

### Threats to biological communities in the Adriatic

Anthropogenic impacts pose a constant threat to living communities in **shallow coastline areas**. This primarily refers to building works carried out on the coast, to backfilling and consequential mudding of some parts of the sea, to solid waste disposal and particularly to pollution by unpurified waste waters of municipal and industrial origin. These factors pose threat to living communities of supralittoral and mediolittoral zones, and especially meadows of sea flowers *Posidonia oceanica* and *Zostera marina* (Box 27) belonging to communities of the infralittoral zone. A highly intensive process of filling up the coastal sea with diverse building and earthworks wastes is adversely affecting the settlements of various algae of genus *Cystoseria*, including the settlements of the endemic brown alga Adriatic wrack (Fig. 46) that has almost completely disappeared from some polluted parts of the Adriatic (western coast of Istria, Split, etc.).

The degradation of ecological balance of benthonic ecosystems is also a result of excessive fishing for economic and sport reasons, including the ravaging of individual divers. In the shallow sea man particularly threatens the complex communities of photophilous algae and meadows of *Posidonia oceanica*, while in the **depths of the sea** the communities of the detrital bottom are most threatened due to consequences of natural stress conditions, and the communities of the muddy bottom due to excessive trawling.

The immigration (or introduction) of the tropical green algae *Caulerpa* in the northern Mediterranean in 1984 represents another threat to biological diversity of the Adriatic (Fig. 48). In the course of three years this alga succeeded in spreading over large areas of the rocky, gravel, sandy and muddy bottom, covered by rich settlements of algae and large meadows of sea flowering plants. In the Adriatic *Caulerpa* was for the first time discovered in the bay of Starigrad in 1994. By the end of 1996 its zone (with a coverage of over 50%) was extended to more than 10,000 m<sup>2</sup> of the sea bottom in this bay.

**Figure 49.** Marine flowering plant *Posidonia oceanica* in the undersea zone of the island of Mljet (photo by D. Zavodnik)



**Figure 48.** Intruder in the Adriatic, *caulerpa* in the undersea zone in the vicinity of Malinska, the island of Krk (photo by A. Jaklin)

**Uneconomical fishing** accompanied by the non-observance of legal provisions led to decline in the number of populations of some fish and other marine animal species.

### Box 26. Threats and consequences of threats to marine flora and fauna

#### Threats

- poor enforcement and control of enforcement of legal provisions related to daily exploitation of the sea
- exploitation of living marine resources which is not based on the principles of rational use
- pollution of the sea by municipal and industrial waste waters, and
- various forms of anthropogenic influences such as, for example, solid waste disposal, backfilling, building works, knocking rocks to pieces (date-shell extraction), sand-blasting, artificial breeding of marine organisms, etc.

#### Consequences of threats

- evident change, withdrawal or disappearance of communities of macrophyte algae (*Cystoseira*, *Fucus*) and marine flowering plants (*Posidonia*) in areas exposed to powerful anthropogenic influences
- impact of sea pollution on the change of biological diversity is particularly reflected in the coastal zone, in the vicinity of major conurbations and in the greatest part of the Northern Adriatic (influence of North-Adriatic rivers)
- populations of some species of fish, crabs, mollusks and corals have seriously diminished.

### Box 27. Biocenosis of photophilic algae

In the Adriatic there are over 600 taxa of red, brown and green algae whose settlements on the shallow bottom of the sea are considered a special living community – a biocenosis of photophilic algae. In the coastal ecological system the ecological importance of this community is reflected in several ways: algae are one of the most important primary producers of organic substances; they are animal feed; their thalus serves as a basis for growing of other algae and many sedentary organisms, and their dense settlements provide an excellent sanctuary and a permanent residence for thousands of tiny animals and fry. In settlements of algae numerous animals spawn. On the other hand, algae affect certain physical and chemical factors of habitats such as, for example, content of oxygen dissolved in water, particles deposition, microdynamics of the aquatic body, illumination of bottommost layers of settlements and others. After decay the thalus of algae decompose and end up in deeper layers of the sea representing a rich source of food for animals living there. For that reason the community of photophilic algae is considered one of the biologically more diverse and ecologically most important living communities found in ecological systems of moderate and subarctic marine zones. The most significant settlements of brown algae in the Adriatic are those of genus *Cystoseira* and *Sargassum* whose dense and well-developed biomass settlements of as much as 10 kg wet mass/m<sup>2</sup> indicate a high degree of the cleanness of the sea. Settlements of photophilic algae are significant for well-lighted and firm base, above all for a craggy bottom. Elements of this biocenosis are regularly found on buoys, solid wastes and growth covering ships. Since many species are vulnerable to various chemical substances dissolved in water, the biocenosis of photophilic algae has, due to waste water pollution, decreased in many places and settlements of algae here and there even disappeared. In the Croatian part of the Adriatic the decay and disappearance of dense clumps of algae of the family *Cystoseira* have been observed, which inevitably resulted in the reduction of overall biological diversity, including the density of fish settlements of our coastal zone too. However, on formerly bare bottom of the sea dense settlements of *Cystoseira* have been found recently, pointing to the possibility of long-time natural fluctuations within the ecological system that do not depend on possible impacts of pollution. The development of autonomous diving techniques and tourism poses a direct threat to communities of photophilic algae along the coast, because date-shells are gathered although prohibited by the law. When crushing the rocks in which date-shells are living the local algae settlements are completely destroyed too. In this way original natural habitats disappear and an important source of organic substances in ecological system is lost.

D. Zavodnik



Figure 50. Original habitat of photophilic algae, community *Cystoseiretum barbatae* in the undersea zone of the island of Silba

(photo by A. Jaklin)



Figure 51. *Cystoseira barbata* in the undersea zone of the island of Silba

(photo by A. Jaklin)

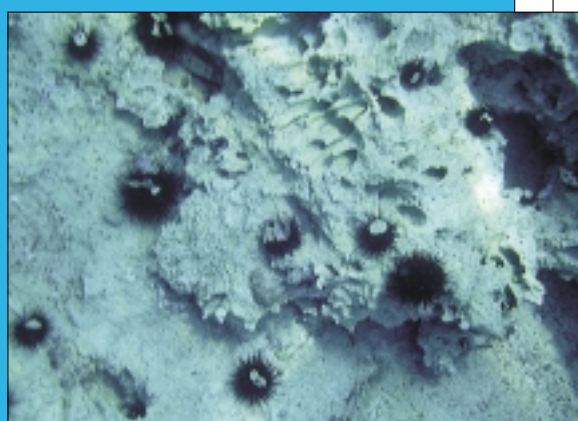


Figure 52. Photophilic algae habitat degraded after gathering date-shells in the undersea zone of the Brijuni National Park (the island of Veliki Brijun)

(photo by D. Zavodnik)

### The Adriatic Sea state and threats

Taken as a whole, the coastal and territorial waters of the Republic of Croatia are to the most part not polluted. Pollution has affected only certain coastal areas in the vicinity of some major conurbations. The most important sources of sea pollution in the Croatian part of the Adriatic are municipal waste waters, pollution of rivers Krka and Neretva and large industrial plants. Data on individual activities and other sources of pollution are not available or not collected systematically.

The living organisms and their diversity are less threatened in protected areas than in others, although the enforcement of legislation governing the preservation, use and behaviour in these areas is felt to be deficient.

### Ecologically vulnerable and threatened areas

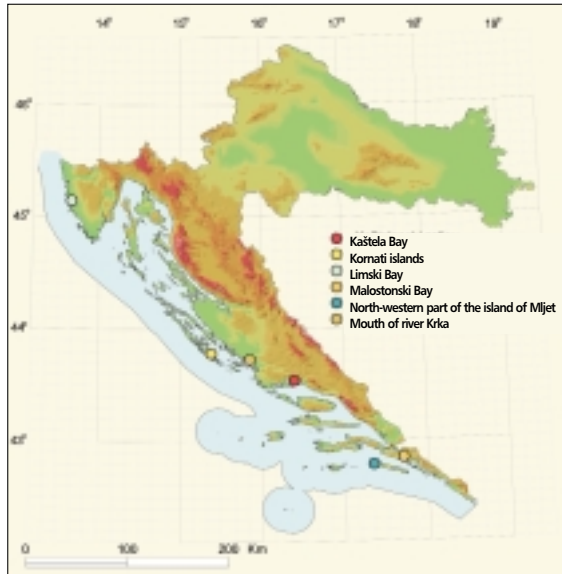
Due to its high productivity the Limski Bay has been protected as a special marine reserve since 1979. The bay has been recently threatened by waste waters discharged from the slaughterhouse situated in the hinterland that reach the bay through the porous karst land.

The Kornati Islands were designated a national park due to their geomorphological, petrographical and biological wealth. The islands are distant from the mainland sources of pollution, but are still threatened by intensive tourist-related and nautical activities.

The mouth of the Krka is a deep canyon ending upstream by the Lake Prokljansko and on the other side by



Map 9. Ecologically vulnerable and threatened areas of the Adriatic



the channel of Šibenik. Upstream from this area the Krka National Park is located. The surface layer of the whole area contains freshwater. The mouth is one of the most productive areas in the eastern part of the Adriatic; the lower section is, however, considerably polluted which is clearly indicated by high concentrations of certain heavy metals in sediments. It is polluted by municipal and industrial waters of Šibenik as well as by the metal processing plants located in the river's catchment area.

The **Kaštela Bay** is a semi-closed bay with a surface area of some 60 km<sup>2</sup> and a comparatively poor exchange of water masses with the open sea. About 40% of totally unpurified municipal waste waters generated by the Split conurbation and total volumes of partly treated industrial waste waters generated in this area have been for some time discharged into the bay. The waste water discharge has resulted in dramatic changes in living communities, "sea blossom", hypoxia and anoxia, including a massive kill of marine organisms.

The **Malostonski Bay** is situated at the end of the Neretva channel into which this river enters. Owing to the favourable primary production and hydrographic features shellfish have been grown in the bay since ancient times. Today it is the most important place for shellfish growing in Croatia. Since the adjacent area is poorly inhabited the bay has not been exposed to a serious eutrophication and is therefore protected as a strict nature reserve.

In 1960 the **north-western part of the island of Mljet** with all small islands lying in front of the island, including the natural phenomena of the Great and the Small Lake and the Solin Channel, was designated a national park. The area of the lakes is threatened by waste waters from settlements situated on the coasts of the island that are discharged into porous septic tanks. Another problem is also the floating waste transported from the open sea by winds and waves (Map 9).

### Threats to biological diversity in protected areas of the Adriatic

The main threat and cause of damage suffered by the living world of the sea in protected areas is absolutely fishing, both for economic and sports reasons. The control of fishing in special reserves is actually only symbolic. It is carried out by the marine police and the fishing inspection, which are insufficiently present at the sea and constantly lack personnel in charge of control.

In addition to the existing protected areas that include the marine living space, there are also some others that need

to be protected. Distant and almost uninhabited islands with their often rich and preserved submarine life which are still not threatened by various forms of use – tourist trade in the first line, deserve legal protection. This group includes the islands of Palagruža, Brusnik, Biševo and Svetac that, after a thorough examination, are to be protected under the category of special reserves – marine reserves. The island of Lastovo and the adjacent island groups of Vrhovnjaci and Lastovci are already foreseen for protection in the category of a nature park.

## GRASSLAND AND ARABLE LAND

Grassland and arable land are ecological systems generated by direct or indirect human influence on areas that were naturally wooded.

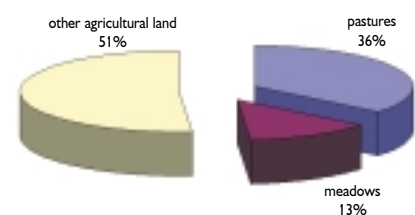


Figure 53. Meadow in the Sava basin  
(photo by M. Schneider-Jacoby)

## Grassland

### Features

The grasslands (meadows and pastures) occupy 48.5% of the total agricultural land or rather more than 1,500,000 hectares of which **pastures** account for 73.8% (1,115,000 hectares) and **meadows** 26.2% (410,000 hectares). Despite their not being of natural origin, the grasslands in this region represent habitats that contribute considerably to biological and landscape diversity. They are inhabited by plant species originating partly from forests and partly from other areas, particularly from the steppes of eastern Europe and Asia, while some taxa of polymorphous species developed directly owing to the anthropogenic influences on the grasslands.



Graph 3. Share of meadows and pastures in the total agricultural land

### Box 28. Grassland

Although originating mostly from human activities, the grasslands of Croatia are semi-natural habitats that enrich the biological and landscape diversity to a large degree. Since used predominantly in the extensive way – without fertilizers and chemicals – they are remarkable for their great biological diversity. At the European level special importance is given to vast flood meadows and pastures in Croatia's lowland.

The sand community of *Corynephorus canescens* and *Festuca vaginata*, *Corynephorus-Festucetum vaginatae*, presently found only in fragments in small areas of the sands of Đurđevac and Kloštar in the Drava basin region, is particularly remarkable.

#### State and threats

In Croatia people have traditionally applied the extensive method of using the grasslands. There are almost no artificial (cultivated, sown) grasslands and those few that existed have recently decreased after failure of former agribusiness complexes.

The ecological systems of grassland are presently **threatened** in all areas of Croatia. In the middle of this century the major part of **lowland grassland** was converted into arable land. The extensive land reclamation and regulation of watercourses left scarcely any marshy and wet grassland that normally belongs to the most threatened type of habitats. They are now very extensively and only temporarily used for grazing and mowing. Should this trend persist, grassland in lowland regions will almost completely "die out" in the foreseeable future. Formerly diverse marshy and wet grassland (communities *Caricetum*, *Deschampsietum*, *Molinietum*) are turning into less wet areas, chiefly communities of tall oatgrass (*Arrhenatheretum*), which leads to gradual impoverishment of flora and uniformity of vegetation, or rather to considerable reduction of the biological diversity.

The areas of **grassland in highland and mountainous regions** are also diminishing, but threats are different. The process of grassland degradation started with the decline in population and substantial reduction in traditional methods of managing woodlands in mountainous regions (Gorski kotar, Lika, Velebit, etc.) where cattle breeding used to be much more developed. Without cattle and regular mowing large areas gradually turned into thickets or forests. The greatest part of **littoral dry grassland and rocky ground pastures** suffered a similar fate. Here, admittedly, due to the dry and hot Mediterranean climate the natural succession takes place very slowly, but the long-term result is the same – the original natural vegetation is driving back all the diverse plant and animal species that have adapted to living in the sun, with the shortage of water, on a poor soil or in gaps between rocks. Floristically this grassland is several times richer than forests that make the natural vegetation of this region.

### Arable land and other nitrophyllous ecological systems

#### Features

Arable land under various crops covers almost a quarter of the total area of Croatia. These are nitrophyllous ecological systems including orchards, vineyard, gardens, marginal areas



Figure 54. Mountain pasture on Velebit, Lomska duliba

(photo by T. Nikolić)

along fields, canals and houses, treading areas of paths and yards and waste disposal sites. Their common feature is the increased nitrogen content that leads to floristic kinship reflected in a great number of common nitrophyllous plants. Here plants are strictly selected by various agricultural measures (ploughing, digging, manuring, using pesticides). Since the **biological diversity is here particularly threatened**, it is necessary to insist on agricultural measures that would minimize such harmful effects as much as possible.

With the exception of a great part of Slavonia and Baranja where land used for monoculture is extremely treated with pesticides and fertilizers, in the major part of Croatia agriculture is not so intensive. For that reason **the**

### Box 29. Classification of grassland in Croatia

#### Class *Thero-Brachypodietea*

- dry grassland and rocky ground pastures of the evergreen part of the littoral

#### Class *Festuco-Brometea*

- dry grassland and rocky ground pastures of the deciduous part of the littoral and continental highlands

#### Class *Elyno-Seslerietea*

- mountain grassland (swards)

#### Class *Molinio- Arrhenatheretea*

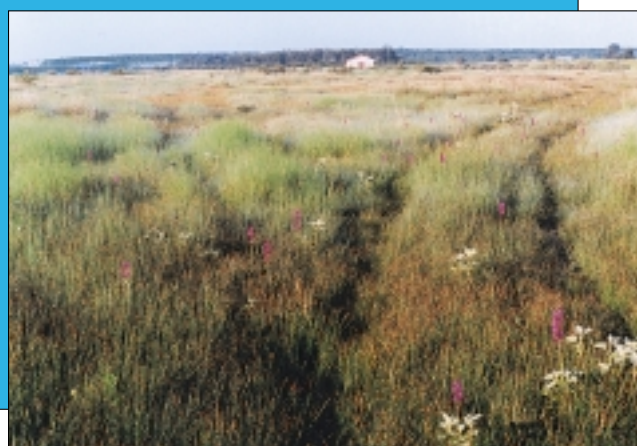
- wet and marshy grassland

#### Class *Nardo-Callunetea*

- grassland on highly acid soils of highlands and mountain areas

Figure 55. Wet meadow of the Mediterranean area, Lake Vransko near Biograd n/m

(photo by D. Grlica)





**Map 10.**  
Agroecological zones  
(made for the needs  
of FAO according to  
the Physical Planning  
Strategy of the  
Republic of Croatia,  
1997)



state is here far better than in most countries of Central and Western Europe. A great number of small parcels separated by natural hedges contribute not only to the wealth of biological, but also considerably to that of landscape diversity in Croatia.

The events in Croatia during this decade, particularly during years of war, resulted in substantial changes in the methodology of arable land management. The areas characterized by the most intensive agriculture (Slavonija,

### Box 30. Threats to grassland ecological systems

#### Lowland grassland

- reclamation of marshy and wet areas
- regulation of watercourses
- ploughing up and reallocation of the land
- manuring and application of chemicals in agriculture
- building and
- overgrowing of sandy areas.

#### Highland, mountain and littoral grassland

- neglecting the land and
- cessation of grazing and mowing.

**Figure 56.**  
Overgrowing of the  
sands of Đurđevac  
(photo by V. Hršak)



### Box 31. Arable land

Arable fields are artificially generated ecological systems intended exclusively for agricultural production and cultivated in the manner that insufficiently respects the need for the protection of biological diversity. This diversity is here particularly impoverished.

Baranja) were exposed to war activities and in some places completely devastated. The major part of arable land was, consequently, left to decay. The process of re-privatization has also here and there blocked the use of arable land. From the aspect of the protection of biological diversity these changes had a positive effect, because they made it possible for numerous species that disappeared to spread again, which means an overall enrichment of ecological systems. In such a situation it is extremely important to include measures for the protection of biological diversity into the process of bringing the deserted areas back into use for agricultural production.

### Threatened types of grassland and arable land

Numerous threatened plant species are connected with grassland, among which the most important are the whole family of orchids (*Orchidaceae*) and representatives of diverse other families or rather genera such as *Anemone*, *Arnica*, *Daphne*, *Dianthus*, *Edraianthus*, *Eryngium*, *Gentiana*, *Iris*, *Lilium*, *Ligularia*, *Linum*, *Narcissus*, *Primula*, *Scilla*, *Veratrum*, etc.



**Figure 57.** Siberian iris on meadows of Bilogora  
(photo by D. Grlica)

Cultivated plants, weeds and ruderal plants with approximately five hundred species make one eighth of the total flora of higher plants. Among cultivated species none is threatened, but, on the other hand, numerous old indigenous fruit and vegetable sorts that have remarkably adapted to specific ecological conditions and naturally resistant to them are highly threatened. Unfortunately, some of them can now only be found in world banks of seeds.

Weeds, as a competition to cultivated species, have been systematically destroyed and therefore numerous species have become threatened. In this country agriculture is much less intensive than in numerous other European countries, making weed and ruderal flora richer in many species that have already disappeared or considerably thinned out in countries of the central and western Europe. Among rare and threatened weed species in this country there are: corn cockle (*Agrostemma githago*) that disappeared from the areas of intensive agriculture (Slavonia and Baranja), then tulip *Tulipa praecox* – locally limited to vineyards of the island of Korčula, and oriental knight's spur, widespread at the eastern border of Croatia only. Among the ruderal species white poppy (*Papaver dubium* ssp. *lecoquii* var. *albifolium*) is rarely met and widespread also in the eastern part of Croatia only.

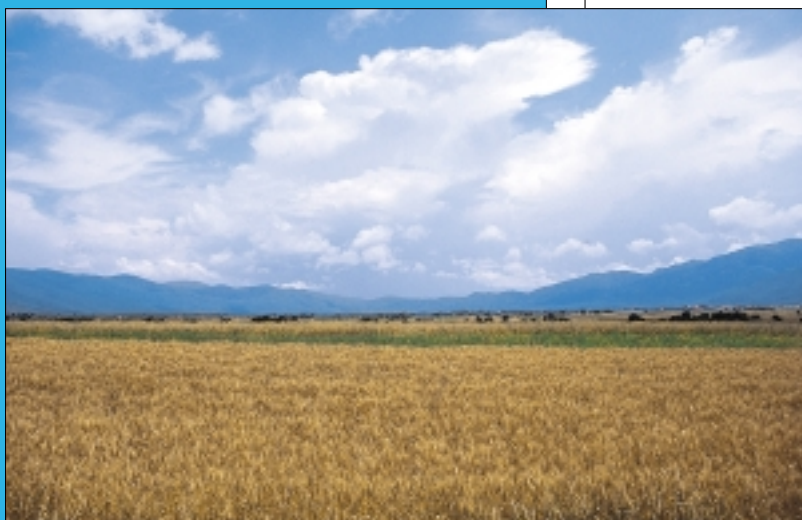
Ecological systems of arable land and grassland include also some **animal species** that are rare and threatened in European proportions. So, among birds, corncrake is connected to wet grassland, partridges and quails to arable land, on the islands of Krk and Pag stone curlew may be found, and in the Mediterranean area woodchat shrike and big lark. Some threatened species, otherwise living in steppes, have also adapted to agricultural habitats. These are the rarest breeding birds in Croatia: **imperial eagle**, **lesser kestrel**, **red-footed falcon** and **saker falcon**. **Common redshank** found in wet meadows is nesting only in two places in Croatia.

### Box 32. Threats to biological diversity of arable land and nitrophylous ecological systems

- methods of land use
- structure and methods of agricultural production (intensive, highly specialised)
- use of chemicals, primarily pesticides and fertilizers
- meliorative drainage and
- waste waters from livestock farms.

Figure 58. Monoculture in the neighbourhood of Otočac

(photo by T. Nikolić)



### Box 33. Endemic and threatened taxa of invertebrates found in grassland habitats

#### Daily butterflies

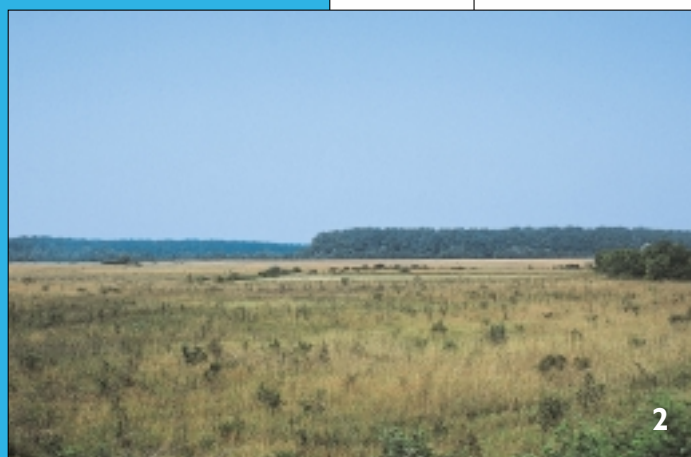
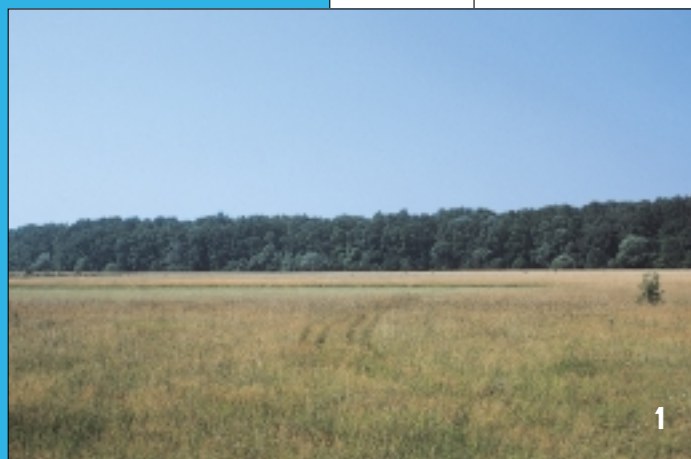
- *Erebia gorge* ssp. *vagana* Lork. – endemic of Vaganski vrh, the Paklenica National Park
- *Erebia styria* ssp. *gorana* Lork. – endemic of the upper Kupa
- *Erebia styria* ssp. *kleki* Lork. – endemic of Klek (the area between 1000 and 1150 m); very small population comprising about one hundred specimens only
- *Erebia oeme* ssp. *megaspodia* Mlad. et Lork. – endemic of the upper Kupa
- *Maculinea alcon* D. et S. – hygrophilic types of grassland with the local plant *Gentiana pneumonanthe*; the Papuk area; threatened over the entire area of the European part of the region
- *Maculinea telejus* Berg. – wet meadows of the Drava basin; threatened over the entire area of the European part of the region
- *Maculinea nausithous* Berg. – Đelekovac in the Drava Basin, Učka mountain; threatened over the entire area of the European part of the region
- *Lopinga achine* Scop. – mesophyllous types of meadow habitats; threatened species in Belgium, Luxemburg, Bohemia, Slovakia, Slovenia
- *Lycaena dispar* Haw. – hygrophilic meadow habitats; threatened over a greater area of the European part of the region
- *Pseudophilotes vicrama* (= *P. schiffermueleri*) – thermophilic meadows of the islands of Unije, Lošinj, Cres and Brač and the sands of Đurđevac
- *Coenonympha oedippus* – wet meadows of Istria in the borderland with Slovenia, Velebit (Box 60, p. 62).

#### Other invertebrates

- viper's bugloss, *Hadena irregularis*
- ladybird spider, *Eresus niger*
- grasshopper, *Acrida ungarica*.

Figure 59. Wet bay-meadows (1) are a habitat of threatened bird corncrake, but as people ceased to mow them these habitats tend to overgrow and rapidly disappear (2)

(photo by V. Dumbović)





Among rare mammals the most important are **hamsters** and mound-building mouse and among the threatened (extinct?) species European ground squirrel and Palestine mole mouse.

Grassland habitats in Croatia have a rich fauna of grasshoppers and butterflies. Croatia's fauna of daily butterflies consists of some 187 species, the majority of which may be found in meadow habitats. Two genera are particularly important: the endemic subspecies and species of the arguses (genus *Erebia*) and the myrmecophyllous genus of large blue *Maculinea*. These are either endemic taxa or species threatened at the European level.

### URBAN ECOLOGICAL SYSTEMS

Urban ecological systems demonstrate the **highest tendency of growth and development**. They are at the same time the most pernicious for conservation of natural biological diversity. Despite all efforts undertaken in nature protection it is an inevitable fact that precisely these urban ecological systems will dominate in the future. Therefore it is extremely important to take **care of planning and developing city areas** so as to provide artificially conditions for the survival of as many indigenous plants and animals as possible. In this connection priority is to be given to parks and other green surfaces. Urban ecology must become one of the inevitable imperatives of physical planning and designing.

Such deliberations are in Croatia, unfortunately, still in the very beginnings, with the problems of urban ecology lacking practically any legislative regulations.

#### Box 34. Urban ecological systems

Viewing the tendency of growth and development of towns in Croatia nature protection efforts are to be in an organized and systematic manner focused on regulating this urban ecology problem area by law, including active participation in the process of urban planning and development, in order to provide conditions for the survival of as much natural biological diversity as possible.

*Figure 60. The Bay of Bakar and the old town of Bakar recovering after the shutdown of the coke plant*

(photo by A. Frković)



### COAST AND ISLANDS

#### Features

Croatia's coastline is about 5,780 km long. The coastal area has a total of some 1,750,000 inhabitants, concentrated chiefly in major towns on the coast. Bigger and smaller islands are 718, with islands and cliffs totalling over 1,100. The surface area of islands is comparatively small – only 3,300 km<sup>2</sup> or 6% of the country's total area. Only 45 islands with a total of 126,000 inhabitants are permanently inhabited (2.6% of the total population of Croatia), with 15 more islands being inhabited temporarily (during the summer season). The biogeographical position, the dominating geological base (limestone) and a distinctly karst relief, including the indentation of the coast and the fact that this area was a sanctuary for plants and animals during the Ice Age, resulted in an outstanding diversity and peculiarity. **The share of the Adriatic coast in the total biological diversity of Croatia is very high.**



*Figure 61. The island of Jabuka, one of the most distant open-sea islands in the Croatian part of the Adriatic*

(photo by I. Lajtner)

#### Box 35. Coast and islands

Croatia's coast belongs to the most indented coasts of the Mediterranean. Coastal mountains and islands are remarkable for their plant and animal endemics. Islands are highly sensitive ecological units. For the time being they are comparatively well preserved, but threatened by planned activities. In order to preserve their natural values it is vitally important to incorporate and subsequently comply with measures for the protection of biological and landscape diversity during planning and implementation of all development programmes.

Species are particularly numerous on Velebit and on the islands of Cres and Krk which, by the number of some animal groups, surpass even much larger Mediterranean islands. The Neretva basin is famous for the number of fish species (34). **Endemic** forms may be found mostly on Velebit and Biokovo mountains, in numerous caves and pits, underground waters, karst springs and streams. Fish endemics live in the rivers of Krka and Čikola, Jadar, Cetina and in the tributaries of the Neretva. The centres of endemism are isolated mountain peaks, screes, cliffs of the



**Figure 62.** A cliff in the Kornati National Park  
(photo by I. Bralić)

islands of Cres, Krk and Prvić exposed to the north-eastern wind, the cliffs of Dalmatia's islands facing south and south-west (Fig. 62), the external archipelago of Palagruža and external islands of Jabuka (Fig. 61), Sv. Andrija, Sušac, Lastovo and Mljet. In addition to species related to the karst of the Dinaric Alps, the biological diversity of the mainland is furthermore increased by numerous **wet oases** on the dolomites and flysch, wet habitats along the karst rivers, streams, lakes and sea-shores, river mouths and periodically flooded karst fields.

## State and threats

As in other parts of the Mediterranean, the influence of human activities on nature has started very early and resulted in substantial changes of biological diversity. During the history the coastal karst area was permanently subject to comprehensive changes of the vegetation cover caused by **intensive cattle breeding and felling** of hardly renewable forests. In the first place islands were cleared to the highest extent possible and cultivated using the system of terraces separated by dry walls. Then, after **abandoning agriculture and cattle breeding**, they were left to succession towards forest communities. During the time the traditional



**Figure 63.** Kolansko blato on the island of Pag, a small Mediterranean marsh threatened by rapid overgrowing  
(photo by V. Dumbović)

economy succeeded in establishing balance in the number of individual species. The biological diversity of the space was, moreover, improved by species that could not have existed here without, for example, mowing, grazing or maintaining puddles. This state was, however, disturbed by new changes. Over the last 150 years several lakes on the coast (Lake Čepičko, Lake Bokanjačko, the lake near Vrgorac) and larger marshes (Valtura, Nadinsko blato) were drained, and the **reclamation of land** diminished considerably the marshlands, particularly round the mouth of the Neretva. The **excessive hunting and fishing, including the excessive use of pesticides** have to a high degree changed the composition and number of the fauna, while some karst rivers changed fundamentally their natural image. The **water reserves** on islands are threatened and limited. On every island freshwater or brackish water lies in the underground in the form of a lens on the seawater and contains a peculiar fauna. On the islands and in some parts of the coastal area the problem of **utility infrastructure has not been solved so far**. Various wastes are disposed of mostly on "wild" sites, while sewage and industrial effluents are often discharged unpurified into the karst underground, watercourses and the sea. For the time being consequences are only of local nature, but the anticipated development of economy, tourism and accompanying facilities could result in far more serious negative and irreparable changes. Unfortunately, **some parts of the coast** are most likely already irreparably devastated, such as the Bay of Bakar (Fig. 60), the industrial zone of Šibenik and the Bay of Kaštela.

The indigenous flora and fauna are additionally damaged by introduction of foreign species, and birds and fish by excessive hunting and fishing in particular, including poaching and disturbing the nesting birds while raising the young.

The changes in habitats or living conditions in some habitats have also brought about the changes in composition of species, but it is likely that only a minor part of those that disappeared was recorded. Many species died out locally, such as the common otter and the griffon vulture, some disappeared from the entire coast such as the white-tailed eagle and for some of them, like Egyptian vulture and Dalmatian pelican this meant extinction in Croatia. The indigenous populations of the hare on islands have to the most part disappeared due to introduction of the hare from Serbia, Hungary and the Czech Republic. From the country's coast some plants such as fern *Ophioglossum lusitanicum* and endemic gilliflower of the island of Jabuka (*Dianthus multinervis*) have completely disappeared.

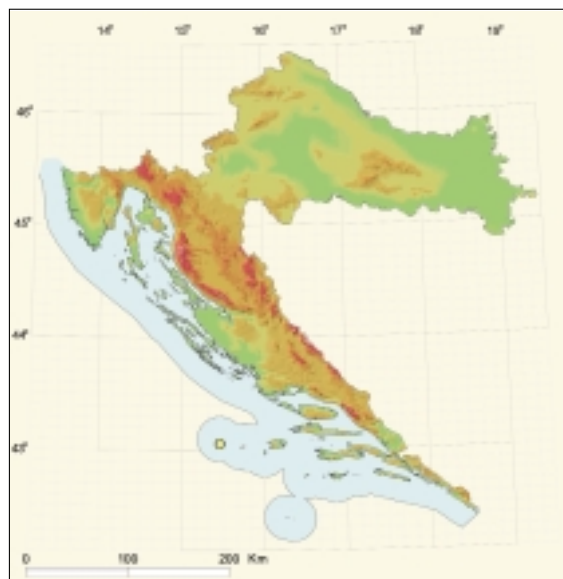


## Critically threatened taxa

### Box 36. Threatened plant species of the coast and islands

- degenia, *Degenia velebitica*
- bedstraw, *Asperula borbasiana*
- Palagruža cabbage, *Brassica botteri*
- Sušak cabbage, *Brassica cazzae*
- knapweed, *Centaurea crithmifolia* (Fig. 64)
- Jabuka knapweed, *Centaurea jabukensis*
- Palagruža knapweed, *Centaurea friederici*
- sea parnship, *Echinophora spinosa*
- seashore false bindweed, *Calystegia soldanella* and
- sea daffodil, *Pancratium maritimum*.

Figure 64. knapweed  
*Centaurea crithmifolia*  
(photo by N. Tvrtković)



Map 11. Distribution of endemic Jabuka lizard (according to data by N. Tvrtković)

## Critically threatened habitats

The sand and gravel beaches are threatened by organic pollution that often causes the dying out of the entire interstitial fauna, with sand beaches suffering additionally from tearing out the characteristic vegetation that “annoys” the swimmers.

Various aquatic and wet habitats are increasingly disappearing as a result of catching spring waters, canalizing watercourses, flooding the river valleys, land reclamation, backfilling and pollution. Pools disappear in the natural way when they cease to be cleaned, because the population is abandoning traditional cattle breeding and migrating from certain islands.

On coastal rocks falcons are often threatened by being disturbed during nesting (tourist sightseeing’s and boating), or even by plundering their nests. Some small islands and

### Box 37. Threatened animal species of the coast and islands

- crab *Salmoneus sketi*, a tropical relict and endemic of the sea-cave on Lavernaki
- true bug *Issus novaki*, an endemic of Sušac
- caddis-flies *Athripsodes dalmatinus*, an endemic of a brook near Makarska
- butterflies: *Leptidea duponcheli*, *Papilio alexanor*, *Parnassius apollo*, *Maculinea nausithous*, *Coenonympha oedippus*, *Coenonympha tullia*, *Zerynthia cerisyi dalmacijae*, *Protoerebia phegea dalmata*, *Erebia gorge vagana*
- freshwater endemic fish of the genera *Leuciscus* and *Phoxinellus* and Adriatic salmon of the genus *Salmothymus*
- Italian agile frog (*Rana latastei*)
- Orsini’s viper (*Vipera ursinii*) (Box 55, p. 58)
- 13 endemic forms of Dalmatian wall lizard each living on only one small island
- birds: lesser kestrel, Eleonora’s falcon, lanner falcon, levant sparrowhawk, Bonellii’s eagle, kentish plover, common redshank, European roller, bearded tit and
- mammals: Mediterranean monk seal and common dolphin.



Figure 65. Endemic lizard *Podarcis melisellensis*  
*ssp. pomoensis* from the island of Jabuka  
(photo by B. Jalžić)



*Figure 66. Lighthouse on the island of Palagruža*  
(photo by D. Grlica)

cliffs, which are the only habitat of endemic taxa of plants, invertebrates and wall lizards, are also threatened. They are exposed to the threat of introducing some other bigger or related, more aggressive species that could drive them out by competition or predatory behaviour. A special threat is the

### Box 38. Threats to coastal and island ecological systems

- **disappearance of natural habitats** caused by human activities: direct destruction, pollution, methods of use threatening the living organisms
- **non-existence of legal protection** accompanied by effective enforcement in the sites important for maintaining biological diversity
- **disappearance of traditional economy** (habitat changes, reduction of the number of threatened species in meadows, pastures and pools; disappearance of indigenous breeds and cultures)
- **poaching**
- **introduction of foreign species and population**, particularly into waters and on islands
- **using small islands for unsustainable tourist purposes**
- **unknown causes** since insufficiently examined.

tendency to develop tourism on such islands, with the first step being to allow the unsustainable use of natural resources and architectural heritage of small open-sea islands with lighthouses without previously elaborated **Programme for investigation, protection and conservation of natural and cultural heritage of Croatia's islands**.

On nearly all coastal mountains the fauna of **pastures and mowing meadows** is also threatened, because there is no traditional economy, and consequently no grazing and no mowing.

## HABITATS

### Features

The analysis of the list of habitat types made within the framework of the international CORINE-Biotopes programme demonstrated a great wealth of Croatia in all essential classes (habitats of the sea and coast; habitats of inland waters; habitats of scrub and grassland; forest habitats; bogs and marshes; habitats of rocks and caves; agricultural and artificial habitats).

Beside peculiar underground habitats many plant communities, or rather associated habitats, are endemic to Croatia. For many of them here is the centre of their site from which they are spreading into adjacent areas. This refers primarily to the following habitat types:

- **underground habitats**
- **aquatic habitats of rivers of the Adriatic catchment area**
- **communities of mountain grasslands** with mostly endemic or subendemic character
- **communities of cracks in rocks**



*Figure 67. Periodical karst watercourse at the upper Mala Paklenica, the Paklenica National Park*  
(photo by T. Nikolić)



- **scree plant communities** with specially adapted species, among which the most important is the endemic species and genus *degenia* growing in a special community of *Bunium alpinum* and *Iberis carnosa*, *Bunio-Iberetum pruitii* developed on screes exposed to strong wind
- **communities of Illirian garigues** showing a great diversity and peculiarity on the European scale and
- **community of coastal cliffs and rocks** with two centres of endemism – belonging to Kvarner and Dalmatia.

### State and threats

Although, considering the threat to habitats, the state in Croatia is not as alarming as in many other countries, it is still very important to stop on time the unfavourable trends in order to preserve the existing natural resources.

### Box 39. Threats to habitats

- industrial development
- management methods (intensive agriculture, felling forests)
- construction of roads, inland and sea transport
- power industry development and
- construction of tourist facilities and massive tourist trade.

*Figure 68. Storage lakes are degrading the biological integrity of river courses, dam on the storage lake on river Drava*

(photo by M. Mrakovčić)



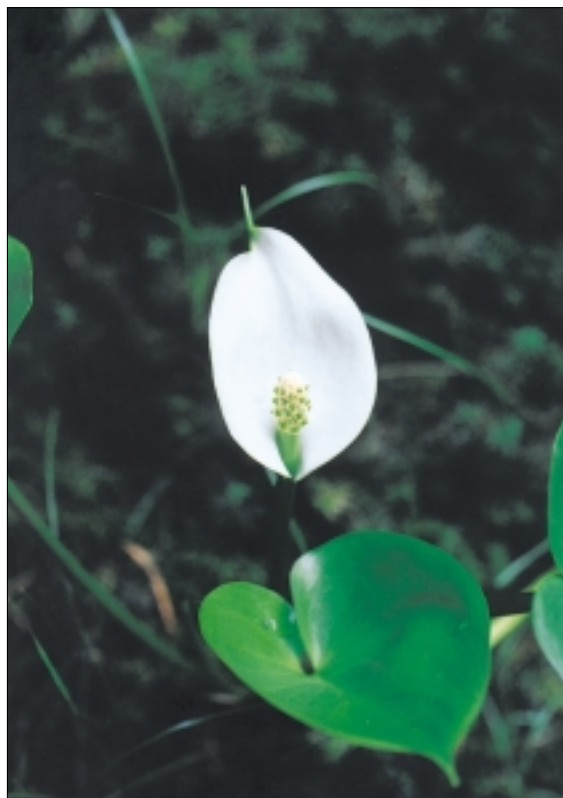
### Threatened habitats

Within greater ecological systems or clusters among which wetlands are the most threatened, there is a number of spatially smaller habitats, some of them very rare or threatened.

Among marine habitats the most threatened are coastal habitats of the littoral belt (waste water pollution, oil and oil derivatives, heavy metals, mechanical damaging of the seabed, gathering date-shells, construction of marinas, tourist facilities, etc.). The increasing frequency of tourists is posing another threat to numerous habitats of the supralittoral, containing coastal biocenoses poor in species and less and less often met. Particularly threatened are habitats found on silty (communities of *Arthrocnemetea*) and sandy coasts (*Ammophiletea*). Therefore it is inadmissible to

*Slika 69. Bog arum, a rare species of the moore Sunger*

(foto J. Topić)



destroy such habitats (for example, silty, flooded coasts in the bay of St. Euphemia, on the island of Rab or the sandy beach of Blaca on the island of Mljet).

The sands of Đurđevac represent an outstanding site with a highly important sandy community of gray-hair grass (*Corynephorus canescens*) and fescue grass (*Festuca vaginata*), *Corynephorum-Festucetum vaginatae*, described only here in Croatia. In a part of the sands a total degradation of the original community took place as a result of a spread of bushes and trees with herbaceous companions, which makes it necessary to take measures of active protection by removing the over-growing vegetation. Together with the adjacent smaller sands of Kloštar these sands of Đurđevac are the only remnants of the former, several kilometres long and wide stretch of "Croatian Sahara" (Fig. 70).

Among habitats and living communities in Croatia moors (blanket bogs) are near extinction. This relict, boreal types of living communities are highly vulnerable to changes of habitat conditions, because general climatic conditions in the area of Croatia are presently not favourable for their development. Their protection poses, therefore, a great problem. Every measure, causing even a slight change in the water system, means practically the disappearance of moors and that is the reason why many of them have already disappeared.

A typical example is Lake Bajer in Fužine where some significant moor habitats have been flooded. In a small section that is preserved a very important and in Croatia today almost extinct flesh-eating round-leaf sundew managed to survive. The moor in Dubravica (the region of Hrvatsko zagorje) is the only remaining finding place of round-leaf sundew in Croatia, but even here it is threatened with extinction due to choking up of the moor. The former small moor near Tršće in Gorski kotar is also nearly devastated (construction of plants, change in the water regimen, overgrowing of the moor by alder bushes and willows). Some ten years ago one species of cottongrass (*Eriophorum latifolium*) was growing here, but disappeared

during the process of moor degradation. It can probably be considered extinct in Croatia, because this was its only habitat known. In the area of Sungerski Lug bog arum is growing in a small moor in the forest. Today this is the only place known where it can be found, although in all probability it will before long become extinct here too (Fig. 69).

As relict habitats of rare species and due to their vulnerability to ecological changes of habitats, moors require special protection measures.

The **Danube basin grasslands of the semi-steppe type**, spreading in Croatia only on edges and over small surface areas, are very rare, but highly important considering their fauna.

The **coastal habitats of rivers Drava and Mura** – unfortified banks, sand and gravel dunes and banks – represent an European rarity, or rather habitats belonging to those most threatened in Europe (Fig. 71).

The Croatian peculiarity are also living communities of **travertine downstream beds** of karst rivers generated by a highly complex and sensitive, dynamic biological and chemical process, but presently more and more threatened by pollution of rivers or changing the existing water regimen.

The **karst watercourses** fall into the category of threatened habitats among which the small threatened watercourses at the foot of Biokovo and underground waters of Ogulin are remarkable for their interesting fauna.

On the whole, all **island waters** and particularly **pools** are threatened, since due to dying out of cattle breeding and migration of population they remain uncared-for.

The changes in habitat water systems are reflected in the composition of biocenoses of **wetlands and wet forests and grasslands**. That is the reason why certain types of wetland and wet grassland, such as wet meadows in Istria, those along river Kupa or in the Drava basin, are today less common.



In large areas of arable land there are no biocenoses that develop along the edges of the mosaic of patches of arable land, grasslands and groves, on the boundaries, along field paths, etc. The flora and fauna in these areas are considerably impoverished, including the weeds flora extremely damaged by the application of weed-killers.

In **mountainous regions** the process is currently taking place focused on the new development of a potential natural forest vegetation in a progressive succession, due to extinction of traditional cattle breeding. In this way the formerly vast pastures and meadows are disappearing.

**Figure 70.** Sands of Kloštar, remnants of the former "Croatian Sahara"

(photo by V. Hršak)

**Figure 71.** Unfortified bank of river Drava is a nesting place for sand martin

(photo by D. Radović)



**Figure 72.** Pond Čambina near Koprivnica, habitat of numerous rare species

(photo by A. Frković)

#### Box 40. Critically threatened habitats

- mainland sands with the sand community of gray-hair grass (*Corynephorus canescens*) and fescue grass (*Festuca vaginata*) (*Corynephor-Festucetum vaginatae*) (blanket bogs)
- moors
- semi-steppe grassland of the Danube basin
- habitats on silty (communities of *Arthrocnemetea*) and sandy coasts (*Ammophiletea*)
- pools on islands
- unfortified banks of rivers Drava and Mura, sand and gravel dunes and banks
- small pools and marshes
- living communities of travertine downstream beds of karst rivers
- karst watercourses.