>Liliopsida</i>	937
		<b>total</b>	5,214
<b>total</b>		5,261	
<b>vascular plants - total</b>		<b>5,347</b>	

Of the total number of known plant taxa, as much as 5.65% is **endemic**. The highest endemism is among vascular plants (total number of 326 taxa) and algae (152 known endemics).

A particularly large number of endemic plants can be found on the Adriatic islands and in high mountain areas of the Biokovo and Velebit mountains. Among the mountain endemics, there are a large number of tertiary relics. The screes of the Central Velebit area are habitats of the well-known endemic species Velebit degenia (*Degenia velebitica*).

Island endemics have mostly developed due to isolation. The most island endemic taxa belong to genus *Centaurea*.



Biokovo bellflower (*Edraianthus pumilio*), endemic species of the Biokovo Mountain (photo: A. Alegro)



Velebit degenia (*Degenia velebitica*) grows on screes of the Velebit Mountain (photo: T. Nikolić)



Endemic Dubrovnik knapweed (*Centaurea ragusina*) inhabits crevices of the steep coastal cliffs (photo: SINP)



## No. of endemic taxa in main groups of plants

GROUP	NO. of TAXA	ENDEMICS	
		No.	%
algae	2,597	152	5.85
mosses	638	7	1.72
ferns	86	2	2.33
gymnosperms	47	1	2.12
angiosperms	5,214	323	6.19
<b>TOTAL</b>	<b>8,582</b>	<b>485</b>	<b>5.65</b>

The Croatian **Red book** of threatened vascular plants comprises 760 taxa which represents 14.2% of Croatian flora. The main cause of threat to Croatian flora are habitat loss or degradation due to the anthropogenic impacts, mostly through agriculture, exploitation, industry development, tourism, infrastructure and settlement construction, habitat drainage, irrigation, etc. Loss of natural habitats is a cause of threat for 62% of Croatian threatened taxa. The greatest impacts are from degradation or loss of water dependent habitats. Many specialized species dependent on habitats influenced by vegetation succession are also threatened, such as the species of bog and sand habitats.



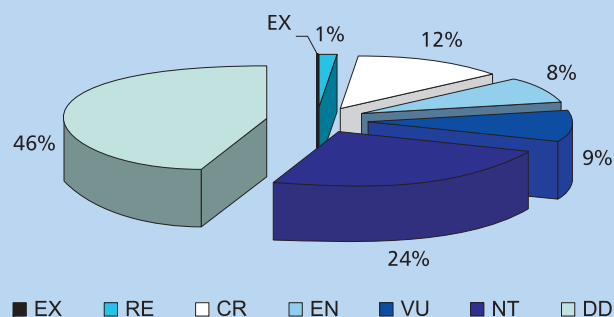
Critically endangered common butterwort (*Pinguicula vulgaris*) on fens along the Dretulja River near Plaški (photo: SINP)

According to the Nature Protection Act (*Official Gazette* no. 70/05), strictly protected species comprise 809 plant taxa (including 37 species listed on Annex II of the Habitats Directive), while protected species include 331 taxa.



Upright water clover (*Marsilea quadrifolia*), one of 37 NATURA 2000 plant species in Croatia (photo: SINP)

## Share of individual threat categories in the total number of threatened taxa of vascular plants



Adriatic wrack (*Fucus virsoides*), endemic brown alga of the Adriatic Sea (photo: D. Zavodnik)



Red bog moss (*Sphagnum rubellum*) found on protected Blatuša bog (photo: SINP)



# FUNGI AND LICHENS

The estimated number of **fungi** in Croatia is 17,000 which is twice that of the flora. However, fungi are by far the most poorly researched group of organisms in Croatia. To date, 3,800 fungi species have been recorded, representing only 22% of the estimated number.

Almost a quarter of Croatian fungi species live in symbiotic communities with algae or cyanobacteria – **lichens**. The total number of known lichen species in Croatia is 930, of which 82 are endemic.

The Croatian **Red List of Threatened Fungi** includes 349 species. Due to the lack of data, the Red List analysis of fungi did not include lichens. However, according to the present research, most rare lichens grow on substrates rare in Croatia, such as silicate rocks, or inhabit areas with rare climatic conditions or are microclimatic determined, i.e. high-mountain species.

The main causes of **threat** to fungi and lichens in Croatia are habitat loss and fragmentation, environmental pollution and inadequate fungi collecting.

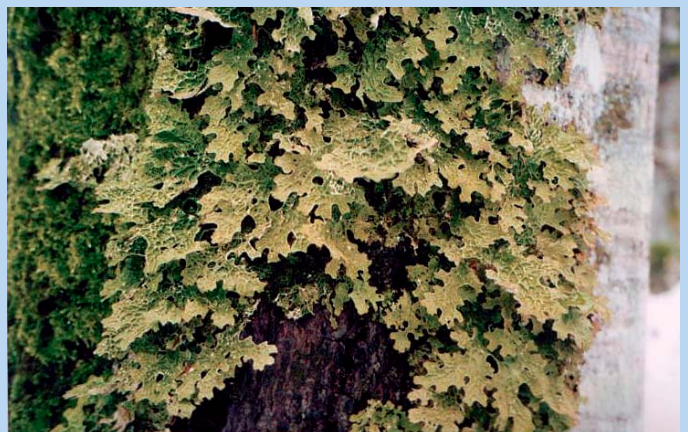
Under the Nature Protection Act, 314 fungi and 20 lichen species are strictly **protected** while 20 mushrooms, 12 truffles and 5 lichens are allowed for supervised commercial exploitation.



Caesar's mushroom (*Amanita caesarea*) - this famous culinary speciality has been threatened by overcollecting and it was strictly protected in 1999 (photo: SINP)

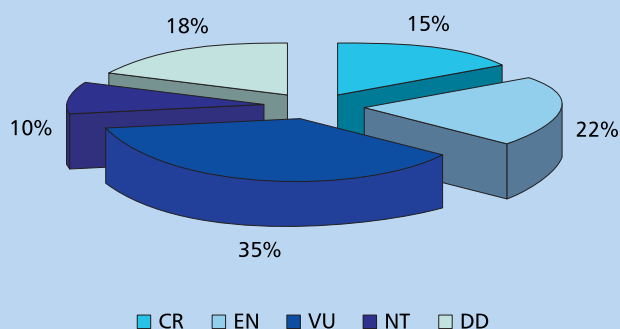


One of specialized fungi inhabiting bogs (photo: SINP)



Lichen *Lobaria pulmonaria* is collected for pharmaceutical industry (photo: A. Partl)

## Share of individual threat categories in the total number of threatened taxa of fungi



## MAMMALS

With 101 mammal species, 90 of which are autochthonous, Croatia is among 8 European countries with the greatest mammal diversity. Mountain areas, covered by vast forest complexes, are inhabited by all three large European carnivores (bear, wolf and lynx) and the diversity of Croatian bat fauna includes 34 species. Among the marine mammals, only the bottlenose dolphin (*Tursiops truncatus*) is a resident species but a variety of cetaceans have been registered in the eastern Adriatic area. The monk seal no longer breeds in the Adriatic; however individual animals are occasionally reported.

The total number of regional mammal **endemics** is relatively small. Several species in Croatia have more or less genetically isolated populations and are thus potentially endemic, but the exact number of endemic species is yet to be determined through further genetic research.

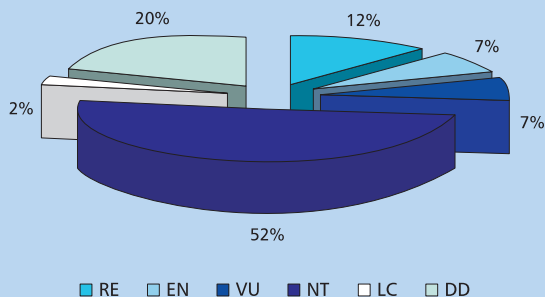
Some 14% of Croatian mammals (14 species) are considered threatened and 6% (5 species) are regionally extinct.

Causes of **threat** to Croatian mammals are primarily habitat loss and fragmentation, hunting, poaching, destruction of bat colonies and excessive use of pesticides. Recent intensive work on motorway construction may have greatly affected large carnivore populations. This problem has been dealt with successfully by building "green bridges", crossing corridors for animals.



'Green bridge' over the highway enables animals to cross this barrier that crosscuts their habitat (photo: Đ. Huber)

Share of individual threat categories in the total number of threatened taxa of mammals



Wolf (*Canis lupus*), one of the three large carnivores of Croatia (photo: B. Krstinić)

Amongst the most threatened mammals are the bottlenose dolphin, 6 bat species and the last island population of the European mole.

Several species are data deficient but there is indication that they could be threatened, such as the common dolphin, otter, relic species of Martino's snow vole and five bats, including two recently described new species: Balkan long-eared bat and Alpine long-eared bat.



Bottlenose dolphin (*Tursiops truncatus*) is the only resident Croatian marine mammal (photo: D. Holcer)



## BIRDS

Croatia's ornithofauna is amongst the richest in Europe when considering the 78 bird species which breed in Croatia and are threatened at the European level. The total number of bird species is 375 and of these, 234 breed on Croatian territory.

Croatia's ornithofauna includes 130 species listed in Annex I of the Birds Directive. There are 39 sites that satisfy BirdLife International Criteria for Important Bird Areas for Europe, covering 40% of Croatian territory. They all qualify for NATURA 2000 sites which indicate Croatia's great responsibility for the protection of European ornithofauna.

Some species highly threatened in Europe are represented with significant populations in Croatia. This is mostly due to the large areas of preserved habitats. There are still large wetland com-

plexes along the lowland Drava and Sava Rivers that are extremely important for the breeding of wetland species such as the spoonbill, herons and terns, the white-tailed eagle, black and white stork and lesser spotted eagle. Globally threatened species like the corncrake, dependent on large wet grasslands, or the ferruginous duck which nests along the old oxbows and extensive fishponds, are very well represented in Croatia. Natural and artificial wetlands, especially carp fishponds, represent internationally important migration and wintering sites for European waterfowl. Large complexes of beech and fir forests in the mountain areas of Croatia are important for numerous owl species, woodpeckers, the capercaillie, golden eagle and others. The coastal area is also inhabited with certain important species like the griffon vulture, the Eleonora falcon, Audonii's gull and others.



Spoonbill (*Platalea leucorodia*) inhabits Croatian carp fishponds and natural wetlands (photo: B. Krstinić)



Peregrine falcon (*Falco peregrinus*) breeds in the middle of the Croatian capital Zagreb (photo: M. Cukrov)



Corncrake (*Crex crex*), the globally threatened bird of wet meadows (photo: S. Harvancik)



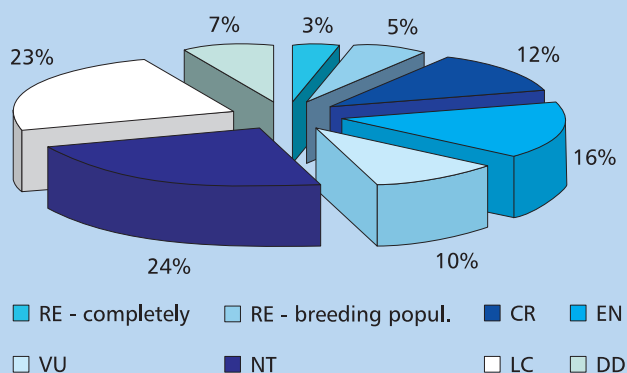
Croatian carp fishponds are extremely important for globally threatened ferruginous duck (*Aythya nyroca*) (photo: D. Krnjeta)

Unfortunately, almost half of the bird species have been listed on the Croatian **Red List of Birds**, with 86 species classified as threatened and the rest are classified as near threatened or species of least concern.

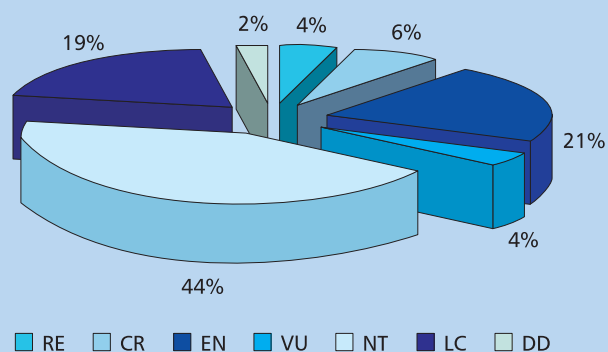
One of the most common threats to the Croatian ornithofauna is uncontrolled hunting and poaching. This affects as much as 78.4% of threatened bird species.

43.2% of threatened birds are affected by the disappearance of wetlands, especially in the coastal part of the country. Wetlands are still being converted into arable land, and the result is an irreversible loss of valuable habitats for a variety of threatened birds.

Categories of threat of breeding birds



Categories of threat of non-breeding birds



## REPTILES AND AMPHIBIANS

Among the 38 species of **reptiles** in Croatia, 9 are endemic. The most diverse part of Croatia, in terms of reptiles, is Dalmatia. Lizards are richest in endemics, especially represented on the islands, and these reptiles are particularly threatened. Namely, the isolation of island populations makes them exceptionally vulnerable. Additionally, there is a great threat from the possible introduction of predators and competitive reptile species.

The most threatened reptile species in Croatia are the critically endangered green turtle (*Chelonia mydas*) and Caspian terrapin (*Mauremys caspica*).

The main cause of threat to marine turtles in the Adriatic Sea is accidental catch in fishing nets. Also, they are endangered by a reduction of feeding areas (posidonia beds) and algal blooms.



Caspian terrapin (*Mauremys caspica*) is a species threatened at European level; in Croatia it can be found only in few ponds and small watercourses of the Southern Dalmatia (photo: SINP)



Olm (*Proteus anguinus*), an endemic species of Dinaric karst (photo: B. Jalžić)





Leopard snake (*Elaphe situla*) lives in the coastal part of Croatia (photo: M. Mrakovčić)

Twenty species of **amphibians**, including 8 endemics, have been recorded in Croatia. When considering amphibian fauna, the western part of the Pannonian lowland is the richest area of the country.

Nine amphibian species are listed in the Croatian Red List. Four are threatened at the national level, while the olm (*Proteus*

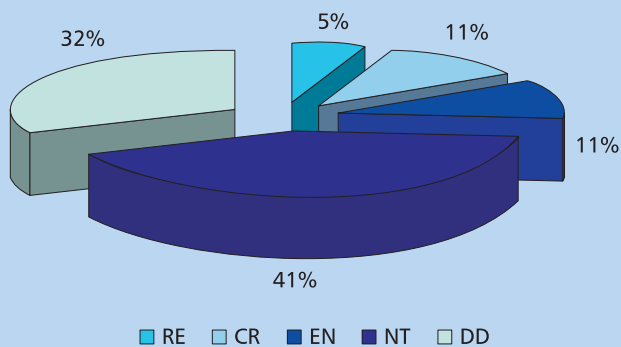


Sharp-snouted Rock Lizard (*Lacerta oxycephala*) is an endemic species of the East Adriatic (photo: SINP)

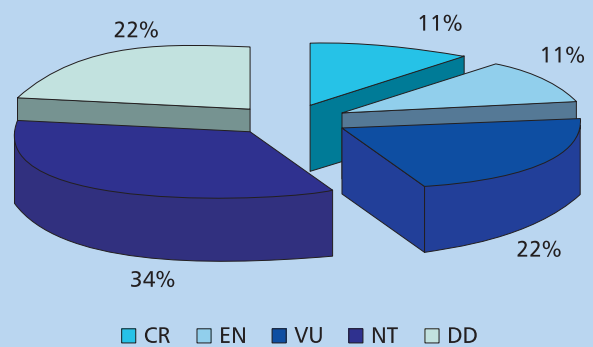
*anguinus*), an endemic species of Dinaric karst, is threatened at the global level.

The most common cause of threat to amphibians is habitat degradation or fragmentation. All amphibian species are protected under the Nature Protection Act.

#### Categories of threat of Reptiles



#### Categories of threat of Amphibians



Hermann's tortoise (*Testudo hermanni*), although strictly protected, is threatened by collecting for illegal trade (photo: SINP)



Common toad (*Bufo bufo*) hidden in the bog moss of the Blatuša bog (photo: SINP)

## FRESHWATER FISH

With 151 freshwater fish species in the rivers and lakes, 18 of which are Croatian karst endemics, Croatia is one of the most diverse countries in Europe in terms of ichthyology. This species diversity is the result of the country's geographic position, covering two drainage basins (Adriatic and Black Sea) and the presence of distinct karst habitats.

The Black Sea (Danube) Basin (covering 62% of the territory) is inhabited by 81 fish species, while the number of species in the Adriatic Basin (covering only 38% of the territory) is as high as 88 species.

### Endemic Croatian freshwater fishes

Visovac trout ( <i>Salmo visovacensis</i> )
Adriatic salmon ( <i>Salmothymus obtusirostris krkensis</i> )
Solin salmon ( <i>Salmothymus obtusirostris salonitana</i> )
Croatian dace ( <i>Telestes polylepis</i> )
Ukliva dace ( <i>Squalius ukliva</i> )
Zrmanja dace ( <i>Leuciscus zrmanjae</i> )
Dalmatian minnow ( <i>Phoxinellus dalmaticus</i> )
Cave minnow ( <i>Phoxinellus fontinalis</i> )
Croatian minnow ( <i>Phoxinellus croaticus</i> )
Jadova Minnow ( <i>Phoxinellus jadovensis</i> )
Krbava Minnow ( <i>Phoxinellus krbavensis</i> )
Dalmatian spined loach ( <i>Cobitis dalmatina</i> )
Neretvan spined loach ( <i>Cobitis narentana</i> )
Vrgorac goby ( <i>Knipowitschia croatica</i> )
Mrakovčić's goby ( <i>Knipowitschia mrakovcici</i> )
Radović's goby ( <i>Knipowitschia radovici</i> )
Dalamtian rudd ( <i>Scardinius dergle</i> )
Basak ( <i>Rutilus basak</i> )

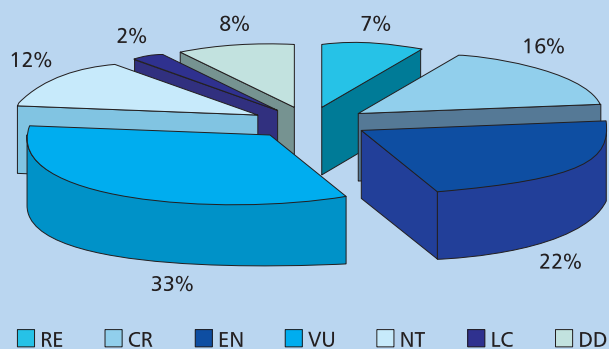


Dalmatian minnow (*Phoxinellus dalmaticus*) - minnows inhabit underground watercourses (photo: P. Mustafić)



European mudminnow (*Umbra krameri*) is NATURA 2000 species; it lives in oxbows along the large lowland rivers (photo: P. Mustafić)

### Share of individual threat categories in the total number of threatened taxa of freshwater fish



Mrakovčić's goby (*Knipowitschia mrakovcici*) is one of recently discovered species in Croatian rivers that is new for the science (photo: P. Mustafić)



The Adriatic Basin is distinguished by high species endemism (44 Mediterranean, 40 Adriatic and 18 Croatian), which is the direct result of the diversity of karst habitats.

Freshwater fish are one of the most threatened groups of vertebrates. There are 89 species included in the *Red Book of Freshwater Fish in Croatia* which represents 59.3% of Croatian freshwater ichthyofauna. Introduction of allochthonous species, pollution, regulation of watercourses and habitat degradation, followed by construction of dams and creation of water accumulations, irrigation, excessive use of water for drinking and industry and uncontrolled fishery have the greatest negative impacts on freshwater fish.



Zrmanja dace (*Leuciscus zrmanjae*) - an endemic fish of the Zrmanja River (photo: P. Mustafić)

## MARINE FISH

433 fish taxa have been recorded in the Adriatic Sea, accounting for 65.2% of all known fish taxa in the Mediterranean Sea. This number is a subject to constant change. Over the past 15 years, 25 new species have been recorded. Some inhabit the Mediterranean Sea and some come through the Suez Canal from the Red Sea. 382 taxa of Adriatic fish belong to the group of bony fish, 50 to the group of cartilaginous fish and one to the lampreys. There are 6 endemic species present in the Adriatic, with two gobies recently described as new to science (*Didogobius schlieveni* and *Gobius kolombatovici*).

When considering the threat status of Adriatic ichthyofauna, 124 fish taxa have been included on the Red List of Marine Fish of Croatia in 2005 (28.6% of Croatian marine ichthyofauna). The main causes of threat to Adriatic fish are uncontrolled fishery, degradation of important habitats (feeding and spawning areas) like *Posidonia* beds, estuaries, coastal areas and channels, as well as pollution and eutrophication.

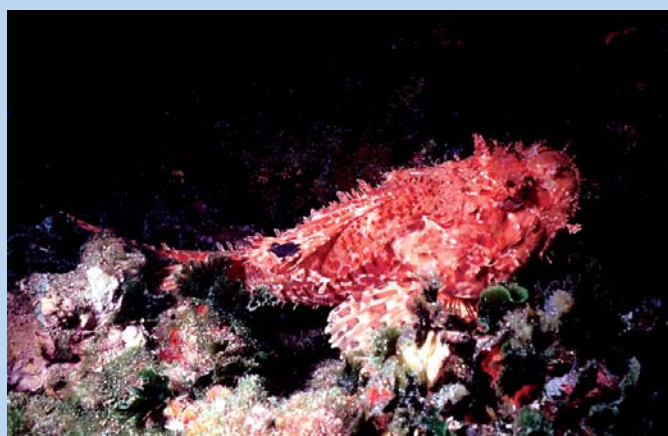
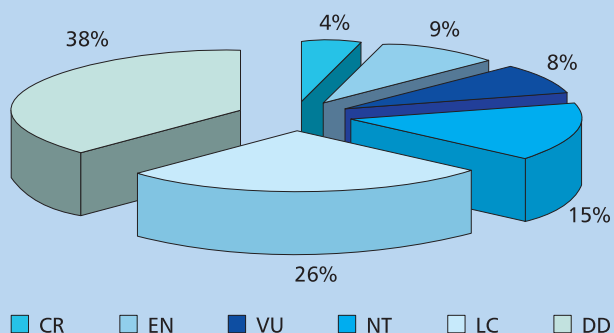
Some of areas with the greatest diversity of marine fish are the waters of the offshore islands and sea straits.

Along with the Nature Protection Act, which incorporates international regulations, marine fish protection and exploitation in Croatia is regulated by the Marine Fisheries Act.



*Posidonia* beds are rich with fish (photo: A. Žuljević)

### Share of individual threat categories in the total number of threatened taxa of marine fish



Small red scorpion fish (*Scorpaena notata*) (photo: NP Telašćica, D. Petricioli)

## INVERTEBRATES

To date, 15,474 taxa of terrestrial and 1,780 taxa of freshwater invertebrates have been recorded in Croatia. They are dominant in abundance and diversity, but are insufficiently studied.

351 taxa of terrestrial invertebrates and 172 taxa of freshwater invertebrates are endemic. Most endemic freshwater species inhabit underground waters.



Troglobitic leech *Croatobranthus mestrovi* was recently discovered in underground of the Velebit Mountain; it is the new species and the new genus for science (Photo: D. Bakšić)

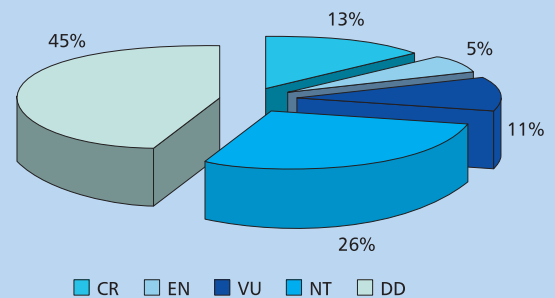
TERRESTRIAL INVERTEBRATES NO. OF TAXA	
Phyllum	No. of taxa
Aschelminthes	127
Mollusca	470
Annelida	141
Tardigrada	7
Arthropoda	14,729
<b>Total</b>	<b>15,474</b>

FRESHWATER INVERTEBRATES NO. OF TAXA	
Phyllum	No. of taxa
Protozoa	268
Spongia	4
Platodes	20
Cnidaria	6
Aschelminthes	360
Mollusca	156
Annelida	99
Tardigrada	7
Arthropoda	869
<b>Total</b>	<b>1,789</b>

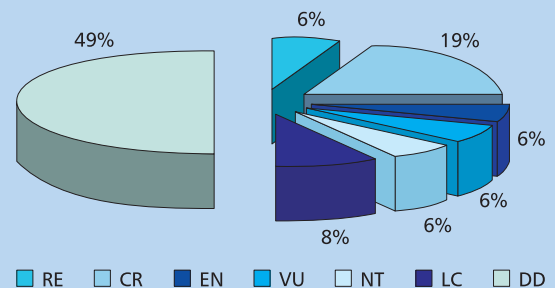
Considering that Croatia's invertebrate fauna has been inadequately studied, the total number of species and number of endemic species is expected to be much higher. The main causes of threat to particular invertebrate species are habitat destruction and change, all types of pollution and the excessive use of pesticides, introduction of alien species and redundant exploitation and collecting.

To date, only the butterflies and dragonflies have been analyzed for conservation status. The Red List includes 28 of the total 180 butterfly taxa considered as threatened as well as 31 of 71 dragonfly species.

### Threatened species of butterflies



### Threatened species of dragonflies



Red coral (*Corallium rubrum*) is an endangered Mediterranean species (photo: D. Frka)



**Invertebrate fauna of the Adriatic Sea** is also very diverse, though poorly researched. Until now, a total of 5,647 species have been recorded. Only one species has been registered as an Adriatic endemic species – the sea squirt *Polycitor adriaticus*, but this too is doubtful due to the insufficient study of this group of species in the Mediterranean Sea.

All species of Adriatic invertebrates, whose habitats are exploited or destroyed to a larger extent than the natural ability of population regeneration, are considered to be threatened. The most threatened economically exploited species are the Norway lobster (*Nephrops norvegicus*) and Jacob's scallop (*Pecten jacobeus*).



Stag beetle (*Lucanus cervus*) is threatened due to the lack of deadwood in managed forests (photo: SINP)



Deep sea carnivorous sponge (*Asbestopluma hypogea*) lives in submarine pits in Nature Park Telašćica on the depth of only 20 meters (photo: NP Telašćica, D. Petricoli)



Mountain blue (*Maculinea rebeli*) is one of threatened Croatian butterflies (photo: M. Šašić)

Despite long-term legal protection, red coral (*Corallium rubrum*) and the giant Mediterranean Pen (*Pinna nobilis*) are still classified as endangered.

### Diversity of Adriatic invertebrate fauna

Phylum	No. of species
SARCOMASTIGOPHORA	676
SPOROZOA	24
MYXOZOA	25
CILIOPHORA	207
PORIFERA	221
PLATYHELMINTHES	129
GNATHOSTOMULIDA	5
CNIDARIA	320
CTENOPHORA	10
ROTIFERA	31
GASTROTRICHA	36
CEPHALORHYNCHA	13
ACANTHOCEPHALA	5
NEMATODA	312
PRIAPULIDA	3
KAMPTOZOA	6
NEMERTINA	27
MOLLUSCA	866
SIPUNCULA	18
ECHIURA	2
ANNELIDA	595
TARDIGRADA	4
ARTHROPODA	1594
PHORONIDA	1
BRYOZOA	263
BRACHYOPODA	11
HEMICHORDATA	4
ECHINODERMATA	104
CHAETOGNATHA	11
TUNICATA	123
CHORDATA	1
<b>TOTAL</b>	<b>5647</b>



Attractive coral sea fan *Eunicella* (photo: NP Telašćica, D. Petricoli)



## INVASIVE ALIEN SPECIES

Like other European countries, Croatia has many problems with invasive alien species (IAS). As late as 1910, 11 individuals of the small Indian mongoose (*Herpestes javanicus auropunctatus*) were introduced on the island of Mljet for the biological control of poisonous snakes. Over a 20 year period, the introduced animals eliminated all the snakes on the island and began attacking other small wild animals, including migratory birds and domestic animals. Although about 100 mongooses are eliminated every year, and some attempts for total eradication were made in the past, these animals still inhabit the island and have a negative impact both on wild and domestic fauna.

### Allochthonous freshwater fish in Croatia

Rainbow trout	<i>Oncorhynchus mykiss</i>
Prussian carp	<i>Carrasius gibelio</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Goldfish	<i>Carassius auratus</i>
Silver carp	<i>Hypophthalmichthys molitrix</i>
Big head carp	<i>Hypophthalmichthys nobilis</i>
Grass carp	<i>Ctenopharyngodon idella</i>
False harlequin	<i>Pseudorasbora parva</i>
Brown bullhead	<i>Ameiurus nebulosus</i>
Charr	<i>Salvelinus alpinus</i>
Brook trout	<i>Salvelinus fontinalis</i>
Largemouth bass	<i>Micropterus salmoides</i>
Black bullhead	<i>Ameiurus melas</i>
Peled	<i>Coregonus peled</i>
Schelly	<i>Coregonus lavaretus</i>
Mosquito fish	<i>Gambusia affinis</i>



Goldfish (*Carassius auratus*) (photo: SINP, M. Povž)

Known threats to Croatian biodiversity by IAS today are numerous. The tropical green algae *Caulerpa taxifolia* and *Caulerpa racemosa* are spreading rapidly across the Adriatic Sea coastal benthic habitats.



Removing of invasive tropical green algae (*Caulerpa taxifolia*) by divers can only slow down its invasion (photo: A. Žuljević)

16 allochthonous fish species have been introduced into Croatian rivers and lakes during the past century - the Adriatic Basin, rich in endemic fish species, is extremely threatened in this regard.

The plant species false indigo (*Amorpha fruticosa*) is spreading through riverine and forest edge habitats in the Pannonian lowlands, creating significant problems for the regeneration of forest areas after the cutting. The common ragweed (*Ambrosia artemisifolia*) has spread through ruderal habitats throughout Croatia - it is known as the greatest allergen in Europe. The clam *Dreissenia polymorpha*, known as a pest in water regulation and hydroelectric power stations, poses a great threat to autochthonous freshwater mussel populations (*Unionidae*) and other benthic organisms. The Mediterranean form of black rat (*Rattus rattus*) and the Italian lizard (*Podarcis sicula campestris*) have had a strongly negative impact on native island fauna. The invasive allochthonous spinycheek crayfish (*Orconectes limosus*), the crayfish plague carrier, has been found in Kopački

rit Nature park and is spreading rapidly along the Danube River. Allochthonous game species, such as the chukar (*Alectoris chukar*), introduced deliberately to hunting grounds, both on the islands and mainland, represent a further problem.

There is a need to organize the prevention of unwanted introductions of alien species at the national level, to recognize and evaluate the level of their impacts on native biological diversity, and to define and implement actions to reduce these threats. Several actions in this regard have already been taken. The Ministry of Culture finances monitoring of *Caulerpa* species and cleaning activities with special attention given to four marine protected areas (Brijuni, Kornati, Telašćica and Mljet). The State Institute for Nature Protection has initiated a project of invasive plant species inventory in cooperation with competent scientists.



Bushes of invasive false indigo (*Amorpha fruticosa*) pose a great problem in forestry (photo: SINP)

## DOMESTICATED TAXA

Throughout history, man has altered nature by adapting certain species to his needs through breeding and selecting specific properties. Such domesticated animals and plants also represent a part of our biodiversity. Over thousands of years, numerous domesticated taxa have adapted to man-made habitats, developing "local" varieties of cultivated plants and "ecotypes" of domesticated animals. The protection of biodiversity implies keeping records of indigenous sorts of cultivated plants and breeds of domesticated animals in individual countries and their conservation. These sorts and breeds, adapted to the local climate,



Posavina horse in Lonjsko Polje Nature Park (photo: B. Krstinić)

BREED	TOTAL NO.	STATUS	TREND
<b>HORSES</b>			
MEĐIMURJE HORSE	29	CRITICALLY ENDANGERED	↓
POSAVINA HORSE	1505		↑
LIPIZZANER	398		↑
CROATIAN COLD-BLOOD HORSE	1406		↑
DONKEYS	804	ENDANGERED	↑
<b>CATTLE</b>			
ISTRIAN CATTLE	300	ENDANGERED	↑
SLAVONIAN PODOLIAN	37	CRITICALLY ENDANGERED	↑
BUŠA OF LIKA	53	CRITICALLY ENDANGERED	↑
<b>SHEEPS AND GOATS</b>			
ISTRIAN PRAMENKA	2240		↑
DUBROVNIK RUDA SHEEP	251	ENDANGERED	↑
RAB SHEEP	1418		↓
CRES SHEEP	384		↓
PRAMENKA OF LIKA	4798		↓
DALMATIAN PRAMENKA	2032		↓
TSIGAI	752	ENDANGERED	↑
DOMESTIC GOAT	299		↓
<b>PIGS</b>			
TUROPOLJE PIG	127	CRITICALLY ENDANGERED	↑
BLACK SLAVONIAN PIG	610	ENDANGERED	↑
<b>POULTRY</b>			
TURKEY OF ZAGORJE	1933		↑





Posavina pointer is recognized as indigenous dog of Croatia (photo: SINP)

are more resistant to disease and often very well incorporated into the surrounding nature and landscape. Due to the great efforts and knowledge of numerous generations invested into their creation, they also represent national cultural heritage.

In Croatia, the Croatian Livestock Centre is the central register for **domestic livestock breeds** valuable for breeding and also evaluating their threat status. In line with 2004 data, the Međimurje horse, Slavonian podolian cattle, "buša" cattle of Lika and the Turopolje pig are critically endangered while donkeys, Istrian cattle, the Dubrovnik ruda sheep, the tzigai sheep and the black Slavonian pig are endangered. During 2005, significant changes occurred in selection of domestic animal breeds. Criteria are now stricter and fewer individuals are accounted as valuable for each breed and listed. The line ministry has given its compliance for proclaiming new domestic breeds: the Rab sheep, Croatian spotted goat and Croatian white goat.



Slavonian podolian cattle (photo: B. Krstinić)





Tornjak sheepdog lives with the sheep herd (photo: SINP)

Dog breeds are also of special concern, with several breeds officially registered: the Dalmatian dog, Istrian shorthaired pointer, Istrian longhaired pointer, Posavina pointer and Croatian sheep dog. The registration procedure is underway for the Tornjak sheepdog breed. The Croatian Kennel Club stresses the Tornjak sheepdog and Croatian shepherd dog as very valuable national breeds.



Turopolje pig is critically endangered indigenous breed of Croatia (photo: B. Krstinić)

There is no central register system for **indigenous plant sorts**. Conservation of indigenous sorts is sporadic and most activities are based on ex-situ methods. The Faculty of Agronomy of the University of Zagreb has initiated the "Croatian gene bank" project.

The Nature Protection Act has recently introduced the category of the **protected autochthonous domestic breed** for endangered plants and/or animal breeds that have developed as a result of traditional breeding and forms a part of the natural heritage. Conservation of endangered autochthonous domestic breeds is implemented keeping the balance between nature protection and agriculture in mind, and their breeding is encouraged by paying annual premiums to breeders and giving special criteria for loans.





# HABITATS



# INTRODUCTION

A great diversity of habitats is distributed throughout the lowland, mountain and coastal areas of Croatia. A variety of geomorphologic forms above and underground allow for a three-dimensional distribution of habitats, contributing to habitat richness. **It is exceptional to find such a diversity of habitats in a relatively small country like Croatia.** Many habitat types are specific to Croatia, such as the underground karst habitats or plant communities of rocks and screes.

A number of habitat types in Croatia are threatened. The aim of nature protection is to conserve all threatened and rare habitat types in a favourable conservation status. For such habitat types, a coherent and functional network of important sites containing these types must be preserved. This is possible through the system of an **ecological network**. To establish such a network, habitat types are being mapped, their conservation status analysed and necessary protection measures defined. The **EU Habitats Directive** (Council Directive 92/43/EEC) requires that a coherent and functional network of important sites be established for threatened habitat types of the EU. This network is called NATURA 2000.

In January 2006, the **Regulation on conservation of threatened and rare habitat types** was adopted. It lists all habitat types protected under the Habitats Directive, Res. 4 of the Bern Convention as well as those threatened at the national level. General conservation measures have been prescribed while specific measures are being incorporated into physical plans,

sector management plans and projects through nature protection requests issued by the Ministry of Culture. For all planned projects with a potential significant effect on habitats that are part of the ecological network or protected areas, it is mandatory to conduct a nature impact assessment.

*Habitat is defined by the Nature Protection Act as follows:*

**"Habitat is the unique functional unit of an ecosystem, defined by geographical, abiotic and biotic features; all habitats of a type constitute a single habitat type."**

Habitat types are described through the systems of **habitat classification**. There are several habitat classification systems in Europe. CORINE classification was developed by the European Community and is used in the Habitats Directive. It was extended to the whole of Europe as the Palaearctic Habitat classification and later as EUNIS classification.

Like other countries, Croatia has developed its **national habitat classification (NHC)** in order to emphasize the habitat diversity of its territory and certain specific characteristics such as habitats related to karst underground and marine environments. With the "key" for transferring one habitat typology into another, it is possible to convert national classification into any European standard.



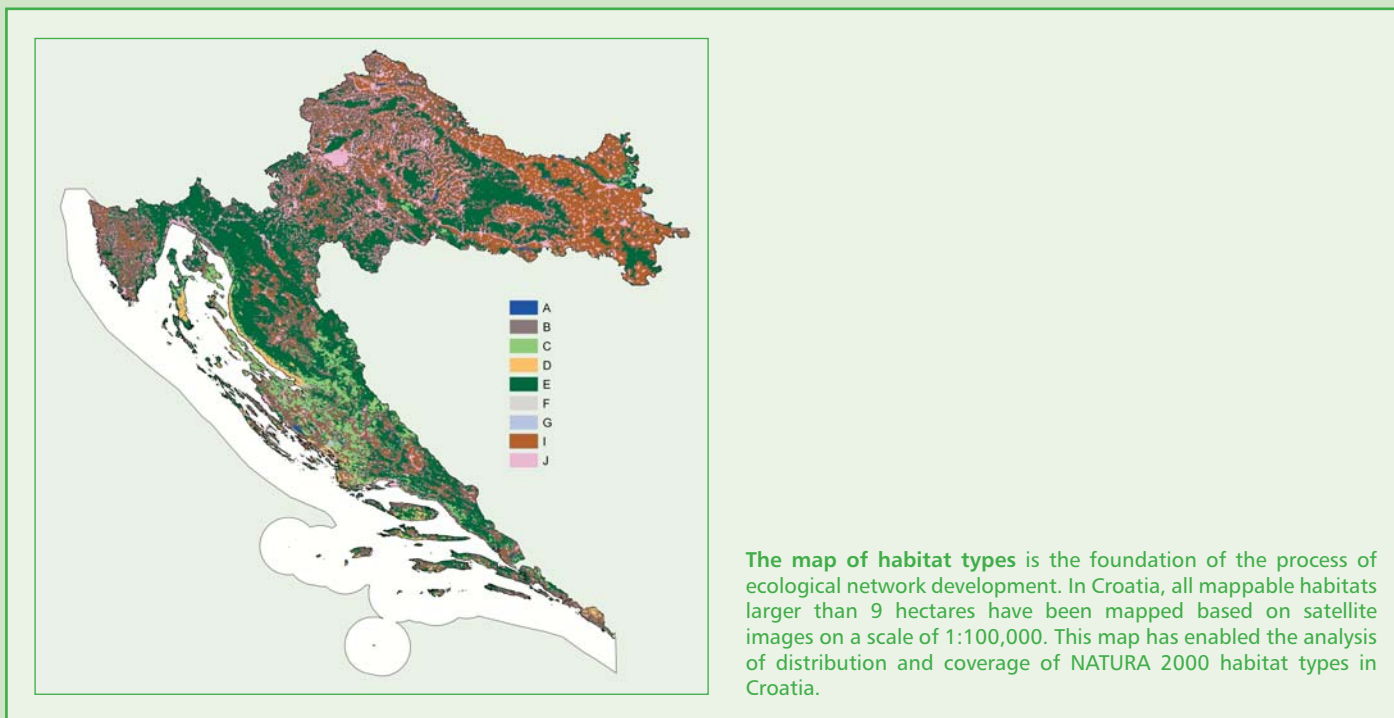
## Biogeographical regions

Europe has been divided into ten biogeographical regions based on a vegetation map. According to EU legislation and the Bern Convention, each country lists its species and habitat types through these biogeographical regions. In Croatia there are four regions – the Pannonian, Continental, Alpine and Mediterranean, thus indicating the great richness and diversity of nature.

National habitat classification of Croatia defines the following main habitat classes, with each divided into four levels of habitat types:

The first eight classes contain the majority of natural habitat types in Croatia, and these classes are presented in this booklet.

A	inland surface water and wetland habitats
B	inland unvegetated and sparsely vegetated habitats
C	grassland, bogs, fens and tall forbs habitats
D	scrub habitats
E	forest habitats
F	coastal habitats
G	marine habitats
H	underground habitats
I	cultivated non-forested land and habitats with weeds and ruderal vegetation
J	constructed and industrial habitats
K	complexes



**The map of habitat types** is the foundation of the process of ecological network development. In Croatia, all mappable habitats larger than 9 hectares have been mapped based on satellite images on a scale of 1:100,000. This map has enabled the analysis of distribution and coverage of NATURA 2000 habitat types in Croatia.

# A. INLAND SURFACE WATER AND WETLAND HABITATS

This class includes inland surface waters with natural or semi-natural communities, with or without vegetation, regardless of whether they are of natural or artificial origin. Standing water and watercourses are included together with water-fringe vegetation. Most wetland types defined by the Ramsar Convention on Wetlands are included in this class.

Among the most **threatened habitats** from this class are river gravels, sands and muds that are particularly represented in the large lowland rivers (Drava and Mura as well as some left-overs on the Sava River). Also threatened are the tufa stream and tufa cascade habitat types specific to the Croatian karst rivers. This vegetation consists of euhydrophyte moss and algae communities of streams poor in nutrients but rich in lime, forming large tufa deposits.

## Ramsar wetlands

In Croatia, 28 of the total 42 Ramsar wetland types are represented in three main groups: natural marine/coastal, natural inland as well as artificial wetland types. All areas that are in some way dependent on water are included. Additionally, the term "floodplain" is used for areas alongside large rivers that are in fact complexes of several wetland types. Ramsar habitat types belong to several classes of the Croatian NHC.

The State Institute for Nature Protection has conducted an inventory of Croatian wetlands in the framework of the project Ramsar Small Grants Fund 2003. Available data on wetlands has been collected and a relevant database established as the basis for follow-up activities of collecting new data. Results of the inventory are shown in following table.

	Ramsar wetland type	Sites	Length (km)	Area (ha)
	Complex sites	11		800,365
A/B	Shallow marine waters and marine beds			26,028
D	Rocky shores*		5,599	
E	Sand/shingle shores*		354	
F	Estuarine waters	8		7,523
G	Tidal flats	18		666
H	Salt marshes	83		
J	Coastal brackish/saline lagoons	6		4,058
Zk(a)	Karst and other subterranean hydrological systems, coastal - vruljas	9		
M	Permanent rivers/streams/creeks		14,338	30,127 (large rivers)
N	Seasonal/intermittent rivers/streams/creeks		15,109	
O	Permanent freshwater lakes	441		8,916
P	Seasonal/intermittent freshwater lakes (including flooded karst fields)	15		29,405
Q	Permanent saline/brackish/alkaline lakes	6		361
Tp/p	Permanent freshwater marshes/pools - ponds	343		1,929
Tp/r	Permanent freshwater marshes/pools - reedbeds			6,290
Ts/p	Seasonal/intermittent freshwater marshes - ponds	994		
Ts/m	Seasonal/intermittent freshwater marshes - flooded meadows			72,486
U	Non-forested peatlands - bogs	29		
W	Shrub-dominated wetlands			4,784
Xf	Freshwater, tree-dominated wetlands			178,262
Y	Freshwater springs	1,027		
Zg	Geothermal wetlands - springs	75		
Zk(b)	Karst and other subterranean hydrological systems, inland	161		
1	Fish ponds	31		12,730
2	Man-made ponds	562		
5	Salt pans, salines	3		495
6	Reservoirs, barrages, dams	24		5,966
7	Gravel/brick/claypits	47		859
8	Wastewater treatment areas	1		
9	Canals and drainage channels		21,069	
	<b>TOTAL</b>	<b>3,883</b>	<b>56,469</b>	<b>390,885 (6.9%)</b>

\* Coastline does not include harbour areas (76.1 km)



## Wetland complexes

Large wetland areas that are extremely important for biodiversity conservation consist of different wetland habitats. In Croatia, these are mostly represented in the floodplains of large rivers. Among them are three Ramsar sites: Kopački Rit on the confluence of the Drava and Danube Rivers, Lonjsko Polje along the Sava River as well as the Neretva Delta on the coast.



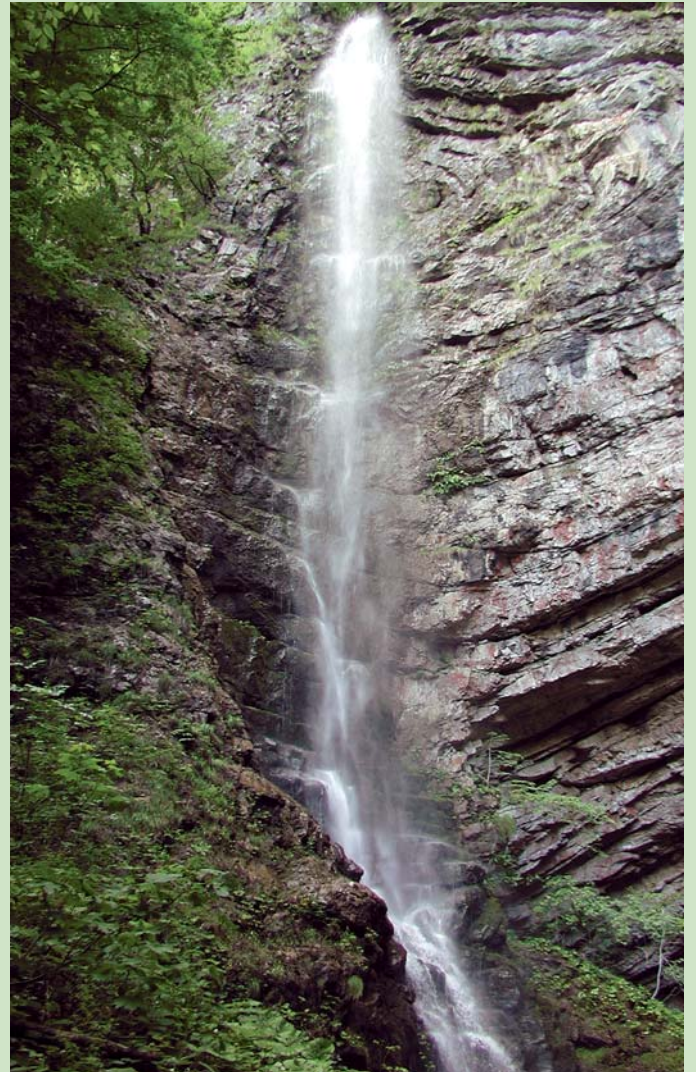
Nature Park Kopački Rit - Ramsar site (photo: SINP)

## Carp fishponds

Along the watercourses in the northern part of Croatia there are a dozen large carp fishponds that are important sites for breeding and migrating waterfowl. Rich in food and suitable vegetation such as reeds and surrounded by alluvial forest, they represent artificial wetlands of international ornithological value for some of the most threatened European bird species. The Crna Mlaka fishpond near Zagreb is one of four Croatian Ramsar sites.



Pakračka poljana carp fishpond (photo: SINP)



Zeleni vir in Gorski kotar (photo: SINP)



The Cetina River in its upper part (photo: SINP)



# B. INLAND UNVEGETATED AND SPARSELY VEGETATED HABITATS

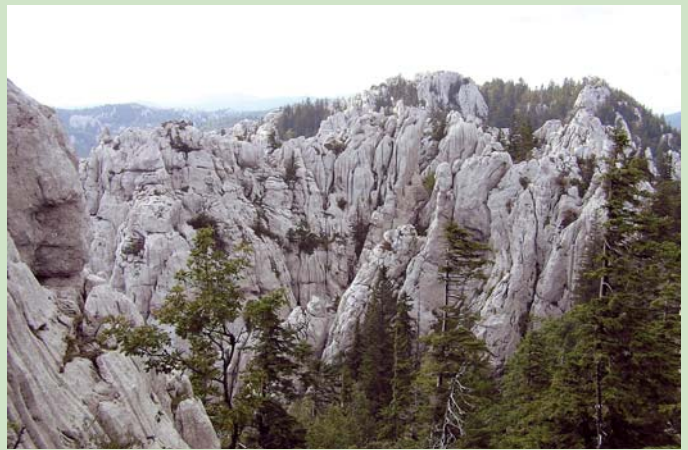
The most interesting habitats of this class are the screes, cliffs and exposed limestone rocks. A number of endemic and relic plants and plant communities are represented, distributed mostly on the mountains and coastal areas.

**Screes** develop where stones, rock fragments and pebbles accumulate at the bottom of slopes. Specially adapted plants grow here, the most significant among them is the endemic species *Velebit degenia* (*Degenia velebitica*) of the specific community of *Bunio-Iberetum pruitii* which has developed on Velebit mountain screes exposed to stormy winds.

**Cliffs and exposed limestone rocks** are inhabited with rock-crevice vegetation that often contains endemic taxa. These communities belong to the Tyrrheno-Adriatic or Alpine-Carpathian-Balcanic group of habitat types. One of the most important communities is *Phagnalo-Centaureetum ragusinae* with the Croatian endemic Dubrovnik knapweed (*Centaurea ragusina*).



Konavoske Stijene (Konavle Rocks) in Southern Dalmatia are rich with endemic plants (photo: SINP)



Karst area of Bijele Stijene (White Rocks) is protected as the strict reserve (photo: SINP)



A detail from the Bijele Stijene strict reserve (photo: SINP)



A scree on the Biokovo mountain (photo: A. Alegro)



# C. GRASSLANDS, BOGS, FENS AND TALL FORB HABITATS

## BOGS AND FENS

Bogs and fens are wetlands with small sedge and moss communities developed on permanently waterlogged soils with nutrient poor water supply and a water table that is below or slightly above the surface.

In Croatia, these habitats are threatened with extinction. They are relics from after-glacial periods and are represented at small sites, mostly smaller than 1 ha and are highly dependent on microclimatic conditions. Many highly specialised and extremely threatened species are dependent on these habitats, such as the bog mosses (*Sphagnum sp.*), sundew (*Drosera rotundifolia*), common butterwort (*Pinguicula vulgaris*), bog arum (*Calla palustris*) and several fungi and spiders.

Most of the Croatian bogs and fens have disappeared during recent decades. About twenty remain and only a handful could be preserved through the application of active conservation measures, like maintaining a favourable water regime and removing overgrowing vegetation.

## GRASSLANDS

From the conservation perspective, the most important grasslands are the wet and Mediterranean dry grasslands. These habitats are highly threatened. While hydromelioration activities

The Dubravica bog is one of few protected bogs where activities of removing overgrowing vegetation have been implemented for several years. This has resulted in a recovery of the sundew that has almost become extinct from this site.



Photo: SINP

The Blatuša bog is one of the largest preserved bogs in Croatia. It is protected for its specific vegetation, including the downy birch (*Betula pubescens*), a critically endangered and extremely rare species in Croatia.



Photo: SINP

are a specific cause of threat to wet grasslands, the neglect of meadows and pastures due to the abandonment of villages and extensive agriculture is a common threat to all grasslands.

**Wet grasslands** are well represented in northern Croatia where they form parts of large wetland complexes along the lowland rivers, especially along the Sava River. The Lonjsko Polje Nature Park is a Ramsar site with large temporarily flooded pastures where hundreds of horses, pigs and cattle roam freely



Wet pastures of the Lonjsko Polje Nature Park (photo: SINP)





Wet meadows in Northern Croatia are habitats with threatened fritillary (*Fritillaria meleagris*) (photo: SINP)

year round, except for the period when flood water covers this retention area. One threatened species highly dependent on the wet grassland is the fritillary (*Fritillaria meleagris*).



Colorful mountain meadows (photo: A. Alegro)

In central Croatia which is mainly mountainous, wet meadows are very specific. They occur along the watercourses that are mostly intermittent in this karst area – sometimes they disappear or “sink” below ground and sometimes they flood large karst fields that become temporary lakes. In these areas, special vegetation of the *Scillo litardierei-Deschampsietum mediae* community develops, with the squill (*Scilla litardieri*), species strictly protected under the Habitats Directive.

Wet grasslands are represented even in coastal Croatia, especially in the Neretva Delta area as well as along the Cetina River.

**Dry Mediterranean grasslands** cover large coastal and inner coastal areas. A large proportion belongs to the East sub-Mediterranean dry grasslands *Scorzoneratalia villosae* that are protected under the Habitats Directive.

Grassland vegetation of the inland sands is represented only on two very small sites near the Drava River. The Đurđevac sands and Kloštar sands are famous for the endemic *Corynephor-Festucetum vaginatae* community. A complete degradation of the original community took place over a part of the sands as the result of spread of bushes and other plants, which makes it necessary to take active protection measures by removing the overgrown vegetation. These two sites are the only remnants of the former area of sand dunes, called the “Croatian Sahara”, which was earlier several kilometres long and wide.



Kloštar sands in Podravina (photo: SINP)



Picturesque dry grasslands under the Dinara Mountain (photo: SINP)



Meadows with threatened Siberian iris (*Iris sibirica*) (photo: A. Alegro)



# D. SCRUB HABITATS

## D. SCRUB HABITATS

This class consists of scrub vegetation that is floristically clearly distinguished from forest vegetation, while forest scrub vegetation is included in the Forests class of habitat types. Among the threatened and rare scrub habitats are some types of willow scrub along rivers and oleander galleries in Southern Dalmatia. Illyrian garrigues represent the characteristic evergreen vegetation of small bushes in coastal areas that often disappear due to development of forest vegetation.



Scrub vegetation overgrowing Drava river gravels (photo: SINP)

The oleander galleries habitat type is rare and protected at the European level by the Habitats Directive. It appears along the temporary watercourses in the Mediterranean area. In Croatia, it has been registered only in 2004 and 2005 on two small sites in the southernmost part of Croatia. Natural oleander stands are situated in gullies along temporary watercourses that end into the sea. Along with the species *Nerium oleander* and *Arundo donax* that characterise this habitat type, vegetation is represented with elements of the holm oak (*Quercus ilex*) macchia.



Stands of wild oleander (*Nerium oleander*) near Slano in Southern Dalmatia (photo: SINP)



*Oleo-Euphorbietum dendroidis* is a rare plant association present on distant islands of Sušac and Palagraža (photo: SINP)



# E. FOREST HABITATS

## E. FOREST HABITATS

There are more than 60 forest communities and around 4500 forest plant taxa in Croatia. The total area of woodland is about 2,490,000 hectares, covering 44% of Croatian territory. Dense forests occupy 37% of the territory while the rest belongs to various forest degradation stages. Only 19% of forests are privately owned with the majority state-owned.



Distribution of forests in Croatia



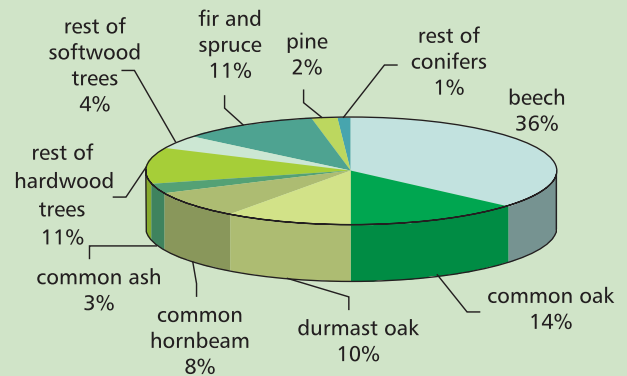
Old pubescent oak forest of Tramuntana on the Cres Island (photo: SINP)

The forests in Croatia belong to the first or the second generation after the natural renewal of vast virgin forests in the area between the Sava and Drava Rivers, as well as in the karst region to the south of the Kupa River. According to the composition of trees, they are natural or very similar to the virgin forests from which they originated. The conservation status of Croatian forests is very good compared to the European level. As high as 95% of forest components show a natural composition, this is rare and highly valuable in global proportions.



Holm oak forests in Glavotok on the island of Krk (photo: SINP)

### Trees of Croatian forests







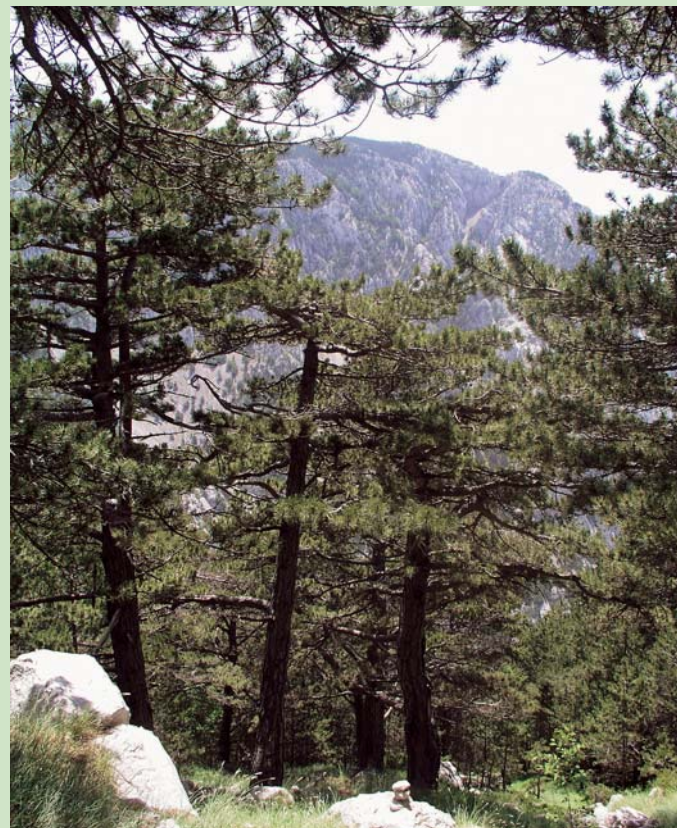
Dinaric beech and fir forests (*Omphalodo-Fagetum*) are distributed in mountain parts of Croatia (photo: SINP)

The largest forest complexes can be found in the western Dinaric Alps (Gorski Kotar, Velebit Mountain) where the beech and fir forests predominate, as well as in the Sava River region with the alluvial basins of Spačva and Lonjsko Polje. In the Mediterranean region, most forest vegetation is in macchia form, though there are also areas with nicely preserved holm oak as well as black pine forests.



Mediterranean beech forest (photo: A. Alegro)

Almost all Croatian forest habitat types belong to one of the classes of NATURA 2000 habitats protected under the Habitats Directive. Some cover large areas like beech forests, durmast oak forests and common oak forests. The others have restricted distribution like relic forests of lime and yew, relic forests of black pine and chestnut woods.



Relic forests of the black pine (*Pinus nigra*) on the Biokovo mountain (photo: A. Alegro)

The main causes of threats to forests in Croatia include: pollution of air, soil and water (fir is the most affected species), change in water regimes due to water management activities in lowland forests (common oak forests are threatened) as well as construction of roads through large forest complexes.



Willow and poplar forests are distributed mostly along the Mura, Drava and Danube rivers (photo: SINP)



# F. COASTAL HABITATS

This class consists of habitats above the high tide line that are under maritime influence. They are grouped into habitats of mud, sand, shingle and rocky shores. Among the most threatened are the rare mudflats of Northern Dalmatia, glasswort swards and tall rush saltmarshes found at a few small localities, mixed delta habitats of the Neretva River as well as sand and shingle beaches.

**Intertidal mudflats** are rare on the Croatian coast and are best preserved in the Neretva Delta area and Northern Dalmatia with nice sea inlets where mudflats border the glasswort (*Salicornia*) swards and wet grassland vegetation. These habitats are important for wintering waders, sea ducks and other waterfowl.

**Sand and shingle beaches** are represented on only 5.4% of Croatian coastline. These are extremely threatened habitats under the pressure of tourism, construction and waste disposal. Their specialised flora and fauna has all but disappeared at many sites. Some of the largest sand beaches are situated on



Rich stands of the glasswort (*Salicornia fruticosa*) like this one on the Cres island are rare on the Croatian coast (photo: SINP)



The biggest part of the Croatian coast is formed of the rocky shore (photo: SINP)

the island of Rab and in the Neretva Delta. Sand vegetation is still preserved at certain small localities like Saplunara beach on the island of Mljet.

Coastal habitats forming parts of **estuaries** are in fact complex habitats classified under the class K in the NHC, together with **lagoons**. They consist of mixture of coastal and marine habitats. Both are threatened and rare areas on the Croatian coast, exposed to great pressures of development projects. Besides the Neretva Delta, the estuaries of the Krka and Zrmanja Rivers, which in fact submerged karst river canyons, are also interesting. Lagoons are isolated brackish waters connected to the sea by a narrow connection. Only a few such sites have been preserved on the Croatian coast, like the small lagoon in the Pantan wetland near Trogir and two large lagoons in the Neretva Delta.



Protected sand beach on the Mljet island with rare and critically endangered sea daffodil (*Pancratium maritimum*) (photo: A. Alegro)



# G. MARINE HABITATS

## G. MARINE HABITATS

These are habitats below the high tide limit, including pelagial and benthos communities. There are several marine habitat types that are quite specific for Croatia.

**Karst marine lakes** are a rare phenomenon of the Croatian coast. These are sea water bodies enclosed in limestone, which are in contact with surrounding coastal sea through fissures in karst rocks or very narrow and shallow channels, so tides are reduced. Their communities in marine lakes significantly differ from those found in the surrounding coastal sea. Typical examples and regions are Zmajevo Oko (Rogoznica) and Mir (Telašćica, Dugi otok). In the broader sense, the Mljet marine lakes can be also included in this category.



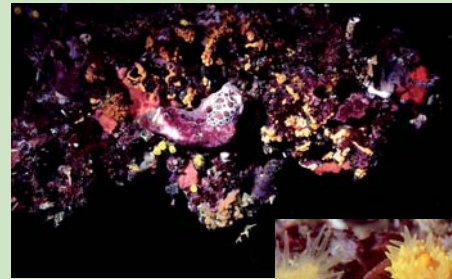
Posidonia beds are threatened in the whole Mediterranean (photo: A. Žuljević)

**Submerged caves and pits** where cold winter water can reside for the whole year contain deep sea organisms even in shallow areas in the littoral zone. Examples are finds of the carnivorous sponge *Asbestopluma hypogea* (submarine pit on Dugi otok) and the hexactinellid sponge *Oopsacas minuta* (in a cave on the southern part of the island of Hvar) at depths of less than 30 m.



Greater forkbeard (*Phycis blennioides*) from the coralligenous biocenosis (photo: NP Telašćica, D. Petricioli)

**Submerged karst** is characteristic for the Croatian Adriatic and is important at the Mediterranean level. Submerged river canyons of the Croatian karst rivers, the Zrmanja and Krka, with remains of submerged calcium tufa barriers can be traced on today's seabed.



Biocenosis of half-dark marine caves (photo: NP Telašćica, D. Petricioli)



*Leptopsammia pruvoti* from half-dark marine cave of the Nature Park Telašćica (photo: NP Telašćica, D. Petricioli)

The Adriatic is a shallow sea, with the greatest depth of 1,330 m. The depths of up to 200 m occupy as much as 73.9% of the Adriatic sea bottom while bigger depths may be found in the depression of the island of Jabuka and of the south Adriatic. The Adriatic stands out in the Mediterranean by its number of flora and fauna endemics. The sea-grass meadows are significant habitats because lot of species feed, breed and hide there. **Posidonia beds** are threatened in the whole Mediterranean. In Croatia they cover rather large areas of coastal waters up to 50 meters of depth. This belt with Posidonia beds is internationally important area for growing stages of the loggerhead turtle (*Caretta caretta*).



Sea urchin (photo: NP Telašćica, D. Petricioli)

# H. UNDERGROUND HABITATS

Karst geology represents 46% of the land area of Croatia. Approximately 7000 caves and pits are known, however this number is expected to increase considerably with new discoveries.

Between the largest is Lukina jama – Trojama pit system on the northern part of the Velebit Mountain with a surveyed depth of 1392 meters. The largest underground system is Đulin ponor – Medvedica cave system that is more than 16 kilometers long.

The diversified geomorphology, hydrology and climate have resulted in remarkable range of underground terrestrial, aquatic and interstitial habitats. Some of them, such as deep, wet sink-



Specific karst phenomenon is the “vrulja” - the spring under the sea level (photo: SINP)

holes and limestone glades, and certain alluvial deposits, are home to numerous relict organisms. A high degree of endemism occurs in animal species in the limestone glades of the Dinarides. Some 70% of almost 500 recorded terrestrial and aquatic cave invertebrates are endemic to Croatia. The largest animal groups with troglobites (terrestrial cave-dwellers) are beetles, false scorpions, spiders, snails and millipedes. Crustaceans predominate between stygobites (aquatic cave-dwellers). Other important groups include sponges, hydrozoa, planarians, snails, the only known aquatic cave clam (*Congeria kusceri*) and the only aquatic cave vertebrate – the olm (*Proteus anguinus*).



The cave Vištica jama in the karst surrounding the Neretva Delta area (photo: SINP)



Marine cave Ropa medvjedina (Monk-seal Cave) on the Lastovo island was in previous times inhabited by the monk-seal (*Monachus monachus*) (photo: Đ. Huber)

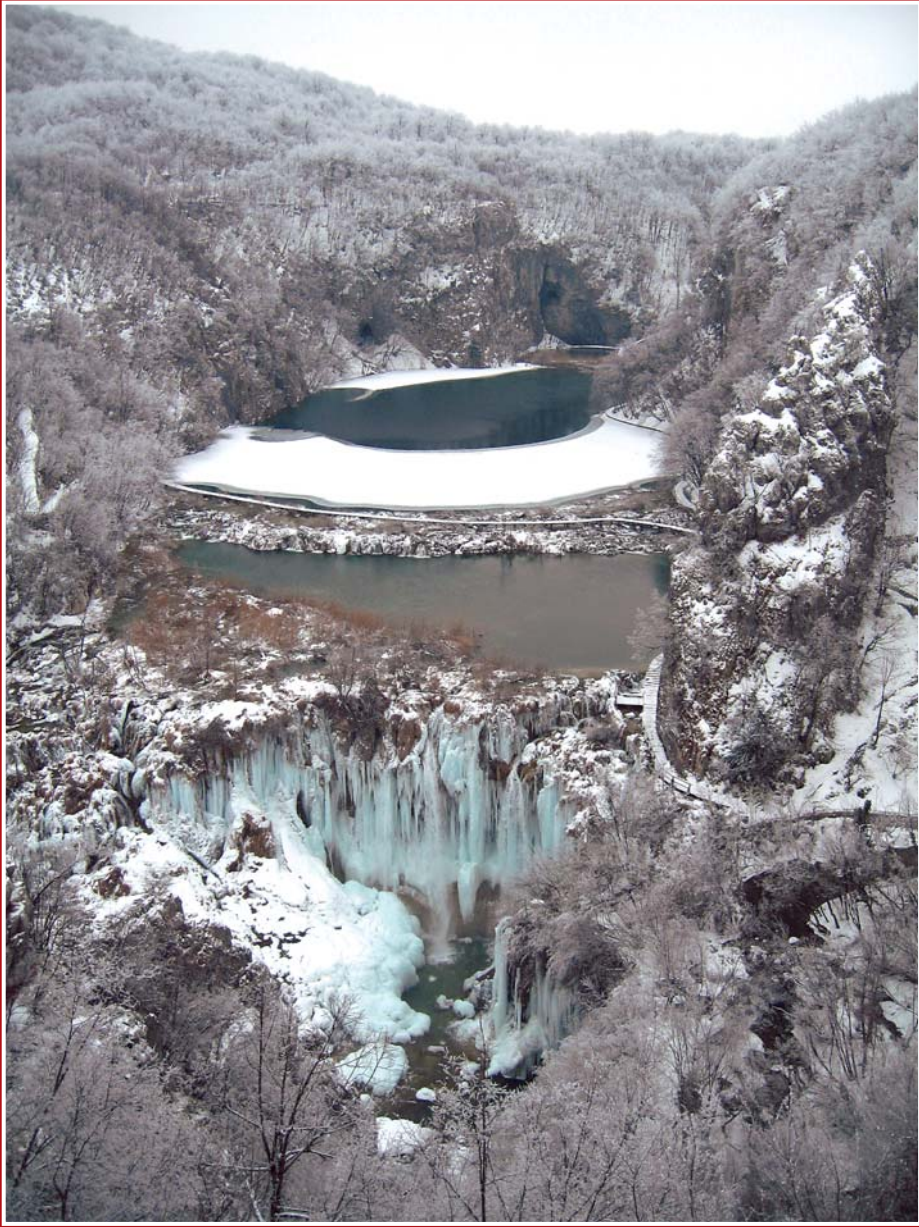
Caves and pits are important habitats for many species of bats whose winter or summer colonies inhabit them, creating rich layers of guano that is food base for many group of invertebrates.

Underground habitats and species are extremely vulnerable and threatened by external influence. Quarrying and road building, pollution of ground waters, disturbance of animals by lighting in caves open for public and overcollecting of underground fauna by amateurs are among the main causes of threat.



Bats are among the most significant inhabitants of underground caves (photo: SINP)



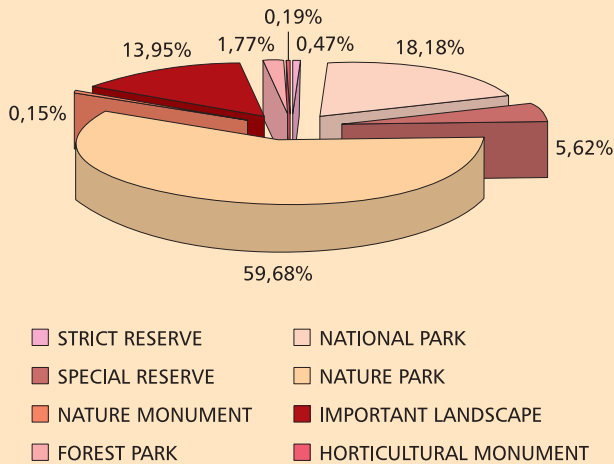


IMPORTANT SITES

# PROTECTED AREAS

According to the Croatian Nature Protection Act, protected areas are classified in 9 categories.

Currently, there are 444 protected nature areas designated in various categories, covering a total area of 5124.80 km<sup>2</sup> (9.05% of total territory). The largest portion of the territory is protected in the nature park or national park categories. There are 2 strict reserves, 8 national parks and 10 nature parks already protected and an 11<sup>th</sup> nature park, the Lastovo Archipelago, is in the process of designation. Several areas are in the process of designation in other categories.



Three of the eight national parks (Kornati, Brijuni and Mljet) are insular and characterised by rich marine life.

The Northern Velebit, Risnjak and Paklenica National Parks are mountainous areas characterised by particular relief features with numerous limestone rocks and scree, high-mountain meadows and vast forest complexes. Habitat diversity in addition to geographical isolation has led to the development of specific vegetation and numerous endemics.

Plitvice Lakes, Croatia's oldest national park, and Krka National Park are characterised by unique karst morphology and hydrology, travertine barriers, lakes and cascades.

Six of ten Croatian nature parks cover mountain areas (Medvednica, Žumberak-Samoborsko gorje, Učka, Biokovo, Velebit and Papuk).

The Kopački rit and Lonjsko polje Nature Parks are large flooded areas of the Pannonian lowland, and each includes a special ornithological reserve. Rivers surrounding and flooding these areas are the cause of high habitat and wildlife diversity, in particular of ornithofauna.

NATIONAL PARKS	AREA/ha
PLITVICE LAKES	29,482
PAKLENICA	9,600
RISNJAK	6,400
MLJET	5,375
KORNATI	21,700
BRIJUNI	3,395
KRKA	10,900
NORTHERN VELEBIT	10,900

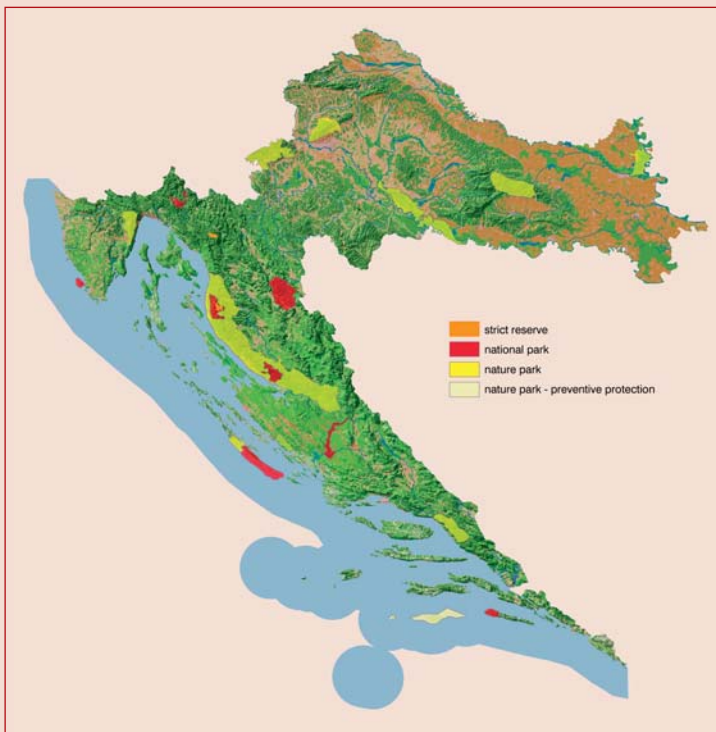
NATURE PARKS	AREA/ha
KOPAČKI RIT	23,894
MEDVEDNICA	22,826
VELEBIT	200,000
BIOKOVO	19,550
TELAŠĆICA	7,050
LONJSKO POLJE	50,600
PAPUK	33,600
UČKA	16,000
VRANSKO LAKE	5,700
ŽUMBERAK-SAMOBORSKO GORJE	33,300

Vransko Lake Nature Park, on the coast near Zadar, is the largest natural lake in Croatia and is important for breeding and wintering birds.



Vransko Lake Nature Park on the Croatian coast near Zadar (photo: NP Vransko Lake)





National Park  
Northern Velebit  
(photo: SINP)

Some Croatian protected areas enjoy international designation as exceptionally valuable biological and landscape diversity areas. Plitvice Lakes National Park is designated as a UNESCO World Heritage Site, while Velebit Mountain, which encompasses Velebit Nature Park and the Paklenica and Northern Velebit National Parks, is a UNESCO Biosphere Reserve. The Kopački rit and Lonjsko polje Nature Parks, together with the Crna Mlaka Special Ornithological Reserve and Neretva Delta area, are listed as wetlands of international importance under the Ramsar Convention.

Site name	International designation	Area
Plitvice Lakes National Park	UNESCO - World Natural Heritage List	29,482 ha
Velebit Mountain Nature Park	UNESCO MAB site	200,000 ha
Lonjsko polje Nature Park	Ramsar site	50,560 ha
Kopački rit Nature Park	Ramsar site	23,400 ha
Neretva Delta (proposed nature park)	Ramsar site	11,500 ha
Crna Mlaka fishponds ornithological reserve	Ramsar site	625 ha
<b>TOTAL</b>		<b>309,867 ha</b>

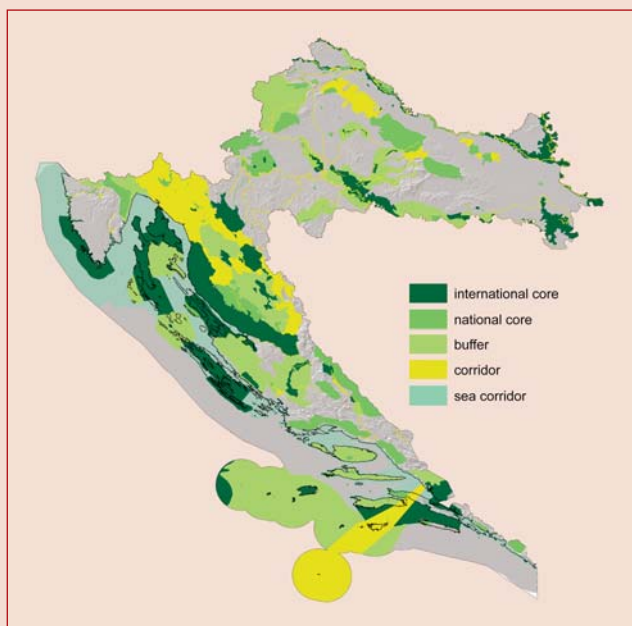
CATEGORY	NO. OF AREAS	TOTAL AREA/ha	PURPOSE	LEVEL OF PROTECTION
strict reserve	2	2395.35	protection of overall biological diversity, scientific research	protected by the Government, managed by county
national park	8	93,181.48	protection of biological diversity, scientific research, tourism, recreation, education	state
special reserve	79	28,796.5	protection of biological diversity focusing on a specific component (forests, plant communities, fauna, hydrology, etc.)	protected by the Government, managed by county
nature park	10	305,864.38	protection of biological and landscape diversity, sustainable development, tourism and recreation	state
regional park	0	0	protection of biological and landscape diversity, sustainable development, tourism and recreation	county
natural monument	103	761.79	protection of a representative element of nature or small site, scientific research	county
important landscape	69	71,467.08	protection of landscape diversity, sustainable development, tourism and recreation	county
park forest	38	9051.95	tourism and recreation, protection of landscape diversity	county
horticultural monument	135	961.82	protection of cultural heritage and landscape diversity, tourism and recreation, education	county
<b>TOTAL</b>	<b>444</b>	<b>512,480.35</b>		

Protected areas in Croatia

An **ecological network** is a system of functionally interconnected sites important for threatened species and habitat types.

In order for an ecological network to function, all of its components must be designated:

**Core areas** – the most valuable sites for species and habitat types threatened at the international and national level; **corridors** – features that connect core areas like “bridges”, enabling species to migrate and communicate; **buffer zones** – protecting the ecological network from negative surrounding influences (pollution, drainage, etc.); **restoration areas** – areas requiring the restoration or re-establishment of degraded habitat types as parts of the ecological network in order to ensure its functionality.



In Croatia, the **National Ecological Network** is defined under the Nature Protection Act (*Official Gazette* no. 70/05). It consists of international and national ecologically important areas connected with corridors. The network has to be organized in such a way that secures the long-term survival habitats and species threatened at the international and national levels (international conventions, EU Directives, national red lists). In line with the mechanism of the EU Habitats Directive, Croatian law regulates that parts of the ecological network can be protected by designating protected areas, the implementation of management plans, or the mechanism of nature impact assessment of any intervention threatening the site with respect to its conservation objectives. Negatively assessed intervention can be approved only in cases of overriding public interest and with compensation measures defined by law. An important mechanism is the possibility of contracting land-owners or land-users

on ecological network sites with adequate incentives for those activities that contribute to biodiversity conservation.

In 2005, the State Institute for Nature Protection completed the LIFE III funded project *Building the National Ecological Network (CRO-NEN)* aimed at proposing the National Ecological Network. This proposal is the basis for the **By-law on the National Ecological Network** that the Croatian Government is to adopt in line with the Nature Protection Act. The National Ecological Network is the first step towards preparing the NATURA 2000 proposal as a part of Croatia’s accession process to the European Union.

The **methodology** for creating an ecological network was based on the analysis of ‘key’ species and habitat type distribution. Selected species and habitat types are those threatened at the national or international level. By overlapping species distribution maps, maps of habitat types and protected areas, areas with the highest density of priority species and habitats were determined. These areas were then evaluated from the perspective of nature protection. It was determined whether and to what extent these areas are situated within the existing boundaries of protected areas; whether the boundaries of protected areas are appropriate for biological diversity protection or should be modified; creation of buffer zones around core areas; planning corridors for key species communication and drafting restoration areas, where needed.

International and national **core areas** were the result of the combination of the following sites:

- all national and nature parks (large protected areas important for biodiversity conservation);



The Mrežnica River is one of the most beautiful karst rivers and proposed nature park (photo: SINP)



- all special reserves, existing and designated in the physical plans;
- areas important for birds listed in Annex I of the Birds Directive;
- areas important for other species threatened at the international (NATURA 2000) or national (Red List) level: bats, dolphins, fungi, endemic species, etc;
- representative part of the total area covered in habitat types threatened at the international (NATURA 2000) or national level.

**Corridors** have been created as follows:

- all large rivers with a surrounding belt of 100 or 50 meters;
- forest corridors between forest core areas;
- migratory route of birds across the Adriatic Sea;
- coastal marine waters important for sea turtles and dolphins.

**Buffer zones** have been estimated as a needed buffer area surrounding particular core zones. Several **restoration zones** have been drafted with their exact locations yet to be determined.

	Land (km <sup>2</sup> )	%	Sea (km <sup>2</sup> )	%	Total (km <sup>2</sup> )
International core areas	7,767	13.8	4,280	13.5	12.047
National core areas	5,491	9.7	109	0.4	5.600
Corridors	4,903	8.7	8,515	26.9	13.418
Buffer zones	6,510	11.5	9,188	29.0	15.698
Total ecological network	24,671	43.6	22,092	69.8	46.763
Outside ecological network	31,944	56.4	9,552	30.2	41.496
<b>Total</b>	<b>56,615</b>	<b>100</b>	<b>31,644</b>	<b>100</b>	<b>88.259</b>

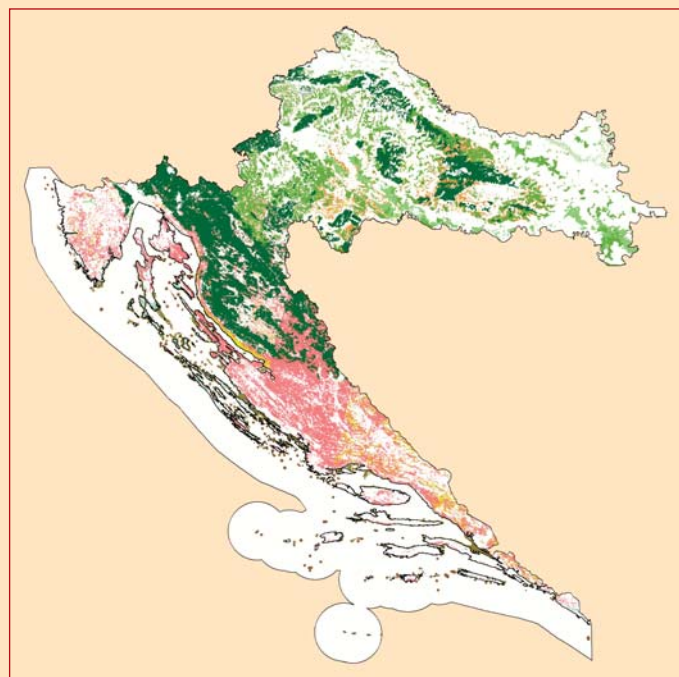


The Dvorina pond along the Sava River - protected ornithological reserve (photo: SINP)



Lonjsko Polje Nature Park - Ramsar site in alluvial wetlands of the Sava River (photo: SINP)

NATURA 2000 is the Ecological Network of the European Union that comprises sites important for the conservation of threatened species and habitat types. This program, which constitutes the foundation of nature protection in the EU, is based on the Birds and Habitats Directives (Council Directives 79/409 and 92/43 EEC). Through designation of Special Areas of Conservation (SAC) in compliance with Article 4 of the Habitats Directive, each Member State contributes to the drafting of NATURA 2000. These areas should be selected in a way that ensures the subsistence of the certain species and habitat types listed in the Directive Annexes. In compliance with the Birds Directive, Special Protection Areas (SPA) are designated for protection of particular bird species. Protection measures should be defined for NATURA 2000 sites that ensure favourable conservation status of species and habitat types for which the certain site has been designated.



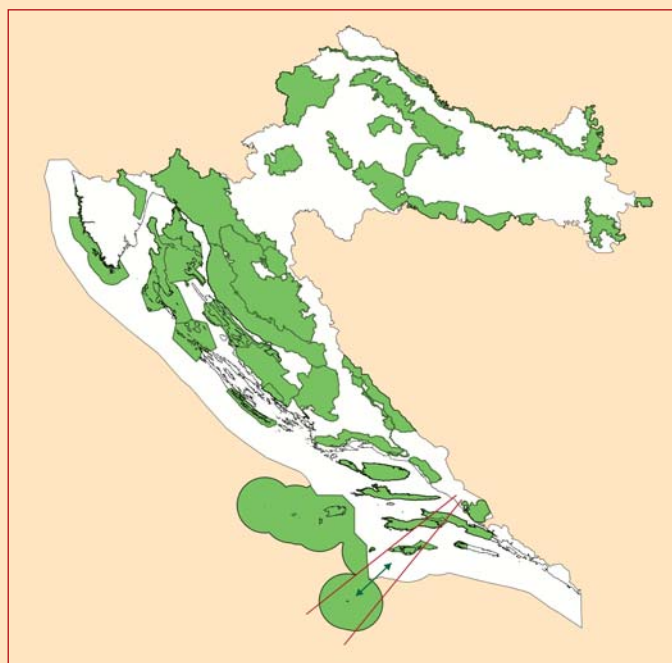
Distribution of NATURA 2000 habitat types in Croatia

Through the LIFE III CRO-NEN project, the distribution and representation of NATURA 2000 species and habitat types have been analyzed. A total of 269 species and 65 habitat types have been determined. Croatia includes the distribution areas of priority species such as wolf, brown bear, Mediterranean monk seal, sea turtles, two species of sturgeon and olm. The most numerous are birds, with 130 bird species listed in Annex I of the Birds Directive present in Croatia. Amongst threatened habitat types in Croatia, the priority types are: posidonia beds, Pannonian in-

land dunes, Mediterranean temporary ponds, petrifying springs with tufa formation, calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* and others.

For each NATURA 2000 species and habitat type, the State Institute for Nature Protection has created a distribution map with all known localities. Basic input for these maps was data derived from the Red Books in combination with habitat type maps. The Institute for Ornithology of the Croatian Academy of Science and Arts additionally analyzed those birds listed on the Birds Directive that were not included in the Red Book of Threatened Birds of Croatia. Furthermore, this Institute conducted an analysis of important sites for each of the NATURA 2000 birds and a proposal of SPA sites for Croatia.

The total area of 39 identified key bird sites covers 35,881 km<sup>2</sup>, of which 22,654 km<sup>2</sup> is land and 13,227 km<sup>2</sup> is territorial sea. This represents 40% of the total Croatian land area and 42% of total territorial sea area. This high percentage is the result of the great diversity of habitats and ornithofauna in Croatia.



Potential SPA sites in Croatia

The State Institute for Nature Protection continues to work on collecting and processing data needed for finalisation of NATURA 2000 for Croatia. These activities are partly conducted through international projects like the EEA/Council of Europe project *Emerald Network for Croatia* and the PHARE project *Implementation of NATURA 2000 in Croatia*.



## NATURA 2000 habitat types represented in Croatia

NATURA 2000 code	Habitat type
1110	Sandbanks, which are slightly covered by seawater all the time
*1120	Posidonia beds
1130	Estuaries
1140	Mudflats and sandflats not covered by seawater at low tide
*1150	Coastal lagoons
1160	Large shallow inlets and bays
1170	Reefs
1210	Annual vegetation of drift lines
1240	Vegetated sea cliffs of the Mediterranean coasts with endemic <i>Limonium spp.</i>
*1340	Inland salt meadows
1410	Mediterranean salt meadows ( <i>Juncetalia maritimi</i> )
1420	Mediterranean and thermo-Atlantic halophilus scrubs ( <i>Sarcocornetea fruticosi</i> )
*1510	Mediterranean salt steppes ( <i>Limonietalia</i> )
2110	Embryonic shifting dunes
*2340	Pannonic inland dunes
3130	Oligotrophic to mesotrophic standing waters with vegetation of the <i>Littorelletea uniflorae</i> and/or of the <i>Isoëto-Nanojuncetea</i>
3140	Hard oligo-mesotrophic waters with bentic vegetation of <i>Chara spp.</i>
3150	Natural eutrophic lakes with <i>Magnopotamion</i> or <i>Hydrocharition</i> - type vegetation
*3170	Mediterranean temporary ponds
3230	Alpine rivers and their ligneous vegetation with <i>Myricaria germanica</i>
3240	Alpine rivers and their ligneous vegetation with <i>Salix eleagnos</i>
3250	Constantly flowing Mediterranean rivers with <i>Glaucium flavum</i>
3260	Water courses of plain to montane levels with the <i>Ranunculion fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation
3270	Rivers with muddy banks with <i>Chenopodion rubri p.p.</i> and <i>Bidention p.p.</i> vegetation
3280	Constantly flowing Mediterranean rivers with <i>Paspalo-Agrostidion</i> species and hanging curtains of <i>Salix</i> and <i>Populus alba</i>
4030	European dry heaths
4060	Alpine and Boreal heaths
*4070	Bushes with <i>Pinus mugo</i> and <i>Rhododendron hirsutum</i> ( <i>Mugo-Rhododendretum hirsuti</i> )
5130	<i>Juniperus communis</i> formations on heaths or calcareous grasslands
5210	Arborescent matorral with <i>Juniperus spp.</i>
6170	Alpine and subalpine calcareous grasslands
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates ( <i>Festuco-Brometalia</i> ) (* important orchid sites)
*6220	Pseudo-steppe with grasses and annuals of the <i>Thero-Brachypodietae</i>
*6230	Species-rich <i>Nardus</i> grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)
*6240	Sub-Pannonic steppic grasslands
62A0	Eastern sub-Mediterranean dry grasslands ( <i>Scorzoneratalia villosae</i> )
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils ( <i>Molinion caeruleae</i> )
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
6440	Alluvial meadows of river valleys of the <i>Cnidion dubii</i>
6510	Lowland hay meadows ( <i>Alopecurus pratensis</i> , <i>Sanguisorba officinalis</i> )
7140	Transition mires and quaking bogs

NATURA 2000 code	Habitat type
7150	Depressions on peat substrates of the <i>Rhynchosporion</i>
*7210	Calcareous fens with <i>Cladium mariscus</i> and species of the <i>Caricion davallianae</i>
*7220	Petrifying springs with tufa formation ( <i>Crotoneurion</i> )
7230	Alkaline fens
8210	Calcareous rocky slopes with chasmophytic vegetation
8230	Siliceous rock with pioneer vegetation of the <i>Sedo-Scleranthion</i> or of the <i>Sedo albi-Veronicion dillenii</i>
*8240	Limestone pavements
8310	Caves not open to the public
8330	Submerged or partially submerged sea caves
*9180	<i>Tilio-Acerion</i> forests of slopes, screes and ravines
*91D0	Bog woodland
*91E0	Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> ( <i>Alno-Padion</i> , <i>Alnion incanae</i> , <i>Salicion albae</i> )
91F0	Riparian mixed forests of <i>Quercus robur</i> , <i>Ulmus laevis</i> and <i>Ulmus minor</i> , <i>Fraxinus excelsior</i> or <i>Fraxinus angustifolia</i> , along the great rivers ( <i>Ulmenion minoris</i> )
*91I0	Euro-Siberian steppic woods with <i>Quercus spp.</i>
91K0	Illyrian <i>Fagus sylvatica</i> forests ( <i>Aremonio-Fagion</i> )
91L0	Illyrian oak-hornbeam forests ( <i>Erythronio-carpinion</i> )
91R0	Dinaric dolomite Scots pine forests ( <i>Genisto januensis-Pinetum</i> )
9260	<i>Castanea sativa</i> woods
92A0	<i>Salix alba</i> and <i>Populus alba</i> galleries
92D0	Southern riparian galleries and thickets ( <i>Nerio-Tamaricetea</i> and <i>Securinegion tinctoriae</i> )
9340	<i>Quercus ilex</i> and <i>Quercus rotundifolia</i> forests
9410	Acidophilous <i>Picea</i> forests of the montane to alpine levels ( <i>Vaccinio-Picetea</i> )
*9530	(Sub-) Mediterranean pine forests with endemic black pines
9540	Mediterranean pine forests with endemic Mesogean pines

\* Priority habitat types for protection



Neretva Delta is one of four Croatian Ramsar sites and proposed new nature park in Croatia (photo: SINP)



Drava river is potential NATURA 2000 site and UNESCO Biosphere reserve (photo: SINP)



