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Biodiversity monitoring in the Kornati Archipelago, Croatia

Protocols for the monitoring of Natura 2000 and Croatian red list habitats and species

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R.J.H.G. Henkens, F.G.W.A. Ottburg, T. Van der Sluis and C. Klok (Eds.)

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Biodiversity monitoring in the Kornati Archipelago, Croatia

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Like any other EU member state Croatia will need to meet the rules and regulations associated with Natura 2000 after EU accession. Member states periodically need to report to the European Commission on the implementation of conservation measures taken and its impact on the conservation status of the Natura 2000 habitats and species concerned. Regular monitoring is essential to gather the data that are needed to meet these EU-obligations. The Kornati Archipelago will become part of the Natura 2000 network and has become the case-study site in this project. Monitoring protocols have been developed for a broad range of marine and terrestrial habitats, mammals (bats), birds, reptiles and amphibians. All listed under Natura 2000 (or the Croatian red list). Many Croatian specialist organisations participated in the fieldwork and assisted in the development of monitoring protocols.

Keywords: Biodiversity, Croatian red list, Kornati Archipelago, Marine habitats, Monitoring protocols, Mediterranean, Natura 2000, Terrestrial habitats

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Inhoud

Foreword 7

Summary 9

1 Introduction 11
1.1 Kornati Archipelago biodiversity values 11
1.2 Why monitoring protocols? 14
1.2.2 Obligations regarding Natura2000 15
1.3 What should be monitored? 15
1.4 Who are able to monitor? 16
1.4.1 Protected area biologists 16
1.4.2 Local volunteers 16
1.4.3 Eco-volunteers 16
1.4.4 Students 17
1.4.5 Others 17
1.5 National monitoring system: future perspectives 17
1.6 How to read and use this report? 18

2 Marine habitats monitoring protocol 19

3 Terrestrial habitats monitoring protocol 33

4 Mammals monitoring protocol 45

5 Birds monitoring protocol 59

6 Reptiles monitoring protocol 73

7 Amphibians monitoring protocol 83

Acknowledgements 89

Literature 91

Annex 1 Overall monitoring schedule habitats and species 93

Annex 2 Poseidonai oceanica field form 95

Annex 3A Croatian field forms for vegetation relevees and terrestrial habitat mapping 97

Annex 3B EBONE field form for Annex I Habitats 103

Annex 4A Bats mist netting field form 107

Annex 4B Bats underground object survey field form 108

Annex 4C Bat detector transect field form 109

Annex 5 Birds field form 111

Annex 6 Reptiles and amphibians field form 113

Foreword

Croatia is currently standing at EU's doorstep. Its accession as a new member state will substantially increase and strengthen EU's Natura 2000 network. Like anywhere else, challenge remains to keep the economic opportunities and biodiversity values within this network in balance. Periodical monitoring of both biodiversity as well as human impacts will be needed to sustainably manage the Natura 2000 sites and to ensure that its natural values are preserved for future generations.

Setting up a monitoring network for all those habitats and species groups concerned takes time, if not only for increasing the needed capacity for skilled fieldworkers. For the future Natura 2000 site of the Kornati Archipelago this start has been made in 2009 with the development of monitoring protocols for the habitats and species concerned. If only one keyword should be considered to describe the 2009 activities of this project it should be the word 'cooperation'.

Funding from no less then five separate sources could be combined to reach the intended goal. The project *Capacity building for long-term monitoring of Natura 2000 species, Croatia* (funded by the Netherlands Ministry of Agriculture, Nature and Food quality) specifically aimed at developing monitoring protocols for the Natura 2000 habitats and species known to date. This project was merged with the 2009 activities of two other projects: *Biodiversity protection in Croatia's Kornati Archipelago; inventorying and monitoring of terrestrial species* (funding from the Finnish Embassy); and, *Biodiversity protection in Croatia's Kornati Archipelago; mapping of marine species and habitats* (MATRA-KNIP fund from the Netherlands Ministry of Foreign Affairs). Further co-funding was provided from the project *Sustainable Island and Coastal Development in Šibenik-Knin* (MATRA-project funded by the Netherlands Ministry of Foreign Affairs) through its activities for developing sustainable tourism products for the Kornati National Park. As such, the development of biodiversity photos for exhibition in the visitor centre and future participation of eco-volunteers in monitoring may be considered as examples of nature-based tourism products. Furthermore the Netherlands division of the World Wildlife Fund co-funded the project through its INNO-fund for the provision of a zodiac boat, a requirement for transportation of fieldworkers to monitoring locations within the archipelago.

The 2009 activities have lead to an increased number of Natura 2000 habitats and species, while the Croatian specialists available during workshops and fieldwork provided essential input for the monitoring protocols. Special thanks go to the Croatian organisations which were active during fieldwork like: Ecological Association Argonauta (local coordination); State Institute for Nature Protection; Student Association BIUS; Association for Nature, Environment and Sustainable Development SUNCE; Croatian Herpetological Society Hyla; Croatian Society for Protection of Birds and Nature; Public Institution for Conservation of Nature Šibenik-Knin County and National Park Kornati. Without their enthusiasm and voluntary work it would never have been possible to develop this joint report. Many thanks to all!

Summary

Like any other EU member state Croatia will need to meet the rules and regulations associated with Natura2000 after EU accession. Member states periodically need to report to the European Commission on the implementation of conservation measures taken and its impact on the conservation status of the Natura 2000 habitats and species concerned. Regular monitoring is essential to gather the data that are needed to meet these EU-obligations.

The Kornati Archipelago has high biodiversity values both marine and terrestrial and will become part of the Natura 2000 network after EU-accession of Croatia. Due to past collaborations this area became case-study site for this project.

Monitoring protocols have been developed for a broad range (but not all) of marine and terrestrial habitats, mammals (bats), birds, reptiles and amphibians. All listed under Natura 2000 or the Croatian red list. The protocols within this report should be seen as a good start for the implementation of regular monitoring of biodiversity within the archipelago. The protocols can always be extended with additional monitoring transects and plots. Present protocols however form a firm basis and a starting point for gathering long-term monitoring data, allowing for the analysis of species and habitat trends.

This report can be regarded as a true Croatian-Dutch product as many Croatian specialist organisations participated in the fieldwork and assisted in the development of monitoring protocols, like: Ecological Association Argonauta (local coordination); State Institute for Nature Protection; Student Association BIUS; Association for Nature, Environment and Sustainable Development SUNCE; Croatian Herpetological Society Hyla; Croatian Society for Protection of Birds and Nature; Public Institution for Conservation of Nature Šibenik-Knin County and the National Park Kornati.

1 Introduction

Before presenting the monitoring protocols of specific habitats and species in the Kornati Archipelago this chapter aims to give some answers to questions about monitoring like:

- Why monitoring protocols?
- What should be monitored?
- Who is able to monitor?

First however, a general overview will be given about biodiversity values in the Kornati Archipelago known to date and its relation with Natura 2000 (see box 1.1).

Box 1.1 Natura 2000

Natura 2000 is the centrepiece of EU nature & biodiversity policy. It is an EU-wide network of nature protection areas established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPA's) which they designate under the 1979 Birds Directive. Natura 2000 is not a system of strict nature reserves where all human activities are excluded. Whereas the network will certainly include nature reserves most of the land is likely to continue to be privately owned and the emphasis will be on ensuring that future management is sustainable, both ecologically and economically. The establishment of this network of protected areas also fulfils a Community obligation under the UN Convention on Biological Diversity[1].

1.1 Kornati Archipelago biodiversity values

With its 141 islands, islets and cliffs, the Kornati Archipelago is the largest archipelago in the Mediterranean. The total land area measures some 68 km², while the surrounding marine area measures some 300km². The islands are grouped into four microgeomorpological rows: Sit, Žut, Kornati and Piškera.

In terms of its conservation status, the Kornati archipelago is divided into the Kornati National Park which includes the Piškera and Kornati rows and the Sit-Žut group of islands protected under the category of a protected landscape. These two areas together with neighbouring Telašćica Nature Park are part of the National Ecological Network as priority habitat for Bottlenose dolphin conservation as adopted by Croatian Government in October 2007 (National ecological network proclamation act, Official gazette 109/07). This National Ecological Network may become part of the EU ecological network Natura 2000.

Based upon the present available information the sea flora and fauna comprises 3 seagrass species, 353 algal species and around 3000 faunal species. Though many of the islands may look quite desolated they're inhabited by an impressive number of species. Up to date some 600 plant species have been recorded and specialists estimate the final count at 700 to 800. Information on faunal species on the islands remains limited though some endangered species have been recorded here as well. This impressive diversity of species illustrates the reason why WWF

[1] Source : http://ec.europa.eu/environment/nature/natura2000

declared the Dalmatian Coast (in combination with the Dinaric Alps) as an eco-region or a so-called biodiversity hotspot.
From the rich biodiversity in the archipelago a list of 7 habitat types and 13 species could be derived that are registered under the EU Habitat- or Bird Directives (see table 1.1). This list has been extended with the species registered on the Croatian Red list, which illustrates the value of the area for biodiversity conservation.

For an explanation of the EU Annexes see box 1.2. Habitats and species that are listed with an asterisk (*) have so-called priority, which means they're having priority in order to favour the early implementation of measures to conserve them. Continuous monitoring of flora and fauna will undoubtedly lead to an increase in the number of EU-protected species on this list.

Box 1.2 Explanation of the Annexes to the Habitat and Bird Directives

Habitat Directive:
Annex I. Natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation. Special Area of Conservation means "a site of Community importance designated by the Member States through a statutory, administrative and/or contractual act where the necessary conservation measures are applied for the maintenance or restoration, at a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated";
Annex II. Animal and plant species of community interest whose conservation requires the designation of special areas of conservation;
Annex IV. Animal and plant species of community interest in need of strict protection.

Bird Directive:
Annex I. "Bird species of Annex I shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. Member States shall classify in particular the most suitable territories in number and size as special protection areas for the conservation of these species, taking into account their protection requirements in the geographical sea and land area where the Directive applies."
"Member States shall take similar measures for regularly occurring migratory species not listed in Annex I, bearing in mind their need for protection in the geographical sea and land area where this Directive applies, as regards their breeding, moulting and wintering areas and staging posts along their migration routes. To this end Member States shall pay particular attention to the protection of wetlands and particularly wetlands of international importance."

Table 1.1

*Present (2009) list of habitats and species present in the Kornati Archipelago that are listed under the EU Habitat Directive (HD) and Bird Directive (BD) or that are registered on the Croatian red list (EN-Endangered, NT-Near threatened, LC-Least concern, DD-Data deficient). Habitats and species marked with an * have so-called priority meaning that the EU has particular responsibility in view of the proportion of the natural range which falls within its territory.*

	HD Annexes			BD Annex I	Croatian RL
	I	II	IV		
Marine Habitats					
Code 1120: *Posidonia* beds (seagrass)	X*				
Code 1170: Reefs	X				
Code 8330: Submerged or partially submerged sea caves	X				
Terrestrial Habitats					
Code 1240: Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.	X				
Code 1420: Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	X				
Code 5330: Thermo-Mediterranean and pre-desert scrub	X				
Code 6220: Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	X*				
Code 8130: Screes of variable rocks in thermophilous situations	X				
Code 8210: Calcareous rocky slopes with chasmophytic vegetation	X				
Code 8310: Caves	X				
Marine mammals					
Tursiops truncates (Bottlenose dolphin)		X	X		EN
Terrestrial mammals (Bats)					
Hypsugo savii (Savi's pipistrelle)			X		
Miniopterus schreibersii (Schreibers' bat)		X	X		EN
Myotis aurascens/mystacinus (Whiskered bat)			X		
Myotis emarginatu s(Geofrey's bat)		X	X		NT
Myotis blythii (Lesser mouse-eared bat)		X	X		
Nyctalus lasiopterus (Greater noctule)			X		DD
Pipistrellus kuhlii (Kuhliis' pippistrelle)			X		
Plecotus kolombatovici (Balkan Long-eared bat)			X		DD
Rhinolophus ferrumequinum (Greater horseshoe bat)		X	X		NT
Tadarida teniotis (Mediterranean freetailed bat)			X		
Birds					
Anthus campestris (Tawny Pipit)				X	LC
Hippolais olivetorum (Olive-tree Warbler)				X	DD
Caprimulgus europaeus (Nightjar)				X	LC
Lanius collurio (Red-backed Shrike)				X	
Bubo bubo (Eagle owl)				X	NT
Falco peregrinus (Peregrine falcon)				X	VU
Ixobrychus minutus (Little bittern)				X	NT
Rallus aquaticus (Water rail)					NT
Phalacrocorax aristotelis (Cormorant shag)				X	NT
Hirundo rustica (Barn swallow)					LC
Marine Reptiles					
Caretta caretta * (Loggerhead turtle)		X*	X		EN
Terrestrial Reptiles					
Testudo hermanni (Hermann's tortoise)		X	X		NT
Elaphe quatuorlineata (Four-Lined Snake)		X	X		

	HD Annexes			BD Annex I	Croatian RL
	I	II	IV		
Zamenis situla (Leopard Snake)		X	X		DT
Telescopus fallax (Cat Snake)			X		
Hierophis gemonensis (Balkan racer)			X		
Pseudopus apodus (European Glass Lizard)			X		
Podarcis sicula (Italian wall lizard)			X		
Podarcis melisellensis (Dalmatian wall lizard)			X		
Amphibians					
Bufo viridis (European green toad)			X		
Marine Bivalves					
Pinna nobilis (Pen shell)			X		
Lithophaga lithophaga (Date mussel)			X		

1.2 Why monitoring protocols?

Monitoring protocols are a tool to support nature management in general (like the overview of the preferred timing of habitats and species monitoring in annex 1, which supports the planning of field activities). Considering the EU obligations in relation to Natura 2000 however, monitoring protocols are indispensable.

1.2.1 Nature management in general

Protected area authorities periodically need to update the nature management plan of their area. With these plans they aim to conserve biodiversity through implementation of (improved) nature management activities as well as to ensure a sustainable integration with user groups like tourists, fishermen, land owners, diving companies or restaurant owners.

Nature management staff generally visits their protected area often and thereby observes the most obvious ecological changes, like for instance a decrease in the number of dolphin sightings. However, convincing user groups who have their own observations requires stronger arguments then just observations. It needs research data which prove statistical evidence for any positive or negative trend. These trends are generally not measurable within one or two years, as the positive or negative changes observed could simply be due to changes in local weather conditions. It requires data over a number of years. Data as well, which are comparable between the years and which have been obtained from research at the same plots or transects. These fixed field research methods are laid down in monitoring protocols or manuals. Figure 1.1 gives an example how a long-term trend could look like.

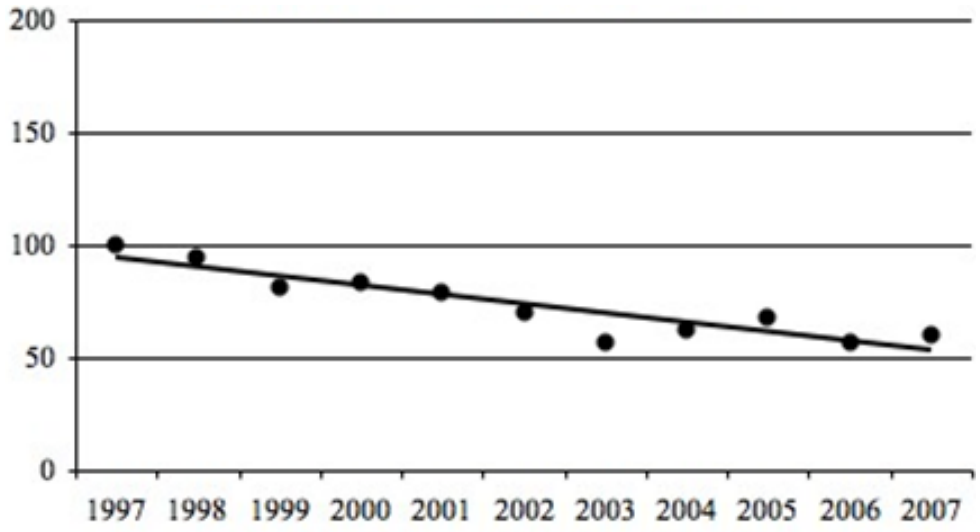


Figure 1.1
Hypothetical status trend of a certain species or habitat over a ten years period of time. The year 1997 is the reference situation (100%). Some years show an increase, other years a decrease. Over 10 years period of time however, the trend is negative as the line indicates. Management action may be needed depending on the cause(s) (internal or external cause) and the species (high or low conservation status) concerned.

1.2.2 Obligations regarding Natura2000

Like any other EU member state Croatia will need to meet the rules and regulations associated with Natura 2000 after EU accession. Member states need to forward to the European Commission every three years a report on the implementation of national provisions taken under the Bird Directive. Under the Habitat Directive member states need to draw up a report to the European Commission every six years on the implementation of conservation measures taken and an evaluation of the impact of those measures on the conservation status of the habitats and species concerned. These regulations, especially under the Habitat Directive, make clear that monitoring is needed to be able to assess the conservation status of the habitat types and species concerned.

1.3 What should be monitored?

The Kornati Archipelago inhabits thousands of floral and faunal species on land and in the water. It's impossible to monitor them all. Selections need to be made. Choosing indicator species, which indicate a certain trend for a whole range of other species or habitats, is important. Marine habitats like *Corraliginous* reefs for instance are very diverse in species. The challenge is to find those species that have best opportunities to indicate any positive or negative trend in this habitat, so-called indicator species.

Another option could be to focus the monitoring on species that have a certain protection status like the National Red list of Croatia or species that are listed on the Annexes of the EU Bird- and Habitat Directives. Once Croatia has become an EU Member State it even obliges itself to protect these species. Especially those specific habitats and species should be monitored, for which a protected area will be designated as a Natura-2000 site. The Kornati Archipelago for instance will (probably) be designated as a Natura 2000 site for *Poseidonia oceanica* seagrass beds, Bottlenose dolphins and bird species like Peregrine falcon and Cormorant shag. Reports about the status and trend of these specific habitats and species need to be send to 'Brussels' periodically as a way to control whether Croatia meets its obligations.

It must be stressed that it is also important to monitor issues other then biodiversity. Especially those issues that can have a substantial impact on habitats and species. One can think of the number and distribution of tourists in the park, the number of anchoring boats, the number of divers, fishing intensity, the number of cats (predation pressure) on the islands, the number of sheep (grazing pressure) but also weather conditions. Certain positive or negative trends in biodiversity can then be correlated to these impacts.

1.4 Who are able to monitor?

The organisation(s) which will use the data are responsible for the quality of the monitoring fieldwork, the protection authorities having first responsibility. They will need to make sure that the monitoring has sufficient quality and that the data will be stored in a GIS database. One or more supervisors, responsible for monitoring, should be appointed.

It's often misunderstood that reliable monitoring data can only be collected from professionals in the field of biology. If that would be true then there would simply be insufficient human capacity to carry out the monitoring. Besides, then it would as well become all too expensive. Luckily there is no need to have completed a biology study before being able to monitor habitats and species. Generally one only needs to be able to distinguish a limited number of species and/or habitats. So-called 'learning by doing' by joining an experienced person is the best way of learning. Some need more time then others, but eventually most people who are willing to learn will eventually succeed. The field forms are usually quite simple to fill in and easy to learn. Supervisors will check the field forms and give feedback.

1.4.1 Protected area biologists

Protected area biologists can be considered having sufficient background knowledge to carry out the monitoring research after some minimum amount of training. The number of protected area biologists however is generally too small to cover all necessary habitats and species groups concerned. Therefore these professionals should act as supervisors being responsible for planning and supervision of the fieldwork as well as storage in the database.

1.4.2 Local volunteers

Monitoring is often carried out by local volunteers, meaning local people who are dedicated to conserve nature in what they consider as their 'backyard'. A small country like the Netherlands for instance counts more than 16.000 local volunteers (data 2009) who are actively involved in field monitoring which ranges from birds to submarine biodiversity. Once local volunteers are trained they can work quite independently only with minor supervision. These experienced locals generally attract and guide new-comers as well.

1.4.3 Eco-volunteers

Another group which may contribute to monitoring are eco-volunteers. These are tourists, mostly from abroad, who are so much dedicated to a certain species that they're willing to spend their holidays to contribute to field research on the species concerned (see for instance www.ecovolunteer.org). Species having high potential for eco-volunteer projects are mostly species like dolphins (like the Lošinj Dolphin reserve) and turtles (nesting beaches). Considering the substantial number of dedicated bird lovers and divers in the world, one may also consider submarine biodiversity and birds, as feasible eco-volunteer subjects. Participation in the whole range of monitoring research, especially in spring, may also interesting for eco-volunteer participation.

Different from local volunteers, one must consider that eco-volunteers need much more support from the protected area authorities. Most eco-volunteers lack any monitoring experience and they need to learn form the start (they generally only stay a couple of weeks). Besides, one should not forget that they are paying tourists who also need some attention after the fieldwork.

1.4.4 Students

Biology students, or students from a related discipline, need field experience. Monitoring protocols can be considered as a very instructive tool for these kinds of students. Monitoring fieldwork within the Kornati Archipelago might be integrated within a study program. Therefore, it would be wise for protected area authorities to set up a partnership with educational (biology) institutes so they're assured to receive students for monitoring every year.

1.4.5 Others

Besides biologists, local volunteers, eco-volunteers and students, data can also be obtained in other ways. Some stakeholder groups make a living in the area and therefore spent lots of time in the Kornati Archipelago like for instance fishermen, diving companies and land owners (but also tourists). Their sightings from species like bottlenose dolphins, loggerhead turtles, peregrine falcons, eagle owls etc. can help to understand the current distribution and status of the species in the area. These data add information to the regular data obtained through monitoring protocols. These incidental sightings as well must be stored in the GIS database.

1.5 National monitoring system: future perspectives

Box 1.3 Ecological monitoring in the Netherlands

The Netherlands have a long history of ecological monitoring. To date 10 specialised private data managing organisations (PGO's) cover the most important flora & fauna groups of the Netherlands. The PGO's monitor with the help of > 16.000 volunteers and this number is still increasing. The PGO's coordinate fieldwork, train volunteers and control the standardised field forms. Their data bases cover ± 80% of monitoring data in the Netherlands.

With the increased national and European juridical obligations in relation to nature conservation it became clear that the collected data did not always meet the knowledge required by government and others. Therefore in 1999 the Ecological Monitoring Network (NEM) was raised. The NEM is a cooperation between government organisations on the monitoring of nature in the Netherlands aiming to adjust the collection of data to government needs. The NEM follows the trends of nearly all important species groups like birds, butterflies and plants. As such the NEM can be considered as the backbone of the monitoring of nature in the Netherlands. The NEM gives order, to PGO's mainly, to carry out the monitoring schemes. In order to guarantee the quality the data will be collected according to standard field monitoring protocols or manuals. Cooperation with the organisation Netherlands Statistics leads among others to the required Status and trends of Natura 2000 habitats and species in the Netherlands.

In order to prevent that all data end up in scattered databases the Ministry of Agriculture, Nature and Food Quality

of the Netherlands raised the National Authority for Data concerning Nature (GaN). The GaN manages the National Database Flora and Fauna in 2007 (NDFF[2]). The NDFF can be considered a data warehouse which contains the distribution data of plants and animals that have been collected by many organisations for past decades. All data entering the NDFF are validated using a quality filter on input. To date the system contains over 60 million records on the distribution of flora and fauna, which is the result of combining over 100 different databases. Each year more then 2.5 million new data are added to the database. As such the GaN directs the NEM on the monitoring of habitats and species. The database is being used by the government, municipalities, provinces, districts, conservationists, construction industries and many more.

The protected area authorities of the Kornati Archipelago can use the results of the monitoring for nature management purposes, as stated in §1.2. Eventually the goal however should be to analyse trends for the habitats and species groups concerned on a national Croatian scale. This means that the nation wide data should end up at a central organisation. This organisation receives the monitoring data from protected area authorities and NGOs specialised in certain species or habitat groups, who all work according to standardised field monitoring protocols. The central organisation should not only take care for management of the database and analyses of trends. Data should also be provided to improve the work of government, municipalities, provinces, districts, conservationists, construction industries and many more. The system on ecological monitoring in the Netherlands, which has a long history, might serve as an example (see box 1.3).

1.6 How to read and use this report?

The remainder of this report describes the monitoring protocols available for the Kornati Archipelago to date (2009). This means that those protocols will be described that were able to be developed within the limited time span of 2009. Though many of these protocols need further fine tuning in the field, all can be considered a good starting point for the monitoring of habitats and species concerned. The report describes the monitoring protocols for marine habitats (chapter 2), terrestrial habitats (chapter 3), mammals (chapter 4), birds (chapter 5), reptiles (chapter 6) and amphibians (chapter 7). All protocols start with an introduction to the habitats or species group concerned. Hereafter some ecological characteristics will be described. Aim of this section is to provide follow-up researchers and volunteers with some basic information about the topic concerned, without having to study all kinds of background literature and field guides. Hereafter some maps are provided which show the monitoring transects and plots within the Kornati Archipelago. This is followed by the monitoring schedules (timing of the monitoring) and the methods for monitoring. Each session ends with a checklist of the field equipment and human resources needed in the field. The annexes to this report mainly refer to the field forms.

Though all protocols are set-up according to the structure described above, they can be quite diverse. On one hand this is due to the diversity of the monitoring per habitat and species group concerned, on the other hand this is also due to the diversity of the expertise available within the project group. Editing however has only been carried out on headlines in order to prevent loosing valuable information.

The protection authorities of the Kornati Archipelago should have this report available within a ring binder. This enables the easy inclusion of additional future monitoring transects and plots and any additional monitoring protocols for other habitats and species like: reefs, Bottlenose Dolphins, Loggerhead Turtles, insects, and what else is still to be discovered in the archipelago. Having the information in a ring binder also easily allows for copying monitoring protocols and taking them into the field.

[2] http://www.gegevensautoriteitnatuur.nl/pages/english.aspx

2 Marine habitats monitoring protocol

Introduction

Croatia has a rich marine biodiversity, more than 750 species of marine flora and fauna have been found on reefs and four species of seagrass are found in the Croatian part of the Adriatic Sea. Croatia owns this rich diversity to its geomorphology and sea currents. The only reef building coral in the Adriatic Sea is the stony coral *Cladocera cespitosa*. Other hard corals like *Bakabphyllia europaea* do not form colonies but live solitary. This implies that the basis of reefs in the Adriatic Sea is not formed of skeletons of hard corals but rocks. These are overgrown by solitary hard corals, many soft corals and other species. The Croatian coast is especially known for its beautiful gorgonians (soft corals) that form fanlike structures like the often dark red *Paramuricea clavata* which can only be found below the 30 m zone. The abundance of these species results from suitable settlement- (rocky underwater cliffs) and food conditions (north bound current). A high salinity (38‰) flow of Mediterranean water streams north wise along the Croatian coastline, thus providing a constant supply of zooplankton that enhances coral growth. In the North Adriatic the water flow turns west, and then goes south along the eastern Italian coast back to the Mediterranean.

Table 2.1
*Marine habitats from the Habitats Directive Annex I to be found in the Kornati Archipelago. Habitats indicated with an * are so-called priority habitats.*

Marine Habitats
Code 1120: *Posidonia* beds (seagrass)*
Code 1170: Reefs
Code 8330: Submerged or partially submerged sea caves

A definition of the three Natura 2000 marine habitat types important for the Kornati Archipelago (table 2.1) is extracted from the EU website[3] and provided below:

1120 Posidonia beds (Posidonion oceanicae)
Beds of *Posidonia oceanica* (Linnaeus) Delile characteristic of the infralittoral zone of the Mediterranean (depth: ranging from a few dozen centimetres to 30 - 40 meters). On hard or soft substrate, these beds constitute one of the main climax communities. They can withstand relatively large variations in temperature and water movement, but are sensitive to desalination, generally requiring a salinity of between 36 and 39‰. Examples for typical species in *Posidonia beds:*

- Plants: Posidonia oceanica;
- Animals: Molluscs- #Pinna nobilis (pen shell); Echinoderms- Asterina pancerii (sea star), Paracentrotus lividus (sea urchin);
- Fish- Epinephelus guaza Dusky Sea Perch, Hippocampus ramulosus (Sea horse).

[3] http://ec.europa.eu/environment/nature/natura 2000/marine/docs/appendix_1_habitat.pdf

1170 Reefs

Reefs (fig. 2.1) can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone (see box 2.1 for clarifications). Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions. Examples for typical reef species:

- Vegetation: *Cystoseira/ Sargassum* beds with a mixture of other red algae (*Gelidiales, Ceramiales*), brown algae (*Dictyotales*) and green algae (*Siphonales, Siphonacladales*).
- Animals forming biogenic reefs: Serpulid polychaetes, bivalve molluscs (e.g. *Modiolus sp. Mytilus sp.* and oysters). Polychaetes (*e.g. Sabellaria alveolata).*
- Non reef forming animals: Cirripedia (barnacles), hydroids, bryozoans, ascidians, sponges, gorgonians and polychaetes as well as diverse mobile species of crustaceans and fish.

8330 Submerged or partially submerged sea caves

Caves are situated under the sea or opened to it, at least at high tide, including partially submerged sea caves. Their bottom and sides harbour communities of marine invertebrates and algae.

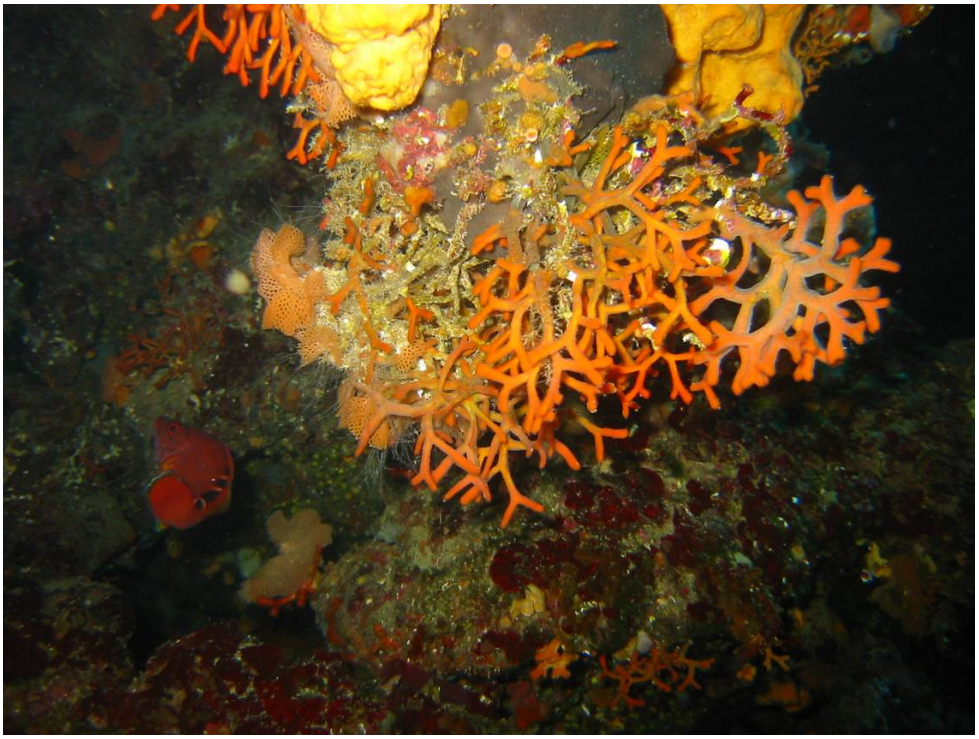


Figure 2.1

Reef with colourful sponges and bryozoans (photo: Chris Klok).

Box 2.1 Clarifications concerning the definition of 'reefs'	
Hard compact substrata:	Rocks (including soft rock, e.g. chalk), boulders and cobbles (generally >64 mm in diameter).
Biogenic concretions:	Concretions, encrustations, corallogenic concretions and bivalve mussel beds originating from dead or living animals, i.e. biogenic hard bottoms which supply habitats for epibiotic species.
Geogenic origin:	Reefs formed by non bi\ogenic substrata.
Arise from the sea floor	The reef is topographically distinct from the surrounding seafloor.
Sublittoral and littoral zone:	The reefs may extend from the sublittoral uninterrupted into the intertidal (littoral) zone or may only occur in the sublittoral zone, including deep water areas such as the bathyal. Such hard substrata that are covered by a thin and mobile veneer of sediment are classed as reefs if the associated biota are dependent on the hard substratum rather than the overlying sediment. Where an uninterrupted zonation of sublittoral and littoral communities exists, the integrity of the ecological unit should be respected in the selection of sites. A variety of subtidal topographic features are included in this habitat complex such as: Hydrothermal vent habitats, sea mounts, vertical rock walls, horizontal ledges, overhangs, pinnacles, gullies, ridges, sloping or flat bed rock, broken rock and boulder and cobble fields.

Of these three habitat types the development of monitoring protocols for *Posidonia* beds has received more attention than the other two habitat types. This obviously stems from the species complexity of the two other habitat types. What to monitor in Reefs is currently under discussion in Croatia and of submerged caves virtually no open source information is available. The only traceable information on submerged caves in Croatia is given by a 2006 brochure on biodiversity in Croatia from the State Institute for Nature Protection[4] where this habitat type is described as caves and pits where cold winter water can reside for the whole year and which 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. For the moment the focus therefore is on the development of monitoring protocols for *Posidonia* beds only.

The European community has evaluated methods to locate and determine the spatial contours and biodiversity of different marine habitat types including *Posidonia* beds, reefs and submerged caves (see box 2.2). Based on their evaluation remote methods are not applicable for submerged caves what makes their location very labour intensive because they can only be detected by diving. The usefulness of side scan sonar and multibeam bathymetry of location *Posidonia* beds is questioned, and satellite images and areal photography can help to locate reefs but cannot distinguish between types of reefs.

Monitoring protocols for seagrass beds have been well developed by SeagrassNet[5]. These protocols are used all over the world, and are based on well established methods to assure statistically relevant results. These monitoring

[4] http://www.dzzp.hr/publikacije/biodiversity_brosura.pdf

[5] http://www.SeagrassNet.org

protocols are practical in use and do not need specialised personnel to be carried out. See box 2.3 for such a protocol.)

Box 2.2 Evaluation of survey methods to assess spatial extend and quality of different habitat types suggested by EU (http://www.SeagrassNet.org)

	Data useful to locate, determine extent and assess biodiversity of habitat or habitat sub-type?							
Type of data	1110 Shallow sandbanks	1170 Reef (bedrock)	1170 Reef (stony)	1170 Reef (biogenic)	1170 Reef (Hydro-thermal)	1180 Submarine structures	8330 Sea caves	1120 Posidonia beds
Remote methods:								
Side scan sonar[1]	Locate, extent?	Locate, extent	Locate, extent	Locate, extent	?	Locate, extent	Not applicable	?
Multibeam bathymetry[1]	Locate, extent	Locate, extent	Locate, extent	Locate, extent	Locate, extent	Locate, extent	Not applicable	?
AGDS (acoustic ground discrimination systems) [1]	Locate, extent	Locate, extent	Locate, extent	Locate, extent	?	Locate, extent?	Not applicable	Locate, extent
Satellite images[1, 2]	Locate, extent	Locate, extent (won't distinguish between sub-types of reef)			? Locate, extent	Not applicable	Not applicable	Locate, extent
Aerial photography[1, 2]	Locate, extent				Not applicable	Not applicable	Not applicable	Locate, extent
Direct sampling or observation methods:								
Grab/core sampling[3]	Extent Biodiversity	Not applicable	Biodiversity (limited application)	Biodiversity (not recommended)	Not applicable	Biodiversity (limited application	Not applicable	Biodiversity (not recommended)
Diver sampling	Biodiversity	Biodiversity	Biodiversity	Biodiversity	Biodiversity	Biodiversity	Biodiversity	Biodiversity
Towed video[3]	Extent Biodiversity	Extent Biodiversity	Extent Biodiversity (not	Extent Biodiversity	Not recommended	Biodiversity (limited application	Not applicable	Extent Biodiversity

Box 2.3 Monitoring through SeagrassNet

SeagrassNet (www.SeagrassNet.org) is a scientific global monitoring program based at the University of New Hampshire that investigates and documents the status of seagrass resources worldwide.

Why monitor?

Seagrass meadows can change in several ways. There can be a change in biomass without a change in area; a change in area, or shape, depth or location of a meadow; a change in species composition, plant growth and productivity; the fauna and flora associated with the meadow; or a combination of some or all of these. Some changes will also occur naturally and on a regular seasonal basis. Environment monitoring programs require knowledge of these patterns of natural change. They also require cost-effective data collection, selection of appropriate parameters and scales, and measures of change which are statistically appropriate for determining if management action is required.

How to monitor?

Choose locations ranging from pristine (1 required) to stressed (optional)
One transect per location
Perpendicular to shore at the centre of a 50m band running to the deep edge
3 cross-transects per transect, each 50m long with centre points at:

- Deep station (1 m into the bed from the offshore edge of the continuous
- meadow) mark with a permanent marker and record GPS location
- Shallow station (1 m into the bed from the onshore edge of the continuous
- meadow) mark with a permanent marker and record GPS location
- Mid depth station (between deep and shallow or at an interesting transition between species) mark with a permanent marker and record GPS location (with the assumption that cross-transects are independent).

Monitoring scheme

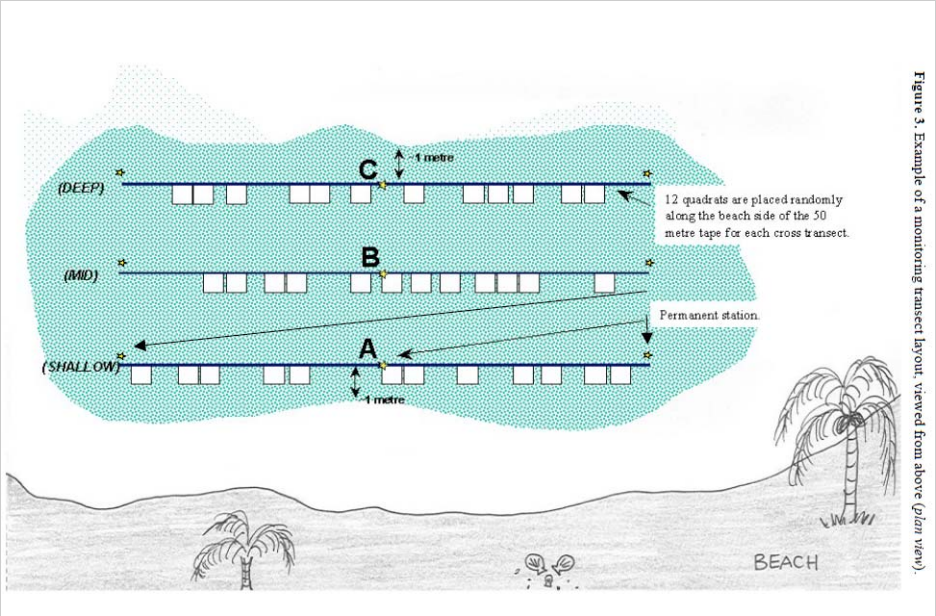


Figure 3. Example of a monitoring transect layout, viewed from above (*plan view*).

Ecological characteristics

General
Posidonia oceanica (L.) Delile is endemic in the Mediterranean Sea, and represents the climax vegetation of the infralittoral soft bottoms. Posidonia colonizes both rocky and sandy substrata, between 0 to 42m depth and can form terraces or fronts with 1-2m high. The species forms extensive and dense underwater meadows, its leaves can attain 1 meter in height. These meadows provide important ecological functions and services and support a highly diverse community of species (about 1000 macroalgae and invertebrate spp.) in the Mediterranean Sea[6]

Especially the Posidonia beds are seen as very important for the reproduction of (commercial) fish while biodiversity values are amongst the highest in the Mediterranean. Some species protected under the EU Habitat Directive like pen shell (Pinna nobilis) (fig. 2.2) are regularly present in Posidonia beds.

Figure 2.2
The Pen shell (Pina nobilis) is the largest shell in the Mediterranean. The species can grow up to 12cm in length. It is endangered, resulting from harvesting; the species is edible and can be found on fish markets. The Pen shell is listed on Annex IV of the EU Habitat Directive and is regularly present in Posidonia beds (picture archive Kornati NP).

Since the 1970´s, a worldwide decline of seagrass distribution and abundance has been detected and causes are mainly attributed to the negative influence of anthropogenic impacts (Orth et al., 2006). *P. oceanica* is very sensitive to specific impacts such as bottom trawling, anchoring, coastal constructions chemical wastes, fish farm effluents, desalination plants, geodynamic alterations, biological invasions and many others. The effect of these impacts, alone or combined; cause either a loss of vegetated areas, a reduction in seagrass abundance (cover and/or shoot density) or a deterioration of plant health.

P. oceanica beds are identified as a priority habitat for conservation under the European Union's Habitats Directive (Dir 92/43/CEE). Conservation management is mainly focused on protection from physical damage through the installation of artificial reefs and seagrass-friendly moorings for boats, which reduce the erosive pressure of otter-trawling and free anchoring in shallow meadows. The control of invasive species has also been performed recurrently in some *P. oceanica* beds.

Regressed meadows are prone to invasion by one or more of the potential substitutes for *P. oceanica* such as the other common Mediterranean seagrass *Cymodocea nodosa*, the native Mediterranean green alga *Caulerpa prolifera* and the two alien green algae *Caulerpa taxifolia* and *Caulerpa racemosa*.

There is a need to further develop regulations for activities that have a negative impact on *P. oceanica* beds (e.g. pollutants level limits and allowed minimum distances of impact sources to meadows) and to implement them through a vigilance system that is coordinated with the existing seagrass monitoring networks. Once the cause of

[6] http://www.racspa.org/dl/CYPRUS%20CAMP_BIODIVERSITY_REPORT%202007.pdf

habitat decline is eliminated, the slow growth of *P. oceanica* implies that recovery can take centuries. Measures like remediation of seagrass sediments enriched with organic matter, or transplanting of *P. oceanica*, are at an experimental stage.

Morphology[7]

Like other angiosperms *P. oceanica* has roots, stems, leaves, flowers and fruits. At the base of each plant is a rhizome, which is actually a modification of the stem (fig. 2.3). The rhizomes of *P. oceanica* can easily be distinguished from those of the other three European seagrass species by the dense, hairy remains of old, degrading leaf sheaths found around the rhizomes. These remains can also be found as conspicuous balls of fibres washed onto the beaches, known as egagropili.

Figure 2.3
Root and shoots of Posidonia oceanica.

Vertical rhizomes are attached to horizontal rhizomes that branch and expand by terminal apices. Rhizome internodes are short (0.5 to 2 mm) reflecting the slow horizontal growth of the plant, and the thickness of the rhizomes vary between 5 and 10 mm. The roots are 3-4 mm thick, up to 40 cm long and richly branched, attaching the plant to the substratum and allowing the absorption of nutrients from the sediment. Nutrients are taken up from the sediments by the roots and transported to the meristems and leaves for growth. Leaves themselves can also absorb nutrients, and are the main structures for absorbing carbon dioxide (CO_2) from the water column. Leaf life span in *P. oceanica* is almost a year with shoots living for decades.

P. oceanica has leaf bundles consisting of 5 to 10 leaves attached to a vertical rhizome. The leaves are broad (5 to 12 mm) and the length usually varies from 20 to 40 cm in length, but may be up to 1 m. A section of the petiole of a leaf shows a true network of lacunae throughout the plant from the tip of the leaf to the end of the roots, called the aerarium, and all the tissues are steeped in gas. This is the main difference between the marine phanerogams and other marine vegetation, which never left the sea.

The rate of formation of seagrass leaves, rhizomes and roots depends on the activity of meristems, where active cell division takes place. The horizontal growth and vertical extension of *P. oceanica* rhizomes is at a rate of only a few centimetres per year, producing, on average, a branch every 30 years. Shoots produce new leaves every 50 days on average.

[7] Sources: Bakran-Petricioli, 2007 and McKenzi et al., 2003

The vascular and lacunal systems of the roots and rhizomes facilitate the transport and exchange of fluids and gasses respectively. A proportion of the oxygen O_2 that is produced in the leaves during photosynthesis is diverted to the lacunae in the leaves, and then diffuses through the rhizomes to the roots. Some of the O_2 diffuses out of the roots to maintain less hypoxic conditions around the rhizosphere. Seagrasses growing in normally hypoxic or anoxic sediments are dependent on transporting sufficient O_2 down to their roots to maintain aerobic respiration and to reduce sulphide formation around the roots.

When factors that negatively inhibit O_2 production, such as low light, occur simultaneously with factors that increase the O_2 demand, such as increased organic loading of the sediments, the risk of sudden, dramatic loss of seagrass beds is increased, accelerated by the further increase in O_2 demand created when the dead plant material is degraded.

Propagation[8]
P. oceanica flowers between August and November. The number of shoots flowering in meadows is generally lower than 3% per year. However, massive flowering events (more than 10% shoots flowering) have been observed associated with extremely warm summers. Flowering intensity is negatively correlated with water depth.

P. oceanica flowers are yellow and can produce half a dozen seeds per shoot. Fruits are large (10 mm) and known as sea olives. Many female flowers do not develop viable fruits due to abortion and predation, and actual seed production is less than 1% of potential. Among the European seagrasses, only *P. oceanica* has buoyant seeds capable of long-range (10's of km) dispersal. Nonetheless, young individuals originating from seedlings are rarely found and *P. oceanica* primarily propagates vegetatively by elongating the rhizomes; a whole meadow may be one single clone resulting from one ancient seedling.

The little investment and low success of sexual reproduction, combined with the extremely slow clonal spread explains the extremely slow colonisation rate of *P. oceanica* plants. Numerical models simulating the occupation of space by a *P. oceanica* meadow indicate that it would need 600 years to cover 66 % of the available space around the Mediterranean coastal strip at depths in which it is able to grow. Similar colonisation time scales have been retrospectively calculated based on patch size and patch growth rate in patchy *P. oceanica* meadows. The very long time scales for colonisation of this species indicate that recovery of disturbed meadows, where important plant losses have occurred, would involve several centuries.

Location of monitoring plots

Monitoring distribution and status of Posidonia beds in Croatia
The spatial distribution of *Posidonia* beds in Croatia has not been well established. Current maps are based on potential presence which is based on bathometry data and other indicators. This may deviate from real presence since the actual presence of *Posidonia* beds has not been checked. Therefore clear information on change in the spatial distribution of *Posidonia* is unknown as is information on the status of these seagrass beds. This makes it difficult to combat factors that are threatening *Posidonia* beds. Monitoring methods applied in Croatia are given in box 2.4.

Tryout of monitoring protocol in 2009 in the Kornati Archipelago
In order to be able to detect changes in the distribution and the status of *Posidonia* over time, it is necessary to first establish baseline data. This can be done by mapping the current spatial distribution of *Posidonia* meadows, and assess their status. These measures must be monitored for the same *Posidonia* meadows over time to detect

[8] Sources: Bakran-Petricioli, 2007 and McKenzi et al., 2003

changes. Therefore permanent transects are chosen. It is important to develop a monitoring protocol that includes enough replicates such that changes are statistically detectable.

In 2009 a monitoring protocol was developed for the Kornati archipelago. Two type of sites were chosen based on prior information on the location of seagrass beds and whether these sites were under stress by anchorage or solid waste (etc.) or could suffice as reference site (being unstressed). Figure 2.4 shows three sites monitored in May 2009. Figures 2.5 - 2.7 show the sites in more detail.

The monitoring protocol included the determination of the depth limits (lower and deeper) of the seagrass beds, determination of the shoot density at three depths (lower, 10 m and deeper edge), and a video transect from shallow to deep. The video transect gives information on the number of anchor scars in the seagrass bed. Given relative inexperience of the divers in counting shoots and restrictions in manpower and diving time a plan has been developed based on the SeagrassNet protocol but with reduced number of quadrants to count shoots to four at each depth. The data of this first sampling round will be analysed to assess whether four quadrates is statistically sufficient. In case shoot density varies widely between quadrates the monitoring protocol will be revised towards more quadrates per depth.

Box 2.4 Monitoring of Posidonia oceanica

Mapping of Posidonia oceanica
Different methods of P. oceanica mapping were developed so far. The combined use of image processing of aerial photographs for the shallower layers (0-15 or 20 m in regions of very sheltered waters) and of side scan sonar for the deeper depths (20-50 m) is a particularly suitable approach but expensive. A new (French) method has been developed using GPS and will be tested by the Institute of Oceanography and Fisheries in Split during 2008 on the Island of Biševo. This method is based on divers that trace the border of the meadow, while a small rubber boat equipped with a GPS follows the divers buoy. A trace of the meadow border is accompanied in GIS software with geographic map.

Monitoring of Posidonia oceanica
There are several monitoring methods at different spatial scales. Monitor of meadow borders by permanent concrete blocks and monitor of shoot density might be appropriate methods for the monitoring of P. oceanica in N.P. Kornati and Sit-Žut group of islands. Monitored locations should be on referential and exposed areas (area under anthropogenic pressure like anchoring points). Monitoring has to be done by experts and interpretation of the results should be done by scientists (Institute of oceanography and Fisheries in Split; CIM Rovinj; etc).

Monitor of meadow border
One of the accepted monitoring methods of P. oceanica beds is photographic monitoring of upper and lower limit of meadows. A certain number of permanent concrete blocks has to be placed near the upper and lower limit of the meadow. They serve as a permanent location from where the underwater pictures have to be made. Successive pictures have to be made any three to five years. Any changes in P. oceanica health is visible in structure of meadow's border.

Monitor of shoot density
The shoot density is the mean number of living P. oceanica shoots per surface area unit. The measurement is performed within 20 cm x 20 cm quadrats, with at least 30 replicates per site. It is worth noting that depth explains 54% of the shoot density variability: it naturally declines with increasing depth.

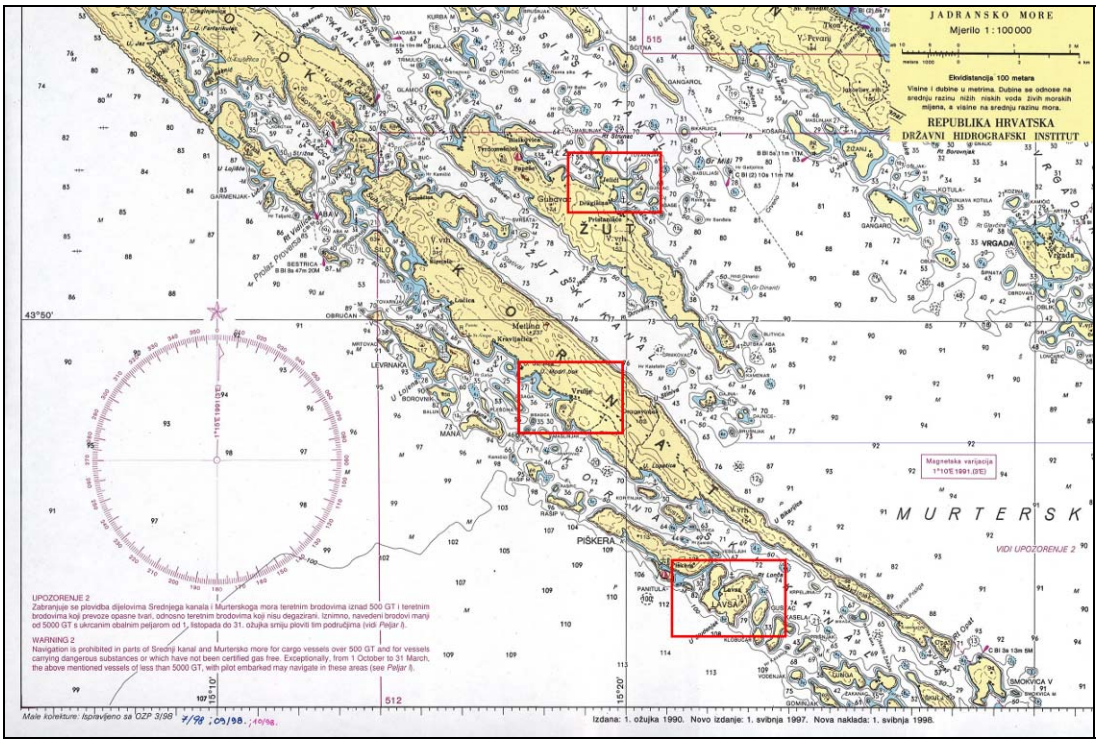


Figure 2.4

Location of three monitoring plots, one reference (Hiljača) and two stressed (Lavsa and Vrulja) sites monitored in 2009.

Figure 2.5

Detailed map of the stressed locations (anchorage, solid waste) Lavsa (43° 45'N; 15° 22.5'E), cove on the north coast of the islet of Lavsa.

Figure 2.6

Detailed map of the stressed site (anchorage) Vrulja (43° 48'N; 15° 18'E), cove on the west coast of the island of Kornat.

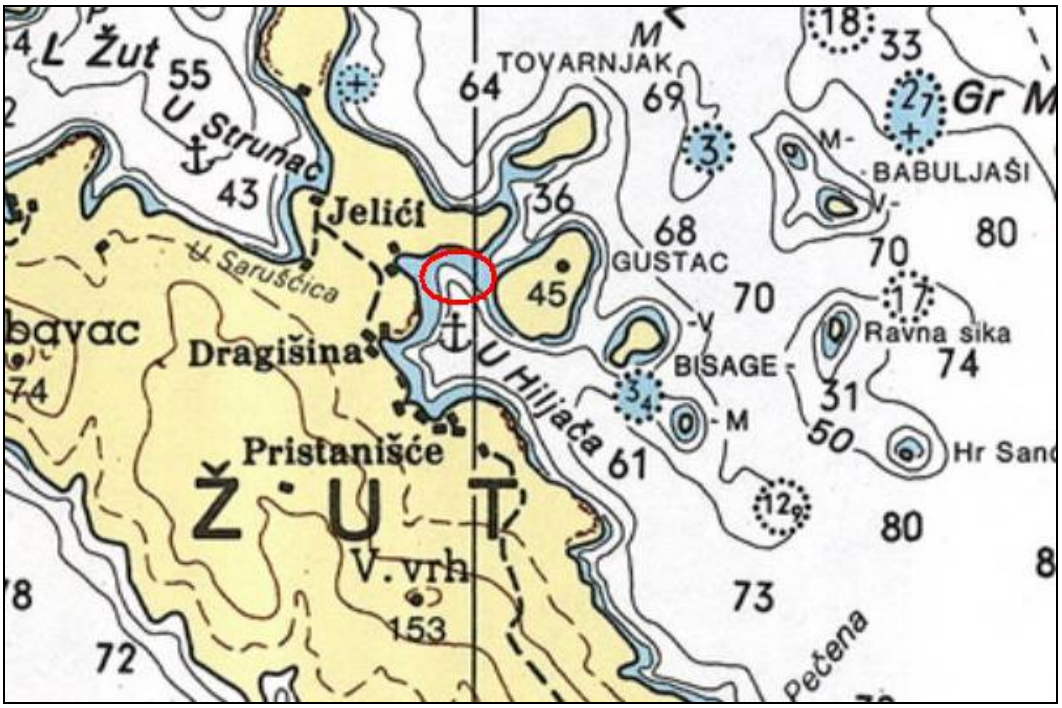


Figure 2.7

Detailed map of the reference location Hiljača (43° 52'N; 15° 19'E), cove on the island of Žut.

Monitoring schedule and methods

Given (present) constraints in time and human capacity it is suggested to monitor sites with a frequency of once per two years.
Posidonia beds can be monitored each month of the year. Winter is, however, not a good season since plants loose their leaves, which may complicate the counting of shoots. Also summer is generally not a good season given the high number of tourist boats in the area which may interfere with the monitoring activities and cause risk for the divers (especially at the sites where anchorage causes stress to the seagrass beds). Furthermore human capacity strongly determines the optimal timing for monitoring. Since initial (2009) monitoring took place in May and September, it's recommended to plan future monitoring rounds also in these months, in order to make results better comparable (see table 2.2).

Table 2.2
Qualification of timing for monitoring Posidonia beds (green = best; orange = good; blank = not so good). Qualification set on constraints concerning ecology, human capacity and interference with tourism).

Monitoring Activity	January	February	March	April	May	June	July	August	September	October	November	December
Code1120*: Posidonia* beds												

Determine lower and upper depth limit
- Lower depth limit:
  - Deep edge of the continuous bed (record the depth at which the deepest shoot is found);
  - Measure depth, record a GPS location (using small buoy with rope to be tethered to diver, one person on the boat records GPS location).
- Upper depth limit:
  - Shallow depth of the continuous bed (record the depth at which the shallowest shoot is found);
  - Measure depth, record a GPS location.

Set up one transect per seagrass bed from lower to upper bed
- Setup a permanent station marker at the shallow edge of the bed and one at the deep edge;
- Measure the distance between upper and lower marker (use measuring rope);
- Record the azimuth of the transect.

Count shoot density at lower, 10m and upper depth
- Along the permanent transect line a group of four divers count shoots with four quadrates (0.16 m^2; 40x40 cm) at the upper seagrass bed, one meter in the bed from the upper depth limit, at 10m and at lower depth again 1 meter in the bed from the edge. At these three depths, quadrates are chosen randomly along a 20m line which is situated under an angle of 90 decrees on the permanent transect line.

Record video transect
- A video transect is made along the permanent transect and holes (anchorage scars) along the video transect are counted and their diameter estimated (< or > 1 meter);
- Any interesting observations (e.g., anchoring damage, presence of invasive species, solid wastes, protected species, etc.) occurrence of *Pina nobilis* is recorded.

Data handling and evaluation

Data need to be recorded in a field form (annex 2) and transferred to a GIS database. Data need to be analysed and *Posidonia* densities need to be expressed per square m. Results should be evaluated

Checklist field equipment and human resources

Field equipment:

1. monitoring protocol on marine habitats including field forms
2. boat
3. diving equipment
4. 0.16 m^2 quadrat (40 x 40 cm)
5. coiled measuring rope (200 m) with markings every meter
6. weight (for rope)
7. marking pens, pencils and sharpener
8. quadrate identification number labeller
9. waterproof data sheets
10. underwater digital and video cameras
11. GPS unit
12. small plastic buoy with rope
13. compass
14. permanent station markers with transect code and contact phone number (use pavement tiles as permanent buoys)

Human resources

– seven divers (divided in two diving groups)
– four divers count the number of shoots, at three depth
– two divers set the permanent markers, spread the rope, deploy the buoy for the GPS marking and record the lower depth limit and upper depth limit
– one diver films the video transect

3 Terrestrial habitats monitoring protocol

Introduction

Although the vegetations within the Kornati Archipelago have undergone years of land clearing and grazing the area encompasses a broad variety of habitats and species. Up to date some seven Natura2000-habitats can be listed (table 3.1). Caves (code 8310) are not dealt with here while this habitat type is void of vegetation, and its monitoring will be combined with the monitoring of bats (see chapter 4). Bare limestone eroded by water with deep cracks can also be recognized in the field. Croatian specialists however decided not to indicate this habitat as the so-called limestone pavements (code 8240) and as such it will not be dealt with here.

Table 3.1
*Terrestrial habitats from the Habitat's directive Annex I mentioned for Kornati. Habitats indicated with an * are so-called priority habitats.*

Terrestrial Habitats
Code 1240: Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.
Code 1420: Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)
Code 5330: Thermo-Mediterranean and pre-desert scrub
Code 6220: Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea**
Code 8130: Western Mediterranean and thermophilous scree
Code 8210: Calcareous rocky slopes with chasmophytic vegetation
Code 8310: Caves not open to the public

Besides habitats the Kornati archipelago is home to a range of Red list plant species. Based on the Flora Croatica Database some 58 species from the Croatian red list occur in the archipelago (table 3.2).

The list of plant species for Kornati exists and can be downloaded from the Flora Croatica Database9, but the actual distribution is still uncertain for some species. A map of habitat types for all of Croatia has been developed on a scale 1:100 000 with the minimum area shown 0.09 km^2 (9 ha). This is too broad to be used for Kornati because most of the habitats are fragmented and present in patches less then 0.09 km^2.

[9] http://hirc.botanic.hr/fcd/

Table 3.2

Croatian Red Book for the flora species present in Kornati NP (also marine).

Taxa	Status
Andropogon distachyos L.	D.D.
Anthyllis barba-jovis L.	NT
Arbutus andrachne L.	NT
Aurinia leucadea (Guss.) C. Koch	NT
Beta vulgaris L. ssp. *vulgaris*	LC
Blackstonia perfoliata (L.) Huds. ssp. *serotina* (Koch ex Rchb.) Vollm.	EN
Carex appropinquata Schumach.	DD
Carex divisa Huds.	EN
Carex extensa Gooden.	EN
Carpobrotus edulis (L.) N.E.Br. in Phillips	LC
Centaurea ragusina L.	NT
Chenopodium bonus-henricus L.	NT
Chenopodium botrys L.	DD
Chenopodium murale L.	DD
Chenopodium opulifolium Schrader ex Koch et Ziz	DD
Chenopodium vulvaria L.	DD
Convolvulus cneorum L.	NT
Convolvulus lineatus L.	CR
Corydalis acaulis (Wulfen) Pers.	NT
Cyclamen repandum Sibth. et Sm.	NT
Cymodocea nodosa (Ucria) Asch.	DD
Delphinium staphisagria L.	EN
Desmazeria marina (L.) Druce	VU
Digitaria ciliaris (Retz.) Koeler	DD
Ecballium elaterium (L.) A. Rich.	DD
Elymus pycnanthus (Godr.) Melderis	NT
Ephedra fragilis Desf.	NT
Ephedra fragilis Desf. ssp. *campylopoda* (C. A. Mayer) Asch. et Graeb.	NT
Euphorbia paralias L.	DD
Hainardia cylindrica (Willd.) Greuter	VU
Hibiscus trionum L.	EN
Hymenolobus procumbens (L.) Nutt.	DD
Iris adriatica Trinajstić ex Mitic	NT
Iris illyrica Tomm.	LC
Juniperus oxycedrus L. ssp. *macrocarpa* (Sm.) Ball	LC
Lolium remotum Schrank	DD
Matthiola incana (L.) R. Br.	NT
Micromeria kerneri Murb.	DD
Narcissus tazetta L.	NT
Ophrys sphegodes Mill.	VU
Orchis tridentata Scop.	VU

Taxa	Status
Parapholis incurva (L.) C.E.Hubb.	VU
Peltaria alliacea Jacq.	NT
Plantago holosteum Scop.	LC
Poa trivialis L. ssp. *sylvicola* (Guss.) H.Lindb.	LC
Polygonum arenarium Waldst. et Kit.	CR
Rhamnus intermedius Steud. et Hohst.	NT
Ruscus aculeatus L.	LC
Salsola kali L.	VU
Salsola soda L.	VU
Serapias vomeracea (Burm.) Briq.	VU
Seseli tomentosum Vis.	NT
Suaeda maritima (L.) Dumort.	VU
Vicia sativa L. ssp. *sativa*	DD
Vincetoxicum hirundinaria Medik. ssp. *adriaticum* (Beck) Markgr.	LC
Zostera marina L.	DD

Ecological characteristics

Due to years of (over)grazing and clearing, the islands of the Kornati Archipelago are nowadays mainly covered with rocky pastures having some patches of garrigue vegetation. The *Stipo-salvietum officinalis brachypodietosum ramosi* is the predominant type of community followed by *Festuco koelerietum splendentis* characteristic for less degraded pastures. Other plant communities are very fragmented throughout the islands. The woodland vegetation is represented by the *Myrto-Quercetum ilicis* community, whereas the rock vegetation is represented by the *Phagnalo-Centaureetum ragusinae* community, and the coastal cliff vegetation by the *Plantagini-Limonietum cancellati* community.

Table 3.3 provides a somewhat broader description of the terrestrial habitat types. Images of the Natura 2000 habitat types are provided in figures 3.1 and 3.2.

Table 3.3
Additional description for the Natura 2000 terrestrial habitat types within the Kornati Archipelago.

Code	Habitat type	Description
1240	Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium spp*.	Cliff and rocky shores of Mediterranean and Black sea and southern shore of the Atlantic on the Iberian peninsula with the halophitic vegetation class of *Crithmo-Limonietea*.
1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	Community of shrubby perennials on low muddy sea shores belonging to the class *Sarcocornia fruticosae*.
5330	Low Phanerophytes/Evergreen	With shrubby chamaephytes, deciduous trees, on xeric soils
6220	Pseudo steppe with thero-brachypodietum	Rocky areas with therophytes, grasses and sedges, herbs and forbs, under xeric conditions, on calcareous soils
8130	Screes of variable rocks in thermophilous situations	Screes of southern exposition of the Alps, Pyrenees, Mediterranean mountains, hills and lowlands. In Croatia it also comes on flattened skeletal terrains exposed to intensive pasture
8210	Vegetated inland cliffs	Inland cliffs, siliceous rocks with chasmophytes, grasses and sedges, herbs and forbs and possible chamaephytes.

Figure 3.1

Pictures of the Natura 2000 habitat types with codes 1240, 1420, 5330 and 6220. See accompanying text for description. Picture 1420 Luca Skunca, others Theo van der Sluis.

Figure 3.2
Pictures of the Natura 2000 habitat types with codes 8130 and 8210. See accompanying text for description. Pictures: Theo van der Sluis.

Location of monitoring plots

The location of the plots is based on a short assessment during a field work week in May 2009 and satellite imagery from Google Earth (table 3.4). The field work was done from Vrulje, on the island of Veliki Kornat, and several sites were visited from there on foot.

The choice of plots was based on floristic diversity, as well as accessibility to the area. Access from the sea is difficult (in particular the small islands as well as sites on the other side from the island). Maps indicating the position of current (2009) plots are presented in fFigure 3.3 and 3.4.

A proper habitat mapping of the entire area of the National Park will be required to establish representative permanent plots (quadrates) for future monitoring. Based on that map the location of current sites may be reconsidered, based on the representativeness of the currently selected sites with regard to the presence of the Natura 2000 habitats. Some of the selected permanent quadrates might be eliminated from the list.

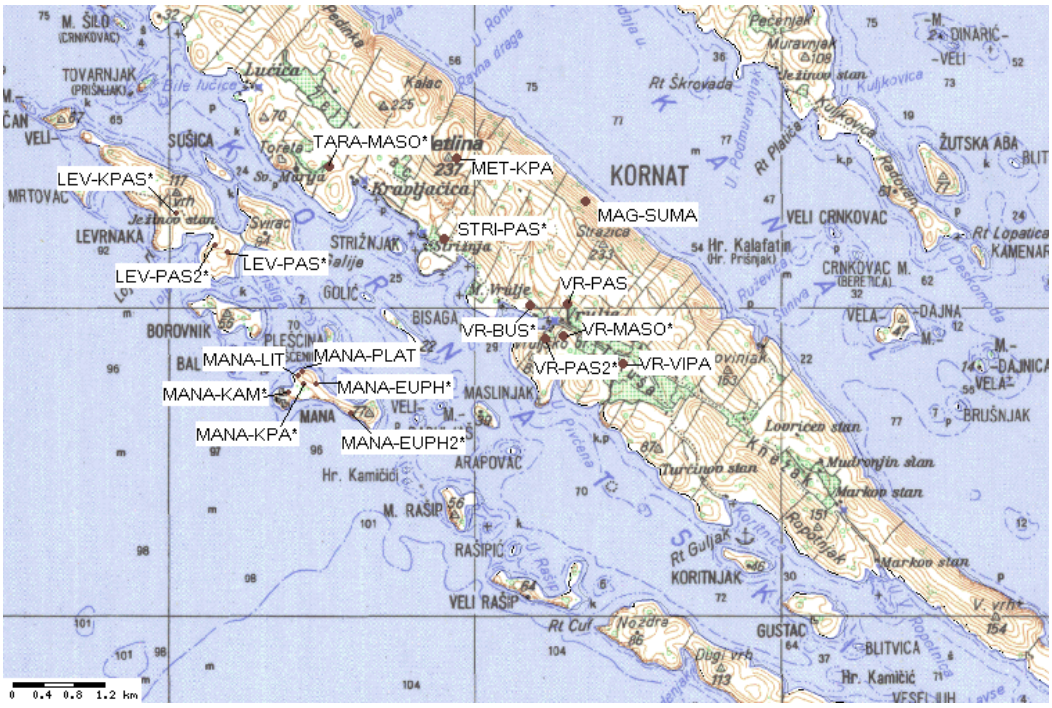


Figure 3.3

Vrulje, island Mana and Levrnaka and pond Tarac.

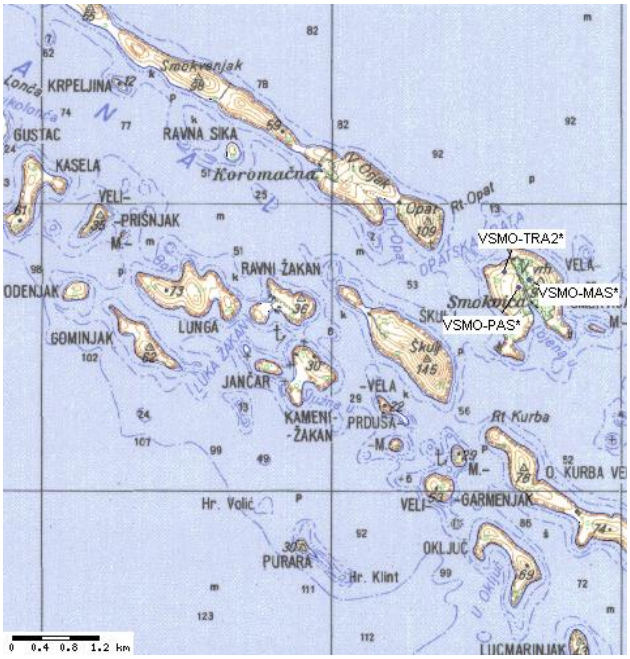


Figure 3.4

Vela Smokvica.

Table 3.4

Location of monitoring plots, and their habitat typology (habitats marked with x are not Natura 2000 habitats). Four coordinates per plot represent plot corners.

Vegetation Plot Code	Locality	X	Y	Plot dimensions (m)	National Habitat Classification (NKS) Code	Natura 2000 Code
VR-PAS	PL4 220m NE from the restaurant Ante in Vrulje	5525052	4851979	8x8	C.3.6.1. C.3.6.2.	6220
		5525051	4851987			
		5525041	4851979			
		5525046	4851974			
VR-VIPA	1.47km SE from Vrulje	5526058	4851136	15x15		x
		5526066	4851147			
		5526081	4851137			
		5526067	4851124			
MET-KPA	97 m E downhill from the peak Metlina	5523719	4854025	10x10	C.3.6.1. C.3.6.2.	6220
		5523728	4854033			
		5523732	4854023			
		5523729	4854020			
MAG-ŠUMA	Magazinova skrila, north-east shore of the Veliki Kornat island	5525267	4853344	30x30	E.8.2.2.	5330
		5525285	4853327			
		5525309	4853355			
		5525281	4853364			
MANA-LIT	0,29 km NE from the sign "Mana" in the dock on the Mana island	5521748	4851174	15x4	B.1.3.1.	8210
		5521765	4851175			
		5521756	4851181			
		5521753	4851178			
MANA-PLAT	0,29 km NE from the sign "Mana" in the dock on the Mana island	5521748	4851181	15x8x15x3	B.1.3.1.	8210
		5521759	4851189			
		5521756	4851181			
		5521753	4851178			
MANA-EUPH	0,38km E from the sign "Mana" in the dock on the Mana island	5521921	4850989	10x10	E.8.2.2.	5330
		5521927	4850993			
		5521922	4850998			
		5521913	4850994			
MANA-EUPH2	0,78km E from the sign "'Mana" in the dock on the Mana island	5522271	4850683	10x10	E.8.2.2.	5330
		5522280	4850679			
		5522290	4850683			
		5522277	4850693			
MANA-KPA	0,27 km E from the sign "'Mana" in the dock on the Mana island	5521823	4850942	10x10	C.3.6.1. C.3.6.2.	6220
		5521831	4850946			
		5521822	4850957			
		5521817	4850948			
MANA-KAM	0.08km SE from the sign "Mana" in the dock on the Mana island	5521603	4850921	5x5	B.2.2.1.	8130
		5521608	4850919			
		5521611	4850919			
		5521607	4850921			
TARA-MASO	Near the pond Tarac, 0,45 km from the Kravljacica	5522069	4853858	15x15		x
		5522052	4853871			

Vegetation Plot Code	Locality	X	Y	Plot dimensions (m)	National Habitat Classification (NKS) Code	Natura 2000 Code
	(between Tarac and Striževa)	5522059	4853881			
		5522072	4853874			
STRI-PAS	0,08 km from the restaurant Darko in Strižnja	5523423	4852791	8x8	C.3.6.1. C.3.6.2.	6220
		5523426	4852785			
		5523431	4852790			
		5523424	4852800			
VR-MASO	0,15km N from the restaurant Ante (Vrulje)	5524994	4851633	15x15		x
		5525006	4851622			
		5525004	4851643			
		5525018	4851635			
VR-PAS2	0,19km N from the restaurant (Vrulje)	5524971	4851603	8x8	C.3.6.1. C.3.6.2.	6220
		5524967	4851596			
		5524973	4851590			
		5524978	4851598			
LEV-PAS	0,48km SE from the docks near the restaurant on the right side of the bay	5520170	4853332	10x10	C.3.6.1. C.3.6.2.	6220
		5520180	4853327			
		5520187	4853335			
		5520175	4853338			
LEV-PAS2	0,30km SE from the docks near the restaurant on the right side of the bay	5520592	4852843	8x8	C.3.6.1. C.3.6.2.	6220
		5520598	4852835			
		5520590	4852828			
		5520586	4852836			
LEV-KPAS	0,40 km NW from the docks near the restaurant on the right side of the bay	5520794	4852766	10x10	C.3.6.1. C.3.6.2.	6220
		5520799	4852773			
		5520789	4852776			
		5520783	4852769			
VSMO-TRA	0,34 km SE from the restaurant Mare	5538614	4842814	8x8	C.3.6.1. C.3.6.2.	6220
		5538614	4842819			
		5538618	4842822			
		5538625	4842818			
VSMO-MAS	0,32 km SE from the restaurant Mare	5538671	4842828	15x15		x
		5538682	4842836			
		5538661	4842843			
		5538668	4842850			
VSMO-TRA2	0,69km from the restaurant Mare	5538371	4843079	8x8	C.3.6.1. C.3.6.2.	6220
		5538380	4843083			
		5538387	4843073			
		5538378	4843067			
VR-BUS	Near the "Karaula" in Vrulje	5524699	4851929	15x15	E.8.2.2.	5330
		5524685	4851935			
		5524690	4851947			
		5524703	4851939			

Monitoring schedule and methods

The focus of the work is on monitoring of Natura 2000 habitats. The EBONE[10] Key for Annex I Habitats was used to classify habitats in the field. EBONE has been applied in many member states already and it's (unofficially) recognised as the EU-standard for Annex I Habitat monitoring. This classification is not based on species but on physical and structural characteristics of the site and vegetation (see below), e.g. soil, slope, moisture conditions, and aspects like deciduous, evergreen, chamaephytes, phanerophytes etc. Box 3.1 describes the EBONE determination steps that were followed for the habitats types relevant in the visited sites of the Kornati Archipelago.

In addition vegetation relevees were made. The information for the detailed vegetation plots gives additional information on changes in habitat types. See box 3.2 for further clarification on the role of vegetation relevees.

Box 3.1 EBONE Determination steps for determining the Natura2000 habitat types in the Kornati Archipelago

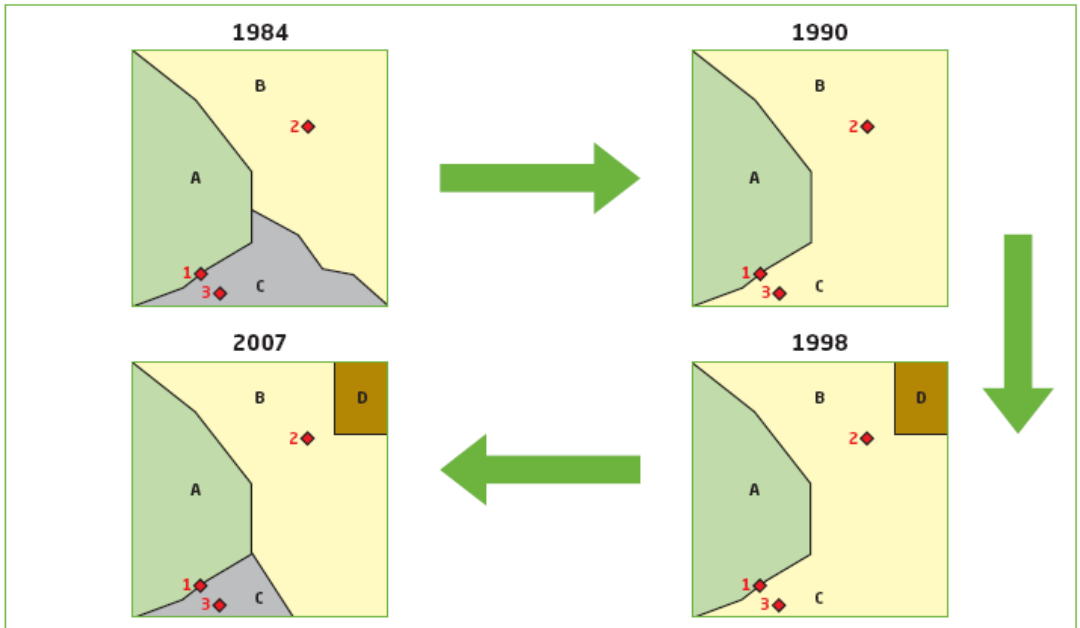
1. Landscape classes and habitat complexes
   1(B): Cliffs and screes
   1 (B) (i) vegetated sea cliffs
   1(B) (i)b: **Vegetated sea cliffs off the Mediterranean coasts with endemic Limonium ssp. (1240)**
   1 (B) (ii) vegetated inland cliffs
   Limestone rocks:
   1(B) (iii) **Vegetated inland cliffs (8210)**
   1 (B) (v) screes
   1(B) (v)c: **Screes of variable rocks in thermophilous situations (8130)**
5. Less than 30% shrub/tree cover
   5. (B): not wetland, other herbaceous
   5. (B)(i):Therophytes
   5. (B)(i)e: **Rocky areas with therophytes: Pseudo steppe with thero-brachypodietum (6220)**
6. Trees (> 30%)
6. (C): Low Phanerophytes
   Xeric soils:
6. (C) (i): **Low Phanerophytes/Evergreen (5330)**
   Saline soils, mud, water mark:
6. (C) (ii): **Low Phanerophytes/Evergreen (1420)**

To establish permanent plots, the habitats in the selected areas were mapped first, so habitat mapping plots were developed for the habitat monitoring sites. These plots measure 250x250 m and corners were marked by GPS (table 3.4). From the corner a course was defined by compass and GPS. After walking 250 m in a straight line the new course was set perpendicular on this line, again 250 m were walked etc. During this process the habitats were mapped. The open vegetation permitted the mapping of the entire plot. Google Earth maps assisted in the siting of the plot. Detailed maps were drafted in the notebooks for field work (see figure 3.5). The SINP has developed habitat mapping forms (form B, annex 3A), however in the project the form from Ebone was used (annex 3B).

[10] EBONE = European Biodiversity Observation Network: http://www.ebone.wur.nl/UK/

Box 3.2 Recording detailed changes in habitats and species: Ebone manual

Source: Bunce et al. in prep.



The relationship between mapped land cover and vegetation plot data for assessing change in a 1km square.

Example: In 1984 there were three Habitats A, B and C. By 1990 Habitat C had been replaced by more of Habitat B and the wall between them removed. In 1998 a new block of Habitat D had been created in the north-east corner and by 2007 part of Habitat C had been recreated. Plots were located in the habitats to sample vegetation in detail (for simplicity only three plots are shown in this figure). Plot 1 was on a boundary and this would have shown any changes to the boundary caused by the change of habitat neighbouring the plot. Plot 2 was in Habitat B and was unlikely to change much, whereas Plot 3 is likely to have changed considerably as the habitat in which it was sited changed between 1984 and 1990 and again between 1998 and 2007.

Permanent plots for vegetation relevees were placed at random within the larger monitoring plot. These relevees vary in size; from 5x5 to 30x30 m. The sites (table 3.5) were placed mostly within the permanent habitat mapping quadrate, but in some cases also outside. The corners of permanent plots were marked with spray paint (black and orange) and GPS coordinates were taken. However, at the second monitoring round in September (2009) it was found that the orange paint had faded completely while the black will fade in a year or so, and was almost invisible on some plots (mainly due to direct sunlight exposure all day). Therefore normal paint and paint brush are recommended for the future, or alternatively subsoil metal pens or other markings. The Braun-Blanquet scale was used which combines numbers of individuals and coverage and is recommended by the manual “Staništa” published by the SINP. The forms for describing vegetation relevees are presented in annex 3A (Form A).

The monitoring of habitat types can coincide with one of the vegetation monitoring activities, i.e. between March and September. Monitoring once is sufficient, the timing within the year is less important for habitat monitoring (see table 3.6).

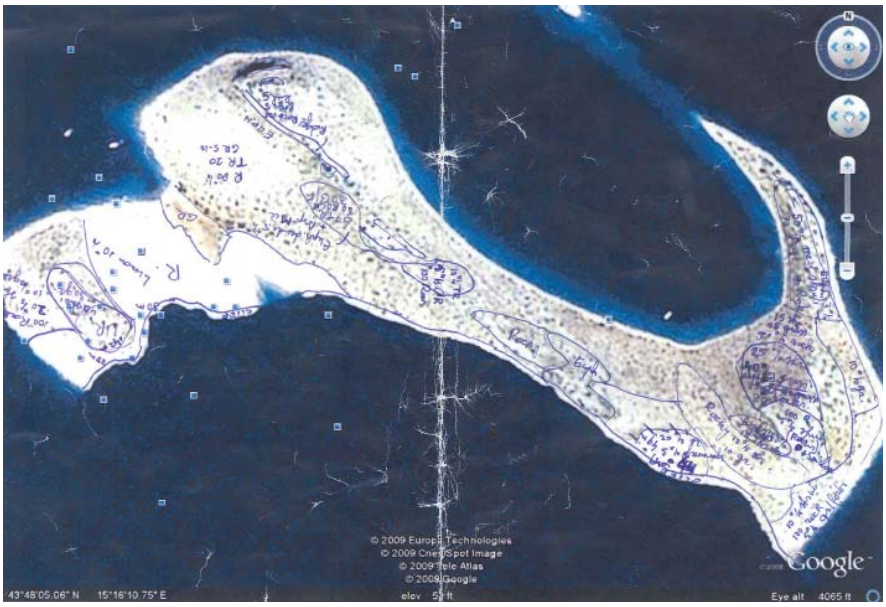


Figure 3.5

Example of a field work map of Mana island with habitat descriptions (fieldwork 2009).

Table 3.5

Size of sample quadrates (Croatian monitoring handbook, SINP).

Vegetation type	***Area (m²)***
Sands (costal and continental)	4 - 16
Cliffs	4 - 16
Gravels (costal and continental)	4 - 16
Aquatic communities	5 - 10
Ruderal communities	10 - 50
Dry grasslands (pastures and meadows)	50 - 100
Garrigues	100 1000
Woodland communities (with tree layer)	500 - 2500
Woodland communities (just the ground floor)	50 - 200
Woodland edges for tree and bush layer (line)	30 - 50
Woodland edges for herbaceous plants (line)	10 - 20

Table 3.6

*Timing for monitoring vegetation plots and habitat types. The months indicated with * are optional and less preferred (depending on field situation).*

Monitoring Activity	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Monitoring vegetation plots (3 years intervals)								*	*			
Monitoring habitat types (3 years intervals)												

Checklist field equipment and human resources

Required materials are the following:

1. monitoring protocol on terrestrial habitats including field forms (annex 3A and/or 3B).
2. all necessary permits
3. determination keys
4. boat
5. herbarium
6. binoculars
7. GPS
8. satellite or aerial photographs of the area
9. paint and brush, or metal pens and metal detector
10. B1 and B2 protocols from the manual 'Habitats' published by SINP
11. local topographic and Google earth maps
12. compass
13. dry newspapers
14. hermetic bags for submersed plants (or wet specimens in case of rain)
15. small shovel for digging plant material
16. pocket knife
17. digital camera
18. a marked rope or a meter for measuring
19. tags with the name of the organisation doing the monitoring
20. big nails (for marking where paint isn't suitable)
21. transparent adhesive tape
22. hiking shoes
23. cell phone
24. sun cream
25. post-it papers
26. hand magnifier.

In the field ideally four people are involved for the vegetation survey, of which at least one with expertise in botany and monitoring. Two people are required for habitat monitoring, of which one with the required expertise.

4 Mammals monitoring protocol

Introduction

Both marine and terrestrial mammals can be found in the Kornati Archipelago. The archipelago is recognised as an important habitat for a population of Bottlenose Dolphins, a highly threatened marine mammal species in the Mediterranean (ACCOBAMS, 2006). A recent dolphin study in the Kornati Archipelago by the University of Hamburg (Kammigan, 2007) distinguished some 50 individual dolphins, including calves, within the study area of the Archipelago and the Murter Sea. Best chance to see the dolphins was south of Kurba Vela island, in the Southeast of the park. A monitoring protocol for this species is highly recommended and should be included within this section in the (near) future. For a priority species like the Monk Seal the archipelago most probably provides suitable habitat (submerged or partially submerged caves) though the species is not present at the moment. Current tourism pressure and the endangered position of the present population in Greece/Turkey, makes that a re-colonisation process is not foreseen within the near future either.

The current protocol for terrestrial mammals completely focuses on bats, as all bat species have a high protection status (see table 4.1). Endangered terrestrial mammals, other then bats, are not expected on the islands of the Kornati Archipelago.

Table 4.1
Mammals present in the Kornati archipelago (2009).

	HD Annexes		Croatian RL
	II	IV	
Marine mammals			
Tursiops truncates (Bottlenose dolphin)	X	X	EN
Terrestrial mammals (Bats)			
Hypsugo savii (Savi's pipistrelle / primorski šišmiš)		X	
Miniopterus schreibersii (Schreibers' bat / dugokrili pršnjak)	X	X	EN
Myotis aurascens/mystacinus (Whiskered bat / primorski brkati šišmiš/ brkati šišmiš)		X	
Myotis emarginatu s(Geofrey's bat / riđi šišmiš)	X	X	NT
Myotis blythii (Lesser mouse-eared bat / oštrouhi šišmiš)	X	X	
Nyctalus lasiopterus (Greater noctule / veliki večernjak)		X	DD
Pipistrellus kuhlii (Kuhliis' pippistrelle / bijelorubi šišmiš)		X	
Plecotus kolombatovici (Balkan Long-eared bat / Kolombatovićev dugoušan)		X	DD
Rhinolophus ferrumequinum (Greater horseshoe bat / veliki potkovnjak)	X	X	NT
Tadarida teniotis (Mediterranean freetailed bat / sredozemni slobodnorepac)		X	

Bats

The European bats are a species-rich group widely distributed through the range of agricultural and non-agricultural landscapes and habitats. They are affected by intensive and varied human influence that has widespread and sometimes devastating effects on bat populations. The threatened status of bats in Europe presents an urgent need of information on bat species distribution and abundance changes over time.
Despite comprising almost one-fourth of all mammals, bats often get excluded from monitoring programs because of research difficulties such as extreme mobility, widely dispersed populations, nocturnal activity patterns and well hidden and/or inaccessible roost sites.

The Kornati archipelago is a special and separate group of islands located in the Adriatic Sea that encompasses an area of about 320 km^2. It includes about 150 land units which are permanently or temporarily above the sea level. The island of Kornat (32.5 km^2) and the island of Žut (14.8 km^2) account for 70% of the total land size.

Very little is known about the fauna of the National Park Kornati. None of the continental fauna groups has been closely observed and published studies almost don't exist. Most of the underground objects are still insufficiently explored or unexplored. This is why the primary goal is to complete the inventory on bat species composition and population structure. Potential roost sites should be monitored over time to evaluate the status and change of roost sites throughout the area. Only after this part of research is completed it is possible to finalize the bat monitoring protocol.

It is also important to stress out the findings of *Nyctalus lasiopterus* species. The only records of this species in Croatia were established by Kolumbatovic (1886) and Wettstein (1928) (in Tvrtković et al., 2006). A large number of species skulls were found in cave Galičnjak on the island of Mljet (Tvrtković and Baltić, 1996). There were some other records that may have been related to *Nyctalus lasiopterus* but unfortunately there is no collected evidence. It is of great importance to evaluate the status of this species in NP Kornati and to establish the whereabouts' of its roost site that can then be implemented in the Bat monitoring protocol.

Ecological characteristics

According to Koeppen's climate classification system, the area of Kornati NP enjoys an olive climate (Csa): a moderately warm rainy climate with dry and hot summers and the highest amount of precipitation (rain) during autumn. Due to the relatively degraded land vegetation, dew replaces rain to a certain extent. The air temperature ranges from an average 8 °C in February to an average 25 °C in July and August. Rain fall is highest in October.

Carbonate rocks (limestone and dolomites) form a significant amount of pits, cracks and karrens. Caves are present in small numbers. Underground objects provide potential roost sites for species like *Myotis blythii, Miniopterus schreibersii, Myotis emarginatus, Rhinolophus ferrumequinum* and *Rh. hipposideros.* Rock crevices in stone walls and buildings are also important roost sites for *Hypsugo savii* and *Pipistrellus kuhlii.*

The Kornati archipelago has many cliffs, which are mostly used as habitat by *Tadarida teniotis*. During the hot spring and summer months, bats visit the few available fresh water sites to forage and drink water. Within Kornati NP there is only one pond which holds fresh water throughout the year and it is located on the island of Kornat. Other fresh water locations are extremely rare and subjected to weather conditions. There are also some manmade watering places for sheep but most of them are smaller than 0,5m^2.

The larger islands are mainly covered with pastures while there are also few areas with olive groves (*Olea europaea*) that provide another form of foraging habitat. Hollow trees provide potential roost sites for *Nycatlus lasiopterus*.

The species specific information below is extracted from the IUCN Red list of threatened species[11]. For more detailed information and references we refer to this website.

Savi's pipistrelle

This species (fig. 4.1) forages over open woodland, pasture and wetlands, and often feeds at lights in rural areas, towns and cities. It roosts in rock crevices, occasionally in fissures in buildings or under bark, rarely in underground habitats. Nothing is known about the migratory behaviour of this species. Migration is suspected in Europe but the longest movement recorded is 250 km.

Figure 4.1

From left to right: Hypsugo savii (Savi's pipistrelle), Miniopterus schreibersii (Schreibers' bat) and Myotis aurascens/mystacinus (Whiskered bat). Photo's: Dina Kovač and Norma Fressel.

Schreibers' bat

This species (fig. 4.1) forages in a variety of open and semi-open natural and artificial habitats, including suburban areas. It feeds mainly on moths, and occasionally on flies. It is a colonial species that roosts mostly in caves and mines (although it can also be found in man made tunnels, ruins and other buildings), often in large mixed colonies with other cave-dwelling bat species. Large warm caves are preferred during the nursing season. In winter it hibernates in underground sites (usually large caves with a constant microclimate). Schreiber's bat is a migrant species which changes its roosts several times during the year; long-distance movements occur occasionally (longest recorded distance 833 km.

Whiskered bat

This species (fig. 4.1) inhabits forest, woodland edge, shrubland, open meadows, steppe and semi-desert habitats and wooded landscape near to water sources, but is generally more a house-dwelling than woodland bat, and is commonly sighted in parks, gardens and villages. They nest in colonies, living in trees, amongst rocks, and in livestock pens, and are also known to nest in caves, living there year round, and moving further back into the cave to hibernate during winter. Summer maternity roosts are typically sited in trees, buildings, and bird and bat boxes. It hibernates in small groups in underground sites (caves, mines, and cellars). It is an occasional migrant, with movements of up to 240 km recorded. Movements of up to 625 km have been described, although the longest distance covered by a bat with certain species identification is 165 km. It is a nocturnal species emerging to hunt at sunset, but has occasionally been sighted hunting during daylight hours. It hunts exclusively near inland waters, but feeds on non-aquatic flying insects. Young are born in June/July.

[11] http://www.iucnredlist.org

Geofrey's bat

This species (fig. 4.2) forages over scrub and grassland. It has an unusual diet in that it feeds mainly on spiders and flies. In summer, it roosts in underground habitats and in buildings (in attics). Generally roosts in summer with *Rhinolophus* species. It winters in underground sites. Reportedly a sedentary species with movements of up to 105 km recorded, but may in fact move longer distances as winter roosts are not known in parts of its range where it occurs in summer.

Figure 4.2

From left to right: Myotis emarginatu s(Geofrey's bat), Myotis blythii (Lesser mouse-eared bat) and Pipistrellus kuhlii (Kuhliis' pippistrelle). Photo's: Dina Kovač and Norma Fressel.

Lesser mouse-eared bat

A gregarious species (fig. 4.2) which congregates in nursery and/or hibernating colonies of up to 500 individuals. In parts of its range it remains an abundant species. In the Balkans the species is regarded as stable. It often occurs in mixed colonies with *Myotis myotis* and identification is sometimes problematic.

Kuhliis' pippistrelle

This species (fig. 4.2) forages over a variety of habitats, including agricultural and urban areas (including around street lights). It feeds on small insects. Summer maternity colonies are located in crevices in buildings. Winter sites include rock crevices and cellars. It's found in temperate grassland and Mediterranean-type shrubland. Kuhl's pipistrelle is probably a sedentary species.

Greater noctule

This species (fig. 4.3) forages over mixed and deciduous forest and wooded river valleys (the latter especially on migration). It is highly dependent on mature forest (the species needs a number of old trees to support a colony, hence any tree removal is a threat). It is largely insectivorous, but is also reported to take small passerines in the southern part of the range during migration. During the bird migration seasons, passerines are likely to form a major part of the diet. Faeces collected during these times are composed 90% of feathers. Tracking the species using radar it is now known that it flies up to several hundred meters presumably to catch migratory birds.
In summer it roosts in hollow trees, and occasionally in buildings. Rock crevices may also be used as hibernacula in winter. It sometimes roosts with other species such as *N. noctula*. Nursery colonies are usually relatively small (up to 35 females). Females give birth to a single pup per litter. It is considered to be migratory in the north-east of its range, but there is very little data. Vagrants have been recorded well outside the normal range. Some areas in the western part of the range appear to be occupied exclusively by males, according to capture results. Its foraging range may be greater than 30 km in a single night.

Figure 4.3

Overview of Nyctalus lasiopterus (Greater noctule). Last record of this species in Croatia was 126 years ago! It lives in olive groves and occasionally feeds on birds. It's span can be 410-460 mm and it weights up to 76 g. Photo's: Dina Kovač and Norma Fressel.

Balkan Long-eared bat

This species (fig. 4.4) forages in a variety of open and semi-closed habitats, mainly steppe but also agricultural landscapes in both lowland and mountain areas. It often forages over small water bodies. It feeds predominantly on moths, but also takes beetles and flies. Summer roosts are primarily rocky cavities, but also dark areas of old monuments, ruins, caverns and buildings. Winter roosts are located in buildings, mines, caves, wells and trees.

Greater horseshoe bat

This species (fig. 4.4) forages in a variety of open and semi-closed habitats, mainly steppe but also agricultural landscapes in both lowland and mountain areas. It often forages over small water bodies. It feeds predominantly on moths, but also takes beetles and flies. Summer roosts are primarily rocky cavities, but also dark areas of old monuments, ruins, caverns and buildings. Winter roosts are located in buildings, mines, caves, wells and trees.

Mediterranean freetailed bat

This species usually forages at 10 to 50 m above the ground over temperate to semi-desert habitats, although it also occurs in humid habitats in some areas. It feeds on aerial drifts of insects including moths and neuropterans. Summer and winter roosts: fissures and hollows in rock outcrops, quarries and cliffs. Common in some urban areas, roosts also in artificial structures including bridges and buildings. The species is probably sedentary in Europe.

Figure 4.4
Left, Plecotus kolombatovici (Balkan Long-eared bat) and at the right Rhinolophus ferrumequinum (Greater horseshoe bat). Photo's: Dina Kovač and Norma Fressel.

Location of monitoring transects or plots

Mist netting sites

Bat sampling occurs at two water bodies, the pond in the Tarac field (fig. 4.5) and the watering pool for sheep (fig. 4.5) both located near olive groves on the island of Kornat (fig. 4.6 and table 4.2). The pond in the Tarac field is unapproachable during spring due to extremely dense vegetation that surrounds the pond. In summer and early autumn, the water level is low - the pond is smaller and it is possible to surround it by mist nets. Water level in the watering pool is even more subject to weather conditions although it has water in it throughout the entire year.

Table 4.2
GPS coordinates of mist netting monitoring sites.

Site / Coordinates	X-coordinate	Y-coordinate
Pond in the Tarac field	43º49.763'	15º16,050'
Watering pool for sheep	4850662	5527638

Figure 4.5
Pond in the Tarac field on the island of Kornat (left), and watering pool for sheep on the island of Kornat (right). Photo's: Dina Kovač.

Figure 4.6

Mist netting sites on the island of Kornati. Source: Google maps.

Potential underground roost sites

The research of underground objects on the Kornati Archipelago resulted in the finding of more than ten speleological objects (see fig. 4.7 and 4.8). In five of the objects either bats or indirect evidence of their presence in the form of guano or Chiropterit were found (table 4.3). These objects have to be monitored during the important periods of migration, hibernation and summer colony forming. The selection of potential winter, summer or migration roost sites depends highly upon the roost temperature, ranging from 16 - 18 °C for the Archipelago area. These temperatures are ideal for summer and maternity bat colonies. The whole archipelago area most probably burrows many more underground objects that yet need to be found and investigated.

Figure 4.7

Mist-netting on the entrance of the Vjetruša pit (left) and entering the Vjetruša pit (right). Photo's: M. Krajnović and D.Kovač respectively.

Figure 4.8
Entering the Green pit. Photo: D. Kovač.

Table 4.3
Spleological objects included in the monitoring programme (T-temperature, H-humidity).

	Name	Coordinates	Island	T/°C	H/%	Found
1	Rupa cave	Y 5527753, X 4851471	Kornat			*1x Rh. ferrumequinum*, Chiropterite
2	Vjetruša pit	Y 5528528, X 4847833	Gustac	16.1	99.9	*Myotis blythii* colony, guano
3	Zanka pit	Y 5521107, X 4855520	Kornat	-	-	guano
4	Green pit	Y 5523768, X 4854295	Kornat			*Myotis blythii* colony
5	Blitvica pit	Y 5528758, X 4846827	Piškera	15.7	72	guano

Bat detector transects

Sampling areas are chosen within the olive groves. Suitable line-transects involve a walk along the educational path (fig. 4.9) and around the pond (fig. 4.10) with five minute stops.

Figure 4.9
Line-transect (1.5 km) educational path near Vruje on the island of Kornat with 3 stops, each 5 minutes.

Figure 4.10
Line-transect (0.8 km) - a square (0.04km²) around the Pond in the Tarac field on the island of Kornat with 4 stops, each 5 minutes.

Monitoring schedule and methods

Considering the variety of NP Kornati's habitats, it is important to include different methods of bat monitoring such as mist netting near water, ultrasound detector transects of foraging bats in olive groves and surveys of potential roosts in trees and underground objects throughout the year. Tabel 4.4 gives the timing for each of those methods during the year. Understanding island-specific patterns of habitat use is essential to bat conservation on smaller islands.

Mist netting

The key concept in obtaining meaningful data is consistency - netting the same water source during the same period of time under the same conditions as much as possible. Each site is surveyed twice during the sample season. It is important to realize the shortcomings of such a practice. Some of these are:

1. Not all species of bats have the same propensity to be netted. The echolocation ability of bats varies greatly from species to species, and some are more likely to pick up the presence of a net.
2. Variation in netting conditions may affect results. For example, changes in temperature, wind, moonlight and storms can affect bat foraging activity. Additionally, even a slight breeze can billow the nets, increasing the likelihood of detection by bats and therefore, decreasing the effectiveness of netting.

Nets should be set up in the way that they surround the entire water surface if possible (fig. 4.11 and 4.12). They should be in place at sunset and maintained at least until 1:00 am. During the mist netting the nets should be checked every 5 min. Bats are capable of swiftly chewing holes in nets. If they are left unattended, the nets may become riddled with holes in a short time. In the intervals between checking the nets, bat extraction and data collection, flashlights should be off, and talking kept to a minimum. This helps both to maintain concentration and to avoid scaring off the bats. All captured bats should be securely placed in small, breathable, cotton bags, one individual per bag. Bats should be kept in a temperate, quiet environment until processing (inspecting and measuring bats) to reduce stress. This is particularly important for pregnant females. External inspection and morphological measurements are used to identify all captured individuals to species and include: species, sex, reproductive status, age, forearm length and additional measurements, focusing first on lactating and pregnant females. For large *Myotis* species, the ear length is measured. For *Plecotus* genus it is important to measure hind foot and tibia length, tragus length and width, length of the upper tooth row. Age is determined by checking the knuckle of the third and fourth (two outer) finger bones for full (adult) or partial (juvenile) ossification. Other information recorded on data sheets for each survey include time and net in which each bat was captured, net open and close time, humidity, wind speed and

temperature and the number and size of nets used. A data form must be completed for each trapping event at each location (annex 4A).

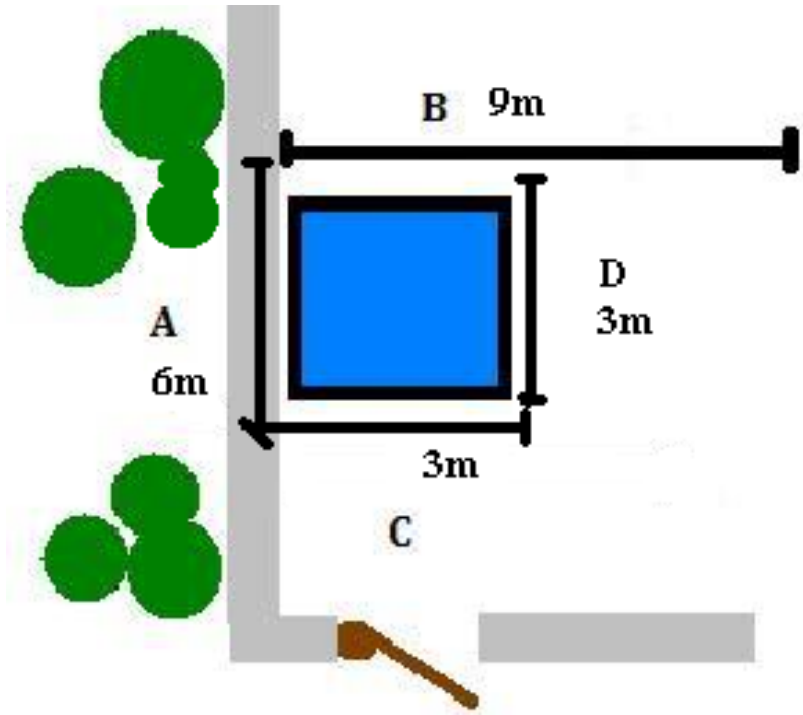


Figure 4.11
Watering pool for sheep, the position of mist nest. By D. Kovač.

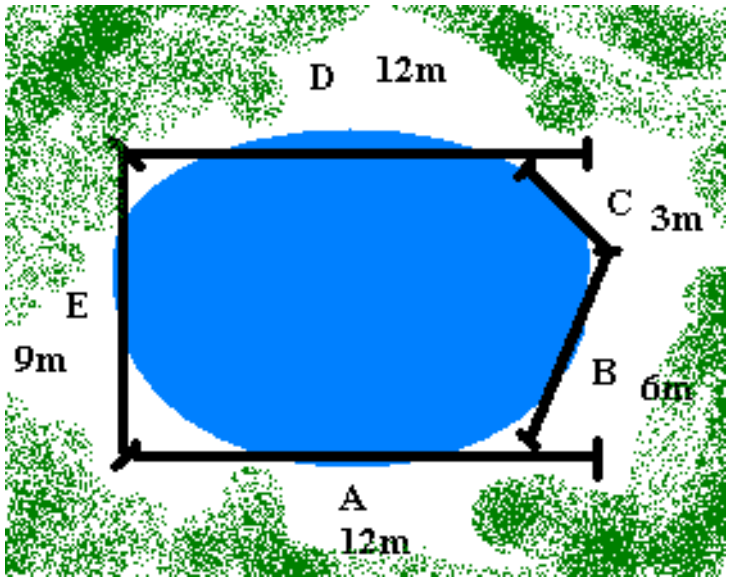


Figure 4.12
The Pond in the Tarac field, the position of mist nest. By D. Kovač.

Potential underground roost site surveys

During the underground roost site survey information recorded on data sheets for each survey include humidity and temperature outside, inside and at the entrance of the underground site. Any traces of bat presence need to be recorded, as well as number and species of bats present at the moment. A data form must be completed for each location (annex 4B). If a hibernating or maternity colony is found, the bats mustn't be disturbed or awaken.

Counts of emerging bats

Observers should be stationed outside each entrance to the roost, but not so close as to disturb the bats or obstruct their flight lines. Recording should begin when the first bat emerges and end when it is too dark to continue counting. It is important to count the bats that are entering the cave as well. The roost entrances should not be illuminated with white light. Ultrasonic detectors can be used to give warning of the approach of a bat. They should be tuned to an appropriate frequency and used with headphones. Counts should not be made in bad weather-conditions, or on nights with previous bad weather, as this is known to inhibit bats from emerging. Bad weather-conditions include low temperature, rain or strong winds. In some cases, for instance when colonies are very large but it is not possible to do internal counts (see below), filming of bats emerging from the roosts using infrared videos connected to bat detectors is desirable.

Counts inside the roost

In regions where mixed species groups occur in caves, a photographic method of counting bats inside the roost may be appropriate. This type of count should be carried out by two people; one taking photographs, the other holding the light, and should be completed as quickly as possible. It is best to take photos of separate groups of bats, but if groups are too large, then 2-3 photos of a group can be taken. Counts can be carried out in any kind of weather conditions.

Hibernation period

Our predictions and former experience on other Mediterranean islands show that caves and pits with average temperatures higher than 15˚C don't serve as favourable hibernation sites, thus having little or no bats during the winter period. All of the mentioned caves need to be investigated to confirm this thesis. One problem with hibernation site surveys is that the relationship between the number of bats seen and the number of bats present is not always clear. In complex sites bats can hide away in cracks and crevices and it is not always possible for surveyors to see all of them.

Migration period

All 5 objects must be examined as potential migration sites. The presence of guano suggests that bats do inhabit the cave at a certain period, perhaps during spring and autumn. Special concern must be undertaken with examining the Vjetruša and the Green pit, where bat colonies have been found during late summer. Species identification can be determined with hand-net colony sampling or mist netting after sunset if the colony is inaccessible. External inspection and morphological measurements are used to identify all captured individuals to species and include: species, sex, reproductive status, age, forearm length and additional measurements.

Summer period

The average temperatures of the mentioned speleological objects are ideal for bat maternity roosts. Already found late summer colonies in the Vjetruša and the Green pit possibly present a part of a former maternity roost, thus need special attention. Once found a maternity roost mustn't be disturbed with a hand net. The colony status can be identified with mist-netting the bat emergence on the cave/pit entrance.

Bat detector transects

Acoustic surveys are conducted by using an ultrasound or echolocation detector, known more commonly as a bat detector. They are conducted to augment the species captured using mist net surveys because not all species present at a survey site on a given night are captured. Counts away from roosts using bat detectors are most suitable for any species which has a loud and distinctive echolocation call. Line-transect surveys require the observer to follow a predetermined path of known length. For approximately one hour after sunset. Point-counts require the observer to listen at a fixed point for 5 minutes. The two methods are combined to give estimates of relative abundance of species being surveyed.

During each survey a data form must be completed (annex 4C) which includes habitat type, time start and finish, air temperature, humidity, wind speed, GPS coordinates, transect length and duration. The survey shouldn't be conducted during extreme weather conditions (rain, strong wind etc.).

Table 4.4
Monitoring schedule.

Methods	January	February	March	April	May	June	July	August	September	October	November	December
Mist netting	-			2 x each site		2 x each site			2 x each site			
Summer roost survey	-			-		1x each site			-			
Hibernacula survey	1x each site			-		-			-			
Migration roost survey	-			1 x each site		-			1x each site			
Bat transects	-			1 x each site		1 x each site			1 x each site			
No. of personnel	3			5		5			5			
No. of required days	max. 4 days			max. 7 days		max. 7 days			max. 7 days			

Checklist field equipment and human resources

The following materials are required for mist netting:

1. Monitoring protocol on bats including field forms (annex 4A);
2. Mist nets, Econet (brand) 20[12]-9[13], 20-3, 20-3, 14-6, 14-6, 14-12, 14-12;
3. Poles, 5m long x 12;
4. Strings for poles, 1 m long x 24;
5. Stakes, the type used for tents x 24;
6. Cloth bags, should have string or cloth ties, used for holding bats after removing from net and while weighing x 20;
7. Calliper Meba, precision 0.1 mm;
8. Scale Pesola, capacity 100 g, division 1.0 g;
9. Thermometer/wind gauge Kestrel 3000;
10. Headlamp, this frees both hands for handling bats, one per person;
11. Leather gloves light-weight, one pair per person;
12. References, Identification key '*Illustrated identification key to the bats of Europe*' (Dietz and Von Helversen, 2004);
13. Digital camera for voucher pictures;
14. GPS, GPSmap 60C, Garmin.

[12] First number gives the mesh opening of the net.
[13] Second number is the length of the net.

The following materials are required for potential underground roost site surveys:

1. Monitoring protocol on bats including field forms (annex 4A and 4B);
2. Hand net;
3. Mist nets, 20-9, 20-3 or 14-6;
4. Poles 5m long x 2;
5. Ropes 50 m;
6. Cloth bags, should have string or cloth ties, used for holding bats after removing from net and while weighing x 20;
7. Calliper, Meba, precision 0.1 mm;
8. Scale Pesola, capacity 100 g, division 1.0 g;
9. Thermometer/wind gauge Kestrel 3000;
10. Headlamp, this frees both hands for handling bats, one per person;
11. Leather gloves light-weight, one pair per person;
12. References Identification key '*Illustrated identification key to the bats of Europe*' (Dietz and Von Helversen, 2004);
13. Digital camera for voucher pictures;
14. GPS, GPSmap 60C, Garmin;
15. Speleologist equipment is required.

The following materials are required for bat detector transects:

1. Monitoring protocol on bats including field forms (annex 4C);
2. Bat detector, Pettersson D-240X;
3. software, Pettersson's BatSound v4.02;
4. headphones, Sony;
5. digital voice recorder, Olympus digital voice recorder VN - 3500PC;
6. GPS, GPSmap 60C, Garmin;
7. Thermometer/wind gauge Kestrel 3000 Pocket Weather Station;
8. Headlamp, one per person;

Capacity needed

Capacity needed for mist netting

This survey method can be efficiently employed by a four person crew per site for setting up a maximum of five nets. Prior to conducting mist net surveys for bats, personnel must receive specialised field training from a bat biologist that can instruct in recommended placement and tension of nets to maximize capture success, proper morphologic measurement techniques, local timing and determination of female reproductive stages and identification of local bat species. Night work can be challenging so personnel has to be comfortable working at night on terrains such as rocky stream beds and sticky mud pond substrates.

Capacity needed for potential underground roost site surveys

This survey method can be efficiently carried out by a two person crew in caves, if a hand net is used to capture bats. A three person's crew is needed when bats are captured by mist nets while emerging from pits. This part of fieldwork should be conducted accompanied by at least one bio-speleologist who can enter the pits to perform a more detailed survey. It is obligatory to enter the pits if potential winter roosts are investigated.

Capacity needed for bat detector transects

This survey method can be efficiently carried out by one person per site. Unlike most of the other field methods, post-field processing time is required to identify recorded calls. The use of bat detectors and the identification of bat calls using software such as BatSound can only be done by specialized biologists. The ability to identify bat species from their echolocation calls requires training and practice during a longer period of time.

5 Birds monitoring protocol

Introduction

The list of bird species described in this section is mainly derived from regular monthly inventories in 2009, covering the whole Kornati, Žut and Sit archipelago. In total some 29 breeding bird species were found (specific inventories of the Eagle owl *Bubo bubo* however were not part of the 2009 fieldwork), as well as 27 species of migratory/wintering birds. Included in the latter group were Bird Directive Annex I species like Honey buzzard (*Pernis apivorus),* Common tern *(Sterna hirundo)* and Common kingfisher *(Alcedo atthis).*

Table 5.1

Breeding bird species in the Kornati Archipelago, registered on Bird Directive Annex I and/or the Croatian Red List (NT Near Threatened; VU Vulnerable; LC Least concern; DD Data Deficient). List up to date since 2009.

Breeding bird species	**BD Annex 1**	**Croatian RL**
Anthus campestris / Tawny Pipit / Primorska trepteljka	X	LC
Hippolais olivetorum /Olive-tree Warbler /Voljić maslinar	X	DD
Caprimulgus europaeus /Nightjar / Leganj	X	LC
Lanius collurio /Red-backed Shrike / Rusi svračak	X	
Bubo bubo /Eagle owl / Ušara	X	NT
Falco peregrinus /Peregrine falcon / Sivi sokol	X	VU
Ixobrychus minutus / Little bittern /Čapljica voljak	X	NT
Rallus aquaticus /Water rail / Kokošica		NT
Phalacrocorax aristotelis /Cormorant shag / Morski vranac	X	NT
Hirundo rustica /Barn swallow / Lastavica		LC
Larus michahellis /Yellow-legged gull/ Galleb klaukavac		

Up to date some ten breeding bird species were found that are listed on Annex I of the Bird Directive and/or the Croatian Red List (see table 1). Some are relatively numerous like Cormorant shag (*Phalacrocorax aristotelis)* and Peregrine falcon *(Falco peregrinus)*. Others are rare and/or only incidental breeders like the freshwater species Little bittern (*Ixobrychus minutus)* and Water rail (*Rallus aquaticus)*. Considering the dry conditions of the islands, with only a few freshwater ponds, the rarity of these species is not so strange. Positive future trends are not expected either because of these reasons. Nevertheless their presence (or not) can be an indication of the ecological condition of these locally rare habitats. As such it's recommended to monitor at least all these species that are having a high conservation status.

Though not a BD Annex I or red list species, the Yellow-legged gull *(Larus michahellis*) is added to the list as the species breeds in fairly large colonies and has been monitored by the Kornati NP for years already.
Most birds are very mobile compared to other species and future inventories will undoubtedly lead to additional threatened species that choose the archipelago for wintering, resting, foraging, mating, breeding etc. Potential

future protected species could be Greater Short-toed Lark (*Calandrella brachydactyla*; Annex I, NT), Short-toed Eagle (*Circaetus gallicus;* Annex I, VU), Eleonora's Falcon (*Falco eleonorae;* Annex I, EN), Rock Partridge (*Alectoris graeca;* Annex I, NT) and Zitting Cisticola (*Cisticola juncidis*; NT) (personal comment Tibor Mikuska). It's recommended to simply increase the list of species which should regularly be monitored. For the analysis of monitoring data and other issues concerning monitoring it's recommended to consult the website of the European Bird Census Council (see box 5.1).

Box 5.1 The European Bird Census Council (EBCC)

The European Bird Census Council (EBCC) is an association of like-minded expert ornithologists co-operating in a range of ways to improve bird monitoring and atlas work and thereby inform and improve the management and conservation of birds' populations in Europe. From a wide range of information available on bird monitoring and atlas methods the EBCC provides some of the most useful by PDF at their website[14]. For the analysis of monitoring data the EBCC provides a downloadable software package named TRIM[15] (TRends and Indices for Monitoring data) that can be used to determine species' population trends. It allows for missing counts using estimation, and yields yearly indices and standard errors using Poisson regression. The latest version can be downloaded from the website of Statistics Netherlands[16].

Ecological characteristics

This section describes some ecological characteristics of the species listed above, like size, colour, sound (phonetic) etc. in a way to support non-specialists in the recognition of the species in the field. The information has been retrieved from field guides and websites from Birdlife International[17], the Royal Society of Birds[18] and the so-called 'soortenbank'[19] (species database) in the Netherlands. It's recommended though to always take a field guide into the field as this gives additional information about a species, as well as it allows distinguishing the species from other similar looking species. The images of bird species provided below are downloaded from the free images website[20] of the ECNC (European Centre for Nature Conservation).

Tawny Pipit

The Tawny Pipit (fig. 5.1; *Anthus campestris*) is a medium-large passerine bird (16.5-18 cm long). It is an undistinguished looking species on the ground, mainly sandy brown above and pale below, with a whitish eyebrow. Its flight is strong and direct, and it gives a variable call, sounding like 'tsliep', 'tsjirrup' or 'tiu'. The song can be heard on the ground or during flight and sounds like 'tsjivie tsjivie'.

The breeding habit is dry open country, on Kornati mainly rocky open habitat, sometimes with solitary trees. The nest is on the ground, with 4-6 eggs being laid.

It feeds on the ground mainly on insects, sometimes on seeds. In the breeding season it can be found in pairs or small family groups, during migration alone or in small groups, often together with other pipits and Blue-headed Wagtails (*Motacilla flava*).

[14] www.ebcc.info/references.html

[15] www.ebcc.info/trim.html

[16] www.cbs.nl/en-GB/menu/themas/natuur-milieu/methoden/trim/default.htm?languageswitch=on

[17] www.birdlife.org

[18] www.rspb.org.uk

[19] www.soortenbank.nl

[20] http://www.freenatureimages.eu

Figure 5.1
Tawny pipit (Anthus campestris). Photo: Mark Zekhuis.

Olive-tree Warbler

The Olive-tree Warbler (*Hippolais olivetorum*) measures 16-18 cm and is the largest *Hippolais* warbler species. It's fairly grey coloured being brown greyish above and grey whitish below. Legs are bluish. Its crown is rather flat. Wings are long and pointed. Its beak is heavy, long and dark, with a yellowish base. It has a clear pale spot at its wings. It's a shy bird often hiding between the leaves.
The call sounds like 'tsjuk', 'tsjek' (like clicking of ones tongue), while the song sounds like slow chatting with raw tones. The breeding habitat is open deciduous forest, with lush undergrowth, on Kornati mainly open-canopy oak woods and olive orchards. It lays 3-4 eggs in a nest in a low tree or a bush. The bird feeds on invertebrates and fruit. Olive-tree Warblers breed in southeast Europe and the near east. It is migratory, wintering in eastern and southern Africa, from Kenya south to South Africa.

Nightjar

The Nightjar (fig. 5.2; *Caprimulgus europaeus)* measures 24-28 cm. With pointed wings and long tails their shape is quite similar to a Kestrel or Cuckoo. The head is flat with a very small beak. Their cryptic, grey-brown, mottled, streaked and barred plumage provides ideal camouflage during daytime. Males have large white spots at the outer quills and wing points.
Nightjars are nocturnal birds. The species hides during daytime on the ground or sits almost invisible parallel on a branch. The first indication that a nightjar is near is usually the male's churring song, rising and falling with a ventriloquial quality sounding like 'errrrrrrrr orrrrrrrrr'. Its call sounds like 'koe-ik', while during mating the bird makes a clapping sound with its wings. The species breeds on the ground mainly in open habitat with some trees, like on Kornati. Nightjars can be seen hawking for food at dusk and dawn. It feeds on insects, mainly moths and beetles caught during flight, but it also catches flies from a sitting spot.

Figure 5.2
Nightjar (Caprimulgus europaeus). Photos: Mark Zekhuis.

Red-backed Shrike

Red-backed shrikes (fig. 5.3; *Lanius collurio*) are 16-18 cm long migratory birds, slightly larger, but slimmer, than house sparrows. The male is unmistakable with a bluish-grey head, a typical shrike black mask, bright chestnut back, white throat, and tinged pink under parts. Females are without grey and generally without black on the head. Sometimes they're having a brown mask. In the female and young birds the upperparts are brown and vermiculated. Under parts are buff and also vermiculated. The species has a thick hooked black bill. The call sounds like 'tsjek', 'tsjak' or rasping 'whrieie'. Its song is hardly heard, quite soft, kind of chatting with rasping tones. Sometimes it imitates other songbird species.

Figure 5.3

Red-backed Shrike (Lanius collurio). Photo: Urska Koce.

The Red-backed shrike breeds in open habitat with some trees and/or shrub, as can be found on Kornati. Shrikes like to perch prominently on the tops of bushes, fence posts and telephone wires, thereby wagging its tail from one side to the other. From these perches they have a good view of potential prey like large insects, small birds, frogs, rodents and lizards. Like other shrikes it impales corpses on thorns or barbed wire as a 'larder'. This species breeds in most of Europe and western Asia and winters in tropical Africa.

Eagle owl

The Eagle Owl (fig. 5.4; *Bubo bubo*) is a large and powerful bird, smaller than the Golden Eagle but larger than the Snowy Owl. It has a wingspan of up to 138-200 cm and measures 58-75 cm long. It has a strong direct flight. Females are larger than males, while the ear tufts of males are more upright than those of females. It's generally a brown bird with lots of black spots and stripes. It has large, orange eyes and long dark ear tufts. The call of the Eagle Owl is a deep resonant 'ooh-hu' with emphasis on the first syllable for the male, and a more high-pitched uh-Hu for the female. Due to its largely nocturnal way of life, generally nothing more can be seen than a shade. Sometimes during daytime it can be seen sun bathing.

The Eagle owl can be found in a variety of remote habitats like mountains and forests with cliffs and rocky areas, usually nesting on cliff ledges.

The species mainly feeds on large birds (like ducks) and mammals and it can kill prey up to the size of foxes and young deer. On Kornati it has also been known to prey on cat.

Figure 5.4
Eagle owl (left: Bubo bubo) and Peregrine falcon (right: Falco peregrinus): Photos Jan van der Straaten.

Peregrine falcon
The Peregrine falcon (fig. 5.4; Falco peregrinus) is a large and powerful falcon. It is 39-50 cm long and a wing span of 95-115 cm. It has long, broad, pointed wings and a relatively short tail. It is blue-grey above, with a blackish top of the head and an obvious black 'moustache' that contrasts with its white face. Its breast is finely spotted. Females are larger and darker then males.
Juveniles have dark brown upper parts and whitish parts with vertical stripes.
It's noisy during the breeding season. The main call being a loud 'kek-kek-kek-kek'. Peregrines are found along rocky sea cliffs and uplands like in Kornati, but also on sky scrapers and industrial chimney's (artificial cliffs) inland. Large gatherings of birds can be a good place in the winter. Peregrines are swift and agile in flight, chasing prey, mainly medium-sized birds, such as wading birds, pigeons and small ducks.

Little bittern
The Little bittern (fig. 5.5; Ixobrychus minutus) is a small-sized heron of 28-36 cm long. It has a dark, shining crown and back. On its black wing upperparts it has clear contrasting yellow-white spots. The female is less bright coloured. The beak is yellowish, legs are green. Young birds look like female though with more spots and stripes. It flies low, with fast wing beats and a drawn in neck.
The bird lives hidden and is mainly active during dusk. It makes short quacking sounds. The male's spring call is a persistent 'wouw wouw'.
Its habitat consists of reed land along lakes and pools preferably with some trees or shrub. As such it is a strange wetland bird within the dry Kornati archipelago and it is therefore almost restricted to the few available ponds like the one on Kornat island. It feeds on fish, amphibians and insects.

Figure 5.5
Little bittern (left: Ixobrychus minutus) and Water rail (right: Rallus aquaticus). Photos: Janus Verkerk (l) and Piet Munsterman (r).

Water rail

The Water rail (fig. 5.5; Rallus aquaticus) is a 23-28 cm long bird. It is smaller and distinctly slimmer than the moorhen. The water rail is a highly secretive inhabitant of freshwater wetlands. It has chestnut-brown and black upperparts, grey face and under parts, black-and-white barred flanks, and a long red bill. Although usually secretive they can become confiding but are still far more often heard than seen.

Calls vary from a sharp 'kip kip kip' to pig-like screaming 'kruie kruie kruie'. It's mostly heard during dusk and nights. Its habitat consists of freshwater wetlands like reed marshes, swamps, rivers, lakes and ponds, like the few fresh water ponds within the Kornati Archipelago. It's an omnivorous bird mainly feeding on small fish, snails and insects. In wintertime they also feed on vegetation.

Cormorant shag

The Cormorant shag (fig. 5.6; *Phalacrocorax aristotelis)* is a medium-large black bird, 65-80 cm long and with a 95-110 cm wingspan. It has a longish tail and yellow throat-patch. Adults have a small crest in the breeding season. It is distinguished from the Great Cormorant by its smaller size, lighter build, thinner bill, and, in breeding adults, by the crest and metallic green-tinged sheen on the feathers. Among those differences are that a shag has a lighter, narrower beak; and the juvenile shag has darker underparts.

Its call is a loud, cracking 'kroak-kraik-kroak'. The species breeds on coasts, nesting on rocky ledges or in crevices or small caves, or under dense thorny bushes as on Kornati National Park. The nests are untidy heaps of rotting seaweed or twigs cemented together by the bird's own guano. Three eggs are laid. Their chicks hatch without down and so they rely totally on their parents for warmth, often for a period of two months before they can fly.

Shags will travel many kilometres from their roosting sites in order to feed. It feeds in the sea, and, unlike the Great Cormorant, is rare inland. It will winter along any coast that is well-supplied with fish. The European Shag is one of the deepest divers among the cormorant family, diving to at least 45 metres. European Shags are preponderantly benthic feeders, i.e. they find their prey on the sea bottom mainly fish and occasionally crustaceans and molluscs.

Figure 5.6

Cormorant Shag (left: Phalacrocorax aristotelis) and Yello-legged Gull (right: Larus michahellis). Photos: Luc Hoogenstein (l) and Jan van der Straaten (r).

Barn swallow

Barn swallows (fig. 5.7; *Hirundo rustica)* are small 17-19 cm birds with dark glossy blue backs, red throats, pale under parts and long distinctive tail streamers. They are extremely agile in flight and spend most of their time on the wing. They breed in small colonies. Swallows are found in areas where there is a ready and accessible supply of small insects. They are particularly fond of open pasture with access to water and quiet farm buildings.

Its call sounds like 'tswit-tswit', while its song is a pleasant twitter from an exposed position or during flight ending in a low thriller. It feeds on a range of small flying invertebrates.

Figure 5.7
Barn Swallow (Hirundo rustica). Photo: Jan Nijendijk.

Yellow-legged gull
The Yellow-legged gull (fig. 5.6) *Larus cacchinans michahellis)* is 52-58 cm long and has a wingspan of 120-140 cm. It has only recently been recognised as a species in its own right, having previously been considered to be a race of Herring gull. Adults have darker grey backs and wings than Herring gulls, but are paler than Lesser black-backed gulls. They have more black in the wing tips than Herring gulls and smaller white 'mirrors'.
The legs are bright yellow, there is a red ring around the eye and the bill is yellow with a large red spot. In non-breeding plumage, the head is less streaked and whiter than Herring gulls. Immature birds gain adult-like characteristics as they mature over the course of five years with the legs turning yellow and dark grey feathers replacing the brown and black immature feathers.
Its call is a typical loud gull-like 'kjauw' or 'ak-ak-ak' if disturbed. Its mating call sounds like 'auw…kjjAA-kjA-kjA-kjA…kjau'. Yellow-legged gulls can be found on reservoirs, on rubbish tips, in fields, on coastal marshes and in large evening gull roosts on reservoirs and lakes. It is an omnivorous scavenger. It breeds in North-West Africa, around the Mediterranean and along the coasts of south-west Europe.

Location of monitoring transects or plots

The transects in the pictures below (fig. 5.8 to 5.11) cover the main habitats within the Kornati Archipelago. Transects should not be replaced with others. New transects should only be added if there's sufficient capacity for monitoring.

Figure 5.8
Kornat island: two transects north and east from Vrulje, the main village.

Figure 5.9
One transect on Lavsa island.

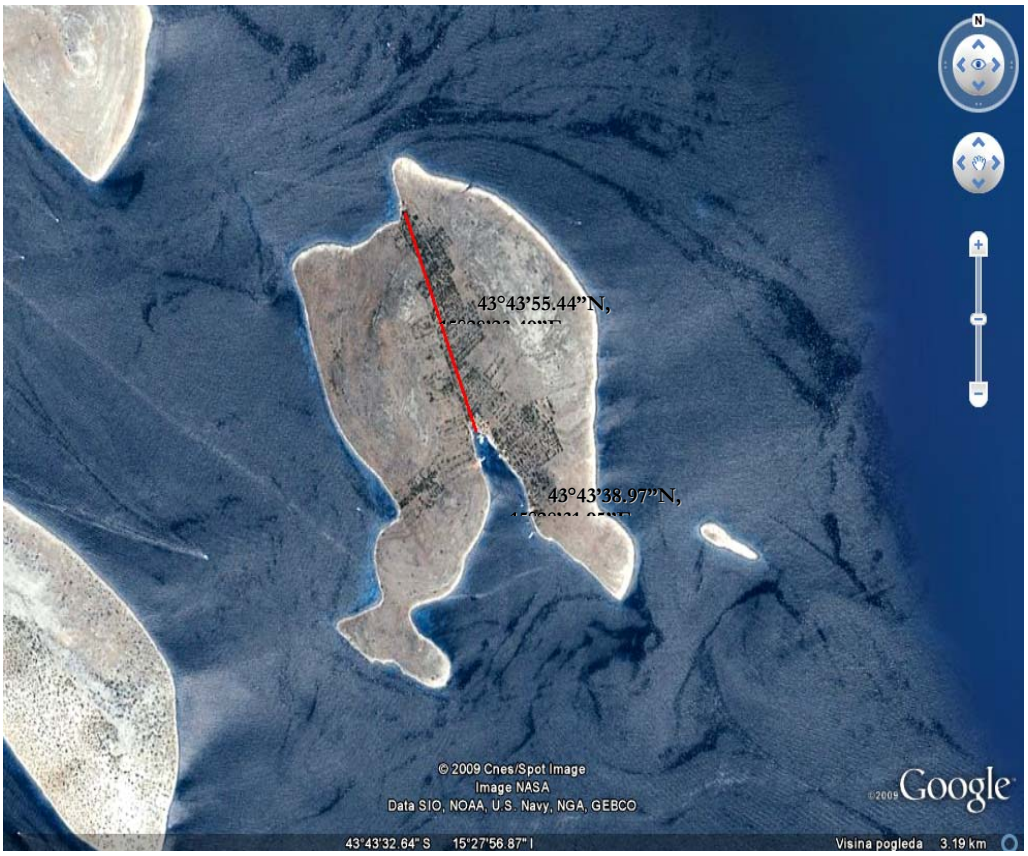


Figure 5.10

One transect on Smokvica island.

Figure 5.11

Cliffs at the western border of the Kornati National Park (red), canyon on Kornat Island (green), colonies of Yellow legged gulls and other species (yellow circle) and fresh water pond at Kornat island (blue circle).

Monitoring schedule and method

This section summarizes issues like when should be monitored, where can the species be found and how and how often should monitoring be carried out. Annex 5 gives the field form that should be filled in during fieldwork. Below are three tables which summarise the preferred habitat of the species on Kornati (table 5.2); the timing of the monitoring during the year (table 5.3) and the day (table 5.4). After that, the way of monitoring of each species will be described. For that we introduce the term 'fusion distance'.

Fusion distance[21] = distance between two observations which determines whether there is one territory of the species or two. This means that two observations within the fusion distance belong to one territory, while two observations beyond the fusion distance means two territories.

Table 5.2

Preferred breeding habitat of the species concerned on Kornati. Green resembles the preferred habitat, orange marginal habitat, while 'blank' habitats are generally not part of the breeding territory of the species.

Species	macchia	open forest	orchards	flood mark	open rocky habitat	open habitat with trees	rocky cliffs	freshwater wetland	villages
Anthus campestris / Tawny Pipit									
Hippolais olivetorum / Olive-tree Warbler									
Caprimulgus europaeus / Nightjar									
Lanius collurio / Red-backed Shrike									
Bubo bubo / Eagle owl									
Falco peregrinus / Peregrine falcon									
Ixobrychus minutus / Little bittern									
Rallus aquaticus / Water rail									
Phalacrocorax aristotelis / Cormorant shag									
Hirundo rustica / Barn swallow									
Larus michahellis / Yellow-legged gull									

[21] Source: SOVON Bird Research Organisation, the Netherlands

Table 5.3

*Timing of the monitoring throughout the year. Green illustrates the peak of the breeding season, while orange illustrates early or late nests. * is the period for monitoring the territory call of Eagle-owls. Blank cells mean that the species is generally absent as a breeding bird.*

Species	January	February	March	April	May	June	July	August	September	October	November	December
Anthus campestris / Tawny Pipit												
Hippolais olivetorum / Olive-tree Warbler												
Caprimulgus europaeus / Nightjar												
Lanius collurio / Red-backed Shrike												
Bubo bubo / Eagle owl	*										*	*
Falco peregrinus / Peregrine falcon												
Ixobrychus minutus / Little bittern												
Rallus aquaticus / Water rail												
Phalacrocorax aristotelis / Cormorant shag												
Hirundo rustica / Barn swallow												
Larus michahellis / Yellow-legged gull												

Table 5.4

Timing of the monitoring during a day. Green is the best time for monitoring, better then orange, while monitoring should not take place during 'blank' periods of the day.

Species	Sunrise	Daytime	Evening	Night
Anthus campestris / Tawny Pipit				
Hippolais olivetorum / Olive-tree Warbler				
Caprimulgus europaeus / Nightjar				
Lanius collurio / Red-backed Shrike				
Bubo bubo / Eagle owl				
Falco peregrinus / Peregrine falcon				
Ixobrychus minutus / Little bittern				
Rallus aquaticus / Water rail				
Phalacrocorax aristotelis / Cormorant shag				
Hirundo rustica / Barn swallow				
Larus michahellis / Yellow-legged gull				

Tawny Pipit

Observations especially in the mornings at warm days. At start of the breeding season pairs tend to follow each other during flight. During breeding they're more relaxed. Special attention for songs (April-May), presence of a pair and young that have leaved the nest (especially early June). Attentive bird at an elevated spot indicates a territory. Fusion distance 500 m. Registration of breeding territory if:

- Nest or territory indicating observation in suitable biotope between mid April and end of July.

Olive-tree Warbler
Breeds in open forest with shrub, high marquis or olive tree yards, often on slopes. Usually breeds in dens scrub or low tree. Registration of breeding territory if:
- Nest or nest indicating observation;
- Two territory indicating observations between mid-April and end of June.

Nightjar
Best time for observation is at dusk and during quiet, warm nights. Song starts 10-70 minutes after sunset, earliest at cloudy weather and latest at bright skies. Song stops at 60-30 minutes before sunrise. Focus should be on song, call and alarm; flying birds should be registered if they fly over breeding place and call "koeiek". Use of a recorder may stimulate territorial activity (though solitary pairs often do not react at all and tend to keep quiet). Fusion distance 500 m. If densities are high one should rely on the maximum number of registered pairs/males. Registration of breeding territory if:
- One observation between early May and mid August.

Red-backed Shrike
Song especially in the morning. Register all observations with special attention for song during mid April-June, presence of a pair, nest construction, alarming, food transport and begging chicks. Species is quite unnoticeable during breeding, especially solitary pairs can be difficult to find. Pellets and pooh under fixed sitting spots, and prey pinned on thorns (like mice, lizards, young songbirds and big insects) indicate presence. Pairs sometimes breed close to each other. Breeding spots are often occupied for years in a row. Fusion distance 500 m. Registration of breeding territory if:
- Nest or nest indicating observation;
- One territory indicating observation of a pair between early May and end of June;
- Two observations of an individual in breeding biotope of which one in June.

Eagle owl
All observations with special attention for calling birds and begging chicks. Attentions for feeding place in open terrain, especially with drawn off legs and wings of pigeons. Breeding pair can behave very quiet and most calling behaviour is observed between November and end of January. Juveniles are often still begging for food until September. Fusion distance 2500 m. Hunting birds are no indication for a territory as they can come from far away. Registration of breeding territory if:
- Nest or nest indicating observations;
- Two territory indicating observations between February 1st and end of June.

Peregrine falcon
Birds generally occupy same nests throughout the years. In Kornati they mainly breed at the western cliffs. Breeding birds show territory or nest indicating behaviour, like mating, alarming, food transport or handing over of prey. Peregrine falcons make no own nest but take over other species nests. Birds can sometimes be very loud (shrill call) during mating and after their offspring leaves the nest, but parents are generally inactive and unnoticed. Begging juveniles often stay for months near the nest. Fusion distance 2500 m. Registration of breeding territory if:
- Nest or nest indicating observation;
- Two territory indicating observations (also paired birds) between February 1st and June 30th;
- Three observations of grown-up individuals in breeding biotope of which twice between May 1st and June 30th.

Little bittern
Breeding birds can make a cuffing sound. As this is a wetland bird, it can actually only be found near fresh water ponds like the Lokva fresh water pond at Kornat Island. Fusion distance = 500 m. Registration of breeding territory if:
- One observation in breeding period between May 15th and end of June;
- If observation of flying birds, then only count individuals that fly up or land.

Water rail
As this is a wetland bird, it can actually only be found near fresh water ponds like the the Lokva fresh water pond at Kornat Island. Sound of male often during the night. Registration of breeding territory if:

- One observation in breeding period.

Cormorant shag
Birds are breeding at the > 30 km long cliffs mainly at the western border of the Kornati National Park. Slowly cruising by the boat along the cliffs and counting nests with the sign of guano at the entrance (or parents flying out) is the best way of counting. Clusters of nests might be pictured which may help counting afterwards. The other parts of the islands should be censed on foot and nests should be searched in the dense vegetation. Registration of a nest if:

- Occupied nest which can be recognised from adult or juvenile birds or eggs in the nest. Occupied nest also indicated by fresh branches, guano (pooh), food or eggshells up or under the nest. Non-occupied nest are generally broken down quickly by neighbouring pairs.

Barn swallow
These species can be found in the villages on the islands. The occupied nest can fairly easily be counted.

Yellow-legged gull
Breeding colonies are known from the islands of Purara and Mrtenjak. Some incidental breeding birds can be found at neighbouring islands. Advise is to have two countings in the period that most nests will be occupied (April-mid-June). There should be at least 10 days between two counting's. End of the breeding season usually is the best time for counting.
Unnecessary disturbance should be prevented when entering a colony. Entering a colony during cold, wet and hot weather as well as presence after sunset should be prevented at all times. Entering of colonies that are mixed with other species should as well be prohibited in order to prevent plundering of these species nests by gulls. Making pictures of a colony may help to count individual nests. Fusion distance 1000 m.

Checklist field equipment and human resources

1. Monitoring protocol on birds including field forms;
2. Monitoring can be carried out on ones own, though a least a boat driver should be arranged when monitoring will be carried out from a boat;
3. Birds Field guide;
4. Binocular: magnification 7x or 8x if observing from a boat, while 7x, 8x or 10x when observing on land;
5. Telescopes for observing nests like from the Eagle owl or Peregrine falcons. Also for reading bird rings;
6. Torch for monitoring during evening and night;
7. Sufficient field forms to be filled in;
8. Camping equipment (if allowed by park management) for monitoring at remote spots during dawn. Not necessary for current transects however.

6 Reptiles monitoring protocol

Introduction

Croatia encompasses a rich variety of habitats which is one of the reasons for having a high number of reptile species. About 40 species are known to date in Croatia: 16 snakes, 6 turtles and 18 lizard species. For the Kornati archipelago only five species of snakes, four species of lizards and two species of turtles are known (see table 6.1). The Montpellier Snake and Turkish Gecko have no high protection status, but are nevertheless included within this list. For the Loggerhead Turtle it has been said that the Adriatic is an important area during the winter period. Nesting occurs at beaches mostly in the Southern Mediterranean. This is a so-called priority species and monitoring is highly recommended. However, this requires specific marine monitoring methods and the species will therefore not be described in this section. The Hermann's tortoise also has a high protection status. One individual was found in National Park Kornati in 2009 but the species was most probably introduced by man according to forester Zlatko Ruzanovic (Kornati NP). Whether there is more than one individual is not clear, but considering its protection status it's recommended to monitor the species. Formally also the European Pond Terrapin (Emys orbicularis, also known as European pond turtle) was present in the Tarac pond on Kornat island, but it hasn't been found anymore since 1926 (Hirtz, 1930).

Table 6.1
Reptiles present in the Kornati archipelago.

	HD Annexes		Croatian RL
Marine Reptiles	II	IV	
Caretta caretta * (Loggerhead Turtle / glavata želva)	X*	X	EN
Terrestrial Reptiles			
Testudo hermanni (Hermann's Tortoise / kopnena kornjača)	X	X	NT
Elaphe quatuorlineata (Four-Lined Snake / četveroprugi kravosas)	X	X	
Zamensis situla (Leopard Snake / crvenkrpica)	X	X	DT
Telescopus fallax (Cat Snake / crnokrpica)		X	
Malpolon insignitus (Montepellier Snake / zmajur)			
Hierophis gemonensis (Balkan Racer / šara poljarica)		X	
Pseudopus apodus (European Glass Lizard / blavor)		X	
Podarcis sicula (Italian Wall Lizard / primorska gušterica)		X	
Podarcis melisellensis (Dalmatian Wall Lizard / krška gušterica)		X	
Hemidactylus turcicus (Turkish Gecko / kućni macaklin)			

One of the biggest threats for the reptiles living on the islands of the Kornati archipelago may be the presence of cats, especially on small islands and especially after the tourism season if there is a lack of food from man and these animals need to prey on wildlife. Human prejudice (killing of snakes) is also an important cause of death for snakes

world wide. Awareness rising is needed to control threats like these and to educate on the fascinating world of reptiles.

Ecological characteristics

Below a short general description will be presented on the species ecology. For more information it's recommended to visit the website of the Croatian Environment Agency[22] which hosts web pages[23] on the protected and strictly protected species in Croatia (still in Croatian language only). At the moment only reptiles, amphibians, mammals, butterflies and freshwater fish are available, but other groups will soon be added. Here it's possible to find information on species biology, habitats, distribution, Red list status and legal framework as well as additional literature.

Hermann's tortoise
The Hermann's tortoise has a yellowish, dome-shaped shell, compromising horny plates. Head and legs are retractable. Two symmetrical plates lie above the tail base on shell margin. It's locally common in warm dry areas including meadows and scrub-covered slopes. It occurs around coastal regions of Croatia, Italy and Greece. In National Park Kornati one individual was found in 2009. According to forester Zlatko Ruzanovic (Kornati NP), this individual was most probably introduced.

Figure 6.1
Adult Four-Lined Snake (left) a species that is fairly easy to find and an allusive Leopard Snake (right). Photo's: Dušan Jelič.

Four-lined Snake
Four-lined Snake (fig. 6.1) adults measure up to 260 cm, including tail, but most animals are under 150 cm. It's a large snake being more robust than other big snakes. Young animals have a row of dark, often black-edged, broad spots or bars and once or two series of smaller spots on each flank; their body is boldly marked and the belly has dark markings that may form two streaks. Adults may be marked more or less like this or with four stripes along the back. They're often found along wood-edges and hedges, in open woods or rocky overgrown hills. In Croatia they're also found in gardens near settlements.

Leopard Snake
The Leopard Snake (fig. 6.1) is a beautiful patterned snake. Ground colour of the body is usually silver grey but it is well marked with dark-bordered red spots or stripes. In Croatia the spotted form is dominant above the striped form.

[22] http://www.azo.hr
[23] http://zasticenevrste.azo.hr/

It favours warm, rocky slopes and field margins with stone walls. Adults mainly hunt on small mammals. The species is distributed along the coastal region of Croatia and several islands including the Kornati National Park. This nocturnal species has a hidden lifestyle and is hard to find.

Cat Snake

The Cat Snake measures up to about 75 cm average, including tail, but some specimen can range up to 100 cm and rarely even 130 cm. It's a slender snake with a broad, flat head. The body is often deeper than wide, the snout is tapering but blunt; eyes are small with vertical cat-like pupils. They're usually found in stony places, rocky degraded woodland, old walls, rock piles, ruins, etc. Occasionally they're found in heaps of old vegetation and sandy areas with bushy plant cover.

Montpellier Snake

The Montpellier snake is a large, back-fanged snake with an angular head. The ridged eyebrows create a menacing expression. Adults normally reach lengths of up to 150 cm, but occasionally this species can reach up to 200 cm (Krainer, 2007). The body colour of adults varies from grey-brown, olive to olive-grey. Young animals are often spotted. The species favours warm, dry habitats such as slopes with interspersed rocks and brush, shrub-lined paths, ruins, stone walls etc. It feeds on a variety of prey, mostly lizards but also snakes, small mammals, birds and their eggs and large insects like grasshoppers. When the Montpellier snake is threatened or disturbed, it responds with a loud hissing.

Balkan Racer

Balkan Racer (also known as Balkan Whip Snake) adults are normally under 100 cm, including tail. Occasionally they can range up to 130 cm or even longer. It's a rather slender snake with a well-defined head, smooth scales, fairly prominent eyes and round pupils. Its colour is olive-grey, grey-brown or yellowish-brown with dark spots on foreparts that are often divided by light streaks and may form very irregular bars. The body tends to have regular narrow light and dark stripes. Small white spots are frequently present on edges of some back scales. The underside is yellowish or whitish with dark spots, typically present at least on one side of the neck. It's found in a wide variety of mainly dry open habitats. It occurs in dry stony places, scrub areas, vineyards, olive yards, overgrown ruins, hedgerows etc. In Croatia it occurs up to 1400 m, but it is most abundant at sea level and near the sea shore (fig. 6.2). The species can have a fierce bite if handled. It feeds on lizards and large insects including grasshoppers, but also small mammals and nesting birds.

Figure 6.2
Typical habitats for the Balkan Racer. Photo's: Dušan Jelić.

European Glass Lizard

Adult European Glass Lizards (fig. 6.4) measure up to 140 cm. The unbroken tail is about 1.5 times as long as the rest of the body. It looks rather like a giant Slow Worm (*Anguis fragilis*). It's a snake like animal with a relatively heavy boy which is easily distinguishable from other more or less limbless European reptiles. Adults can be as thick as a man's wrist and they are usually uniform yellowish brown or warm brown. When they grow older they become darker, though the head remains pale. It's usually found in fairly dry habitats. It can be frequent on rocky hill-sides with some cover, light woods, dry-stone walls, around houses in gardens (villages) and embankments, piles of stones etc. (fig. 6.3).

Figure 6.3
Typical habitat for the European Glass lizard. Photo: Dušan Jelić.

Figure 6.4
Close up of a European Glass Lizard, typical is the yellow head. Photo: Fabrice Ottburg.

Italian Wall Lizard

The Italian Wall Lizard (fig. 6.5) can measure up to 9 cm but is usually smaller. It's a highly variable wall lizard, usually with a rather deep often fairly long head and robust body. Its downside is whitish, greyish or has a greenish tinge, nearly always without dark spots. From above the species is typically green, yellowish, olive or light brown. Females tend to be smaller with a smaller head than males and they have a more obviously striped pattern. Individuals of some populations slowly change colour, being browner during summer. There are many regional variations within this species. It's a vigorous, opportunistic lizard with a variable habitat. It's found in grassy places, roadside verges, wood edges, ruins, old stone walls etc.

Figure 6.5

A male Italian wall lizard coming out of his 'cave' in a wall next to NGO Argonauta in Murter. Photo: Fabrice Ottburg.

Dalmatian Wall lizard

The Dalmatian Wall Lizard (fig. 6.6) measures up to 6.5 cm from snout to vent, but is often smaller. The tail is about twice as long as the body. It's a small, fairly stocky lizard with a rather deep, short head. The downside is white, orange or red, usually unspotted. From above it is light brown or with a green back. It has considerable differences in colour and size and recently around 20 mainly island subspecies have been recognized. Island populations near shallow water relatively close to the mainland are generally similar and closely related to mainland populations. The species is found in a variety of dry habitats: path and road banks, dry ditches, open woodland, scrub or dry, stony pastures with overgrown edges.

Figure 6.6

A male Dalmatian wall lizard and its habitat. Photo's: Dušan Jelič.

Turkish Gecko

The Turkish Gecko (fig. 6.7) is similar to the Moorish Gecko (Tarentola mauritanica) but more slender, with adhesive pads on the underside of its toes. Its eyes are proportionally large and with a vertical pupil. It favours warm, sunny areas and is often found at stones (like outer walls, ruins, small fields with lots of stones like olive yards) and houses, also inside. It's mostly nocturnal. The species is widespread in coastal areas across the Mediterranean.

Figure 6.7

An adult Turkish Gecko and its typical habitat, a close up of a house wall. Photo's: Dušan Jelić.

Location of monitoring transects or plots

Figure 6.8 and 6.9 show the maps of the monitoring transects for reptiles on the islands Kornat and Žut which were monitored in the summer of 2009. The red dots give the location of the several transects.

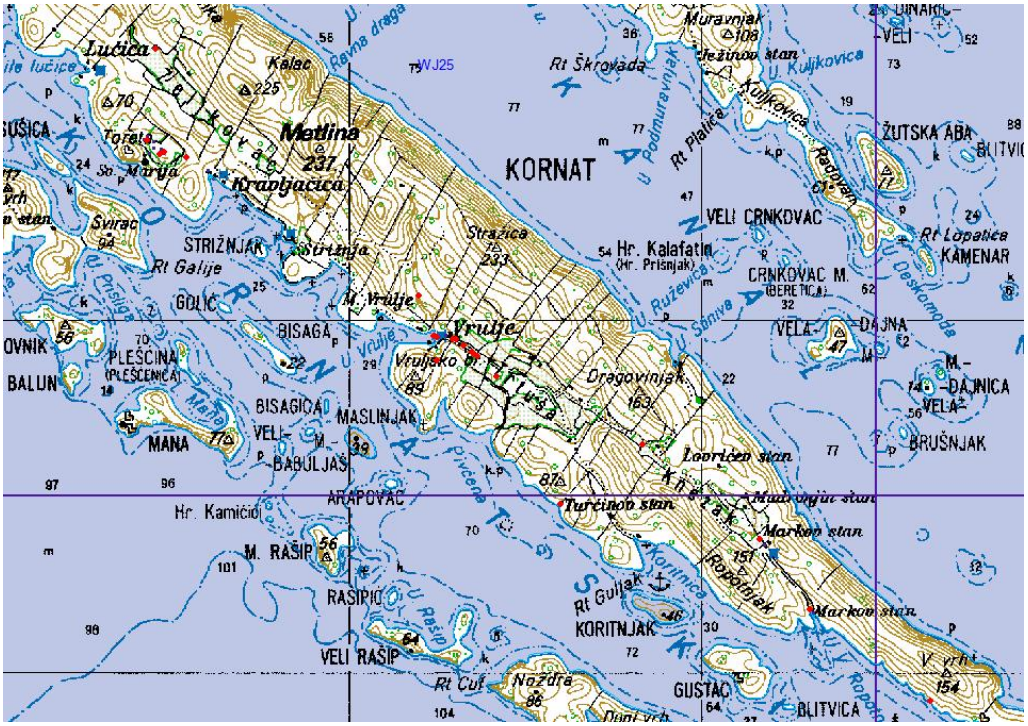


Figure 6.8

Map of the island Kornat with the monitoring transect for reptiles in the summer of 2009.

Figure 6.9

Map of the island Žut with the monitoring transect for reptiles in the summer of 2009.

Monitoring schedule and activities

Table 6.2 shows which period of the year the monitoring should take place for the ten reptile species currently known in the Kornati Archipelago. From March till May is the best period to search for adult reptiles. For two of them, the Cat Snake and Turkish Gecko, the best period is from April till mid July.

Table 6.2

Timing for the monitoring of reptiles during the season. Green is the best period for adults and orange is the best period for juveniles.

Monitoring Activity	January	February	March	April	May	June	July	August	September	October	November	December
Testudo hermanni (Herman tortoise)												
Elaphe quatuorlineata (Four-Lined Snake)												
Zamenis situla (Leopard Snake)												
Telescopus fallax (Cat Snake)												
Malpolon insignitus (Montepellier Snake)												
Hierophis gemonensis (Balkan racer)												
Pseudopus apodus (European Glass Lizard)												
Podarcis sicula (Italian wall lizard)												
Podarcis melisellensis (Dalmatian wall lizard)												
Hemidactylus turcicus (Turkish Gecko)												

The late summer and autumn period (generally from August till October) are best to search for juvenile reptiles. Every round should take at least five days though fourteen days is preferred. For weather conditions the rules of thumb are: don't walk transects when the temperature is 30 ^{0}C or more; don't walk transects during rain; don't walk transects on days without sun or on days with much wind, meaning 3 Beaufort or more.

Snakes

For snakes, including the European Glass Lizard (a limbless lizard), transects should be 2000 m long with a time limitation of two hours. There should be three transects next to each other (see fig. 6.10). Between each transect line is a distance of 10 m. The monitoring should be done with three persons at the same time. This increases the change to really see snakes during the monitoring. Otherwise animals easily escape without being noticed. Some five till ten locations/transects are recommended. During spring, the period for searching of adult snakes, each transect should be visit four times. Between each visit there is a period of fourteen days. During autumn, the search for juvenile snakes should be three visits and again fourteen days between every round.

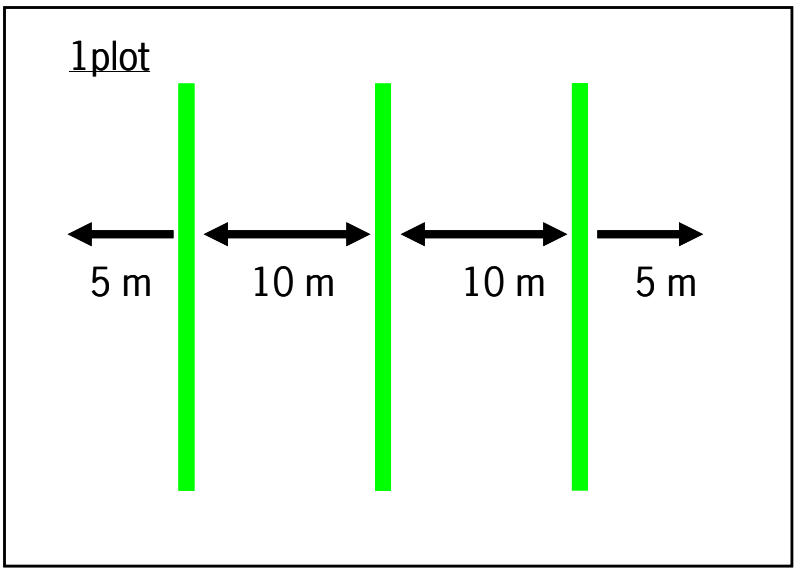


Figure 6.10
Overview of the necessary three transects for snakes.

Wall lizards

For wall lizards, the transect length is 200 m with a time limitation of 30 minutes. During monitoring one has to look 5 m at both sides of the transect. The monitoring can be done by one person per location. Some five till ten locations/transects are recommended. During spring time (the period for searching of adult lizard) four monitoring rounds are needed. There should be a period of fourteen days between every monitoring round. The autumn period (the period for juvenile lizards) is almost similar, except that three monitoring rounds are sufficient instead of four.

Geckos

For Geckos, transect length is 500 m with a time limitation of 45 minutes. And monitoring takes place in settlements. The monitoring can be done by one person per location. In the spring four round and in the autumn three rounds. Between every round is kept a period of fourteen days.

Recommendations

Try to make combinations. One transect can be good for several species. For example:

- For Cat Snake also look in (old) wells, dry walls and sandy/rocky roads;
- For Four-Lined Snake look in vegetation and settlements;
- For Leopard Snake look in both types (vegetation/rocks);

- The transect is situated in such a way that it includes the favourable sites;
- The transect isn't changed during monitoring;
- The transect is plotted on a field map.

Checklist field equipment and human resources

1. Monitoring protocol on reptiles including field forms (annex 6)
2. Container;
3. Gloves for handling snakes. Preference however is not to handle the snakes at all;
4. Field form. Croatian field forms (Janev Hutinec B, 2008 and annex 6) can be downloaded from the website of the State Institute for Nature protection[24];
5. GPS;
6. Camera;
7. Notebook and pencil.

[24] http://www.dzzp.hr/publikacije_knjige.htm#prirucnici Also available for downloading are several species sheets and manuals with overview of methods used for herpetofauna survey and monitoring in Croatian. All under number 13.3.

7 Amphibians monitoring protocol

Introduction

Croatia habituates no less than 20 amphibian species. The dry Kornati National park only has one: the Green Toad (table 7.1). It is unknown what the population size is, where the most individuals live and if the population is increasing or decreasing. In the past also the Common Tree Frog (*Hyla arborea*) was found in the ponds and waterholes for sheep in National Park Kornati. It's even described within brochures about the biodiversity of the park. It should be checked however if this species is still present.

Table 7.1
The only amphibian species currently known from the Kornati archipelago.

	HD Annexes		Croatian RL
Amphibian	II	IV	
Bufo viridis ≈ Epidalea viridis (European green toad / zelena krastača)		X	

The main causes that threaten amphibians are related to mismanagement (≈no management which leaves ponds to dry up), water pollution and the introduction of alien species, like cats on the islands of Kornati and release of gambuzia (*Gambus affinis*/rice fish in the ponds (fig. 7.1).


Figure 7.1
Predation by cats (left) may threaten the population of Green Toads, while Gambuzia fish are known to eat the tadpoles of the Green toad. Photo's: Theo van der Sluis (left) and Dušan Jelić (right).

Ecological characteristics

The Green Toad (fig. 7.2) can be found all around Croatia but is more common in dry areas (like Islands, Dalmatia, East Slavonia). The species measures up to 10 cm but is usually smaller; females are larger than males. It's a robust toad with prominent paratoid glands that are roughly parallel. Its pupil is horizontal.

Figure 7.2
Close up of a European Green Toad. Photo: Fabrice Ottburg.

Males sing at night in chorus, while sitting on the bank of breeding waters. There song is a rather high pitched trilled liquid 'r-r-r-r-r-r-r…'. It starts quietly and often lasts up to about ten seconds and may be repeated about four times a minute (Nicholas Arnold, 2002). Males spend quite long periods at the breeding ponds but females only lay their eggs and depart again. Spawning strings are 2-4 m in length. Eggs are arranged in 2-4 rows (fig. 7.3). The strings are deposited among aquatic plants or on the bottom of the pond. Tadpoles develop in about three to six days. Newly metamorphosed toads are about 1-1.7 cm long and mature in about three years (fig. 7.3). Green Toads are potentially long living creatures like other European toads (Nicholas Arnold, 2002).

Figures 7.3
A string of eggs at the bottom of a pond (left); a juvenile Green Toad (middle); and an example of habitat where Green Toads can be found (right). Photo's: Dušan Jelić.

Location of monitoring transects or plots

In the current situation (2009) there are three fresh water ponds known for the Kornati National Park (see fig. 7.4 and 7.5). In only one of them there is water during the whole year. This pond lies on the island Kornat. Another pond on Kornat lies in the field Tarac. This pond is dried up.

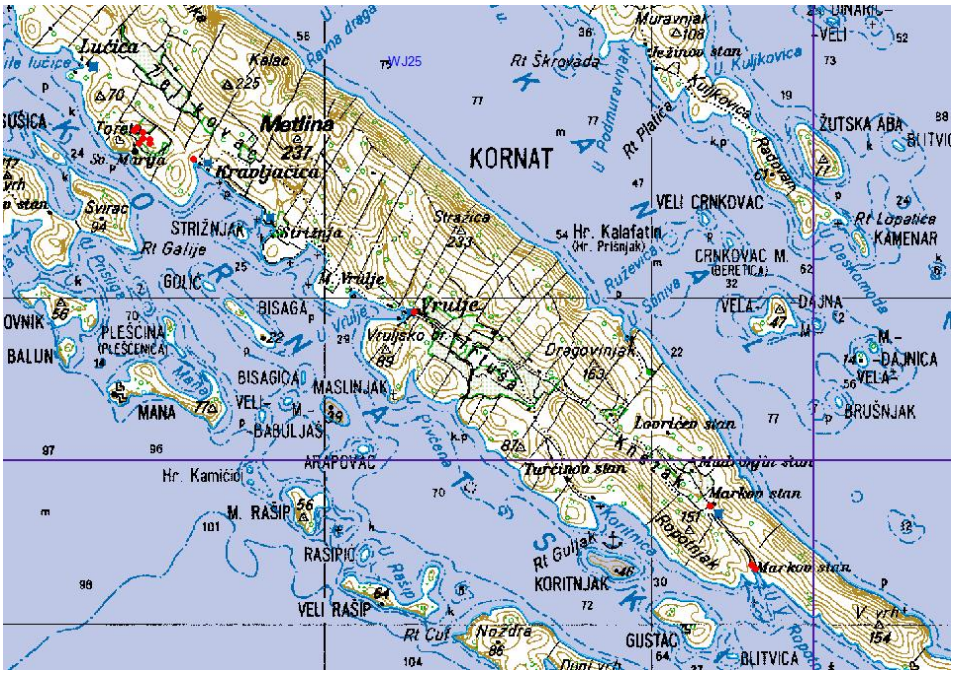


Figure 7.4

Locations where Bufo viridis was found on the islands of Kornat in 2009 (red spots).

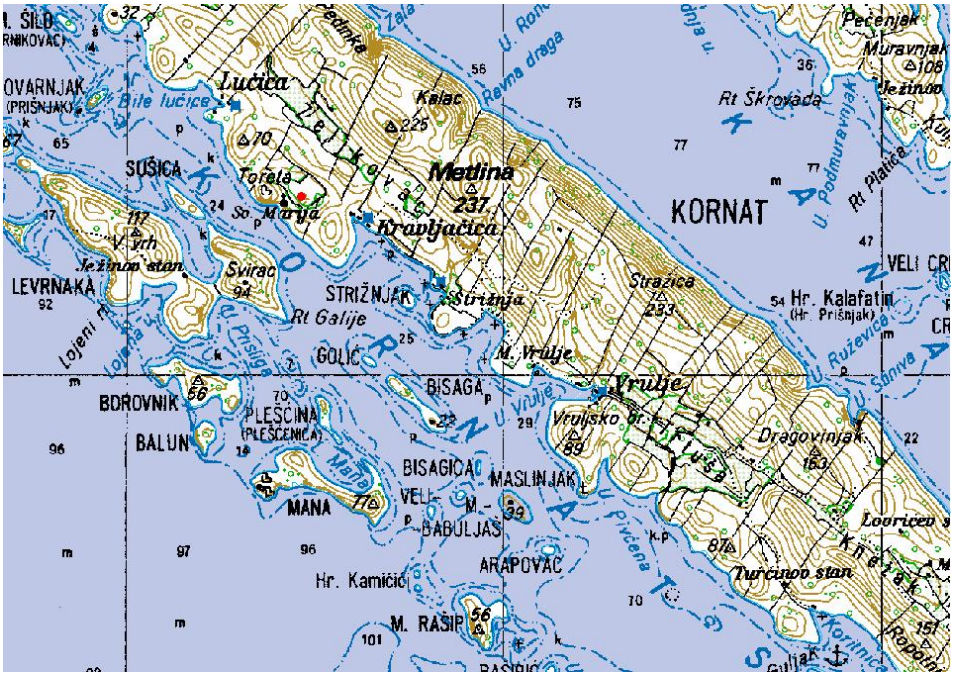


Figure 7.5

The red dot shows the pond on the island Kornat-Tarac.

The third pond is found on the island of Lavsa (fig. 7.6). In April it may contain some 50 cm of water in the middle after a good rain. In about two months the pond however can be completely dried up. To extent the population of the Green Toad it is necessary that those (former) ponds are restored. New ponds would stimulate the population of toads (as well as all other wildlife which depends on fresh water).

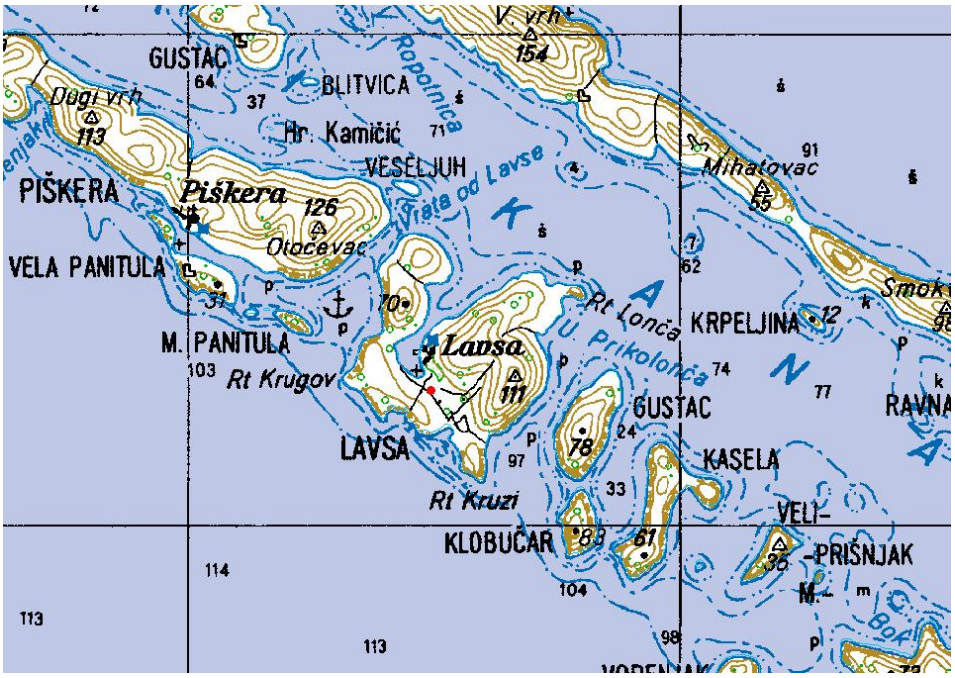


Figure 7.6

The red dot shows the pond on the island Lavsa, where no toads were found.

Monitoring schedule and method

Table 7.2 shows the inventory method during the season for the Green Toad. The four methods that can be used for inventory/monitoring are 1) counting calling males during the evening and night, 2) searching for eggs, 3) searching for larvae and 4) searching for juveniles late summer or early autumn.

Table 7.2

Inventory method during the season for the Green toad. Orange only when conditions are moistury.

Green toad (*Bufo viridis*)	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Calling males												
Visual observation eggs												
Visual observation larvae												
Visual observation juveniles												

Checklist field equipment and human resources

1. Monitoring protocol on amphibians including field forms (annex 6);
2. Net
3. Torch
4. Container
5. GPS
6. Camera

7. Field form. Croatian field forms (Janev Hutinec B, 2008 and annex 6) can be downloaded from the website of the State Institute for Nature Protection25
8. Notebook and pencil
9. Chest wader

[25] http://www.dzzp.hr/publikacije_knjige.htm#prirucnici

Acknowledgements

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For all those who feel they should be mentioned here as well, we apologize for not knowing but we hereby would like to thank them with the work and cooperation in this project.

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Annex 1 Overall monitoring schedule habitats and species

Summary of the preferred timing for monitoring of habitats and species in the Kornati Archipelago. Roughly marine habitats should be monitored once/2 years; terrestrial habitats once/3 years while species should preferably be monitored every year. For the number of monitoring rounds per year, please have a look at the monitoring protocols. Generally the rule of thumb is: the more monitoring, the more data, the better the result (though the level of disturbance due to monitoring remains acceptable).

	January	February	March	April	May	June	July	August	September	October	November	December
Marine habitats												
Code 1120: *Posidonia* beds (seagrass)												
Terrestrial habitats												
All terrestrial habitats												
Mammals												
Bats all species – Mist netting												
Bats all species – Summer roost survey												
Bats all species – Hibernacula survey												
Bats all species – Migration roost survey												
Bats all species – Bat transect												
Birds												
Anthus campestris / Tawny Pipit												
Hippolais olivetorum / Olive-tree Warbler												
Caprimulgus europaeus / Nightjar												
Lanius collurio / Red-backed Shrike												
Bubo bubo / Eagle owl												
Falco peregrinus / Peregrine falcon												
Ixobrychus minutus / Little bittern												
Rallus aquaticus / Water rail												
Phalacrocorax aristotelis / Cormorant shag												
Hirundo rustica / Barn swallow												
Larus michahellis / Yellow-legged gull												
Reptiles												
Testudo hermanni (Hermann's tortoise)												
Elaphe quatuorlineata (Four-Lined Snake)												
Zamenis situla (Leopard Snake)												
Telescopus fallax (Cat Snake)												

	January	February	March	April	May	June	July	August	September	October	November	December
Malpolon insignitus (Montepellier Snake)												
Hierophis gemonensis (Balkan racer)												
Pseudopus apodus (European Glass Lizard)												
Hemidactylus turcicus (Turkish Gecko)												
Podarcis sicula (Italian wall lizard)												
Podarcis melisellensis (Dalmatian wall lizard)												
Amphibians												
Bufo viridis (European green toad)												

Annex 2 Poseidonai oceanica field form

Posidonia oceanica **monitoring data sheet**

Location:

Date:

Researchers:

Shoot density :

min. depth	**1**	**2**	**3**	**4**	**/0,16 m²**
	6.25	6.25	6.25	6.25	**/m²**
10 m	**5**	**6**	**7**	**8**	**/0,16 m²**
	6.25	6.25	6.25	6.25	**/m²**
max. depth	**9**	**10**	**11**	**12**	**/0,16 m²**
	6.25	6.25	6.25	6.25	**/m²**

Transect lenght:

GPS locations of permanent station markers:

Lower depth limit:	
Upper depth limit:	

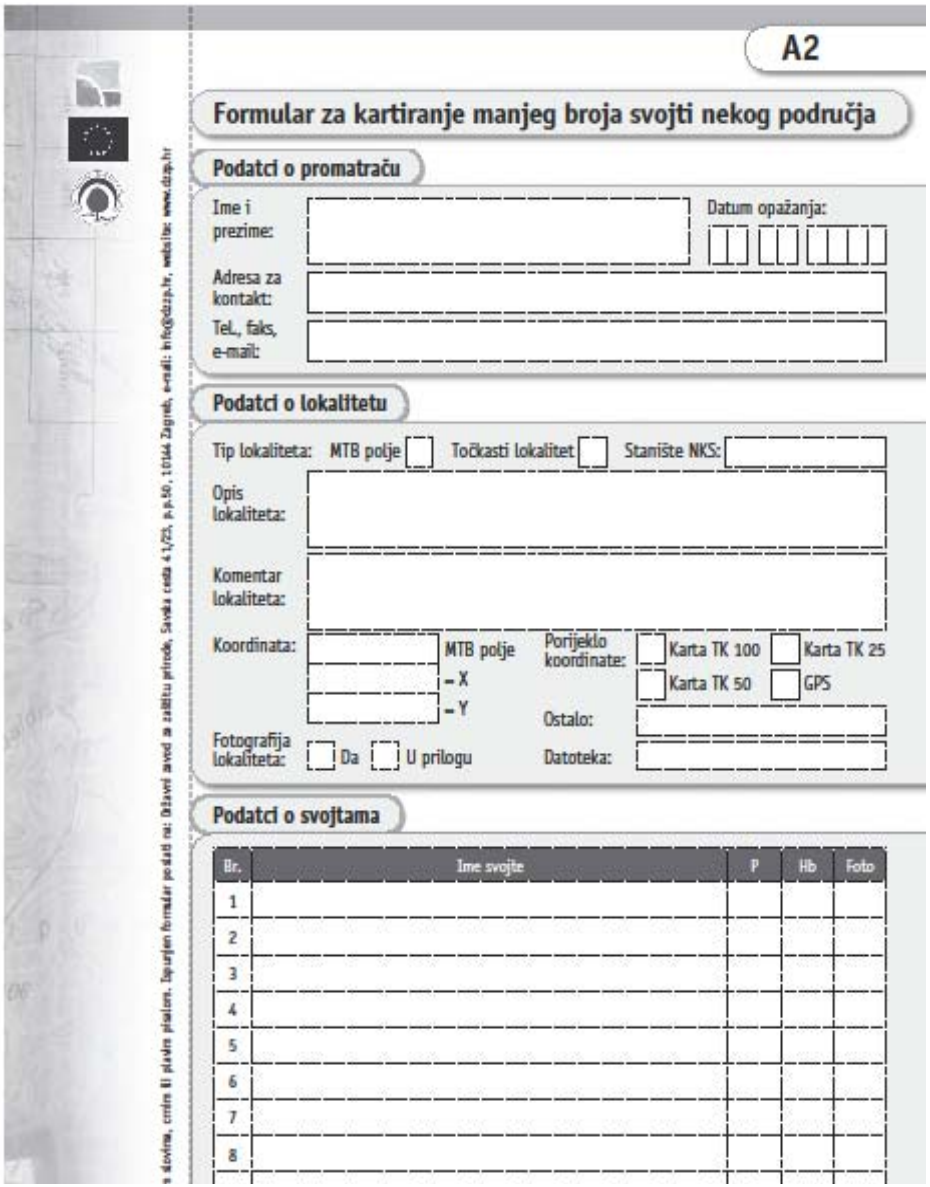
Comments:

Annex 3A Croatian field forms for vegetation relevees and terrestrial habitat mapping

This annex shows the Croatian language field forms for vegetation relevees (form A2 and A3) and terrestrial habitat mapping and monitoring (form B1 and B2). The forms are too specific to provide English versions. Therefore the forms are in Croatian language, while an English translation is provided.

A2 /A3 Form for mapping a small number of species of an area

Podatci o promatraču:	Data on the observer
Ime i prezime:	Name and owner
Datum opažanja:	Date of observations:
Adresa za kontakt:	Contact address
Tel., faks, e-mail:	Tel., Fax, e-mail:
Podatci o lokalitetu	Site data
Tip lokaliteta:	Type locality
MTB polje:	MTB field (= National network for habitat mapping; each field is 10'x6' big (or 12x11 km or 133km^2)
Točkasti lokalitet:	Point site
Stanište NKS:	Habitat NKS (NKS = National Habitat classification codes)
Opis lokaliteta:	Site description
Komentar lokaliteta:	Sites feedback
Koordinata:	Coordinates
Fotografija lokaliteta:	Photo sites
Da	Yes
U prilogu	Enclosed
Porijeklo koordinate:	Origin coordinates:
Karta TK 100	Topographic map 1:100.000
Karta TK 50	Topographic map 1:50.000
Karta TK 25	Topographic map 1:25.000
GPS	GPS
MTB polje	MTB field
Ostalo:	Other:
Datoteka:	Filename:
Podatci o svojtama	Data on taxa
Br.	No
Ime svojte	Name of species
P	P = assessment of population size of a certain species – for plants
Hb	Hb = herbarium specimen collected or not (for plants)
Foto	Photo



A2

Formular za kartiranje manjeg broja svojti nekog područja

Podatci o promatraču

Ime i prezime:

Datum opažanja:

Adresa za kontakt:

Tel., faks, e-mail:

Podatci o lokalitetu

Tip lokaliteta: MTB polje ☐ Točkasti lokalitet ☐ Stanište NKS:

Opis lokaliteta:

Komentar lokaliteta:

Koordinata: MTB polje – X – Y

Porijeklo koordinate: ☐ Karta TK 100 ☐ Karta TK 25 ☐ Karta TK 50 ☐ GPS

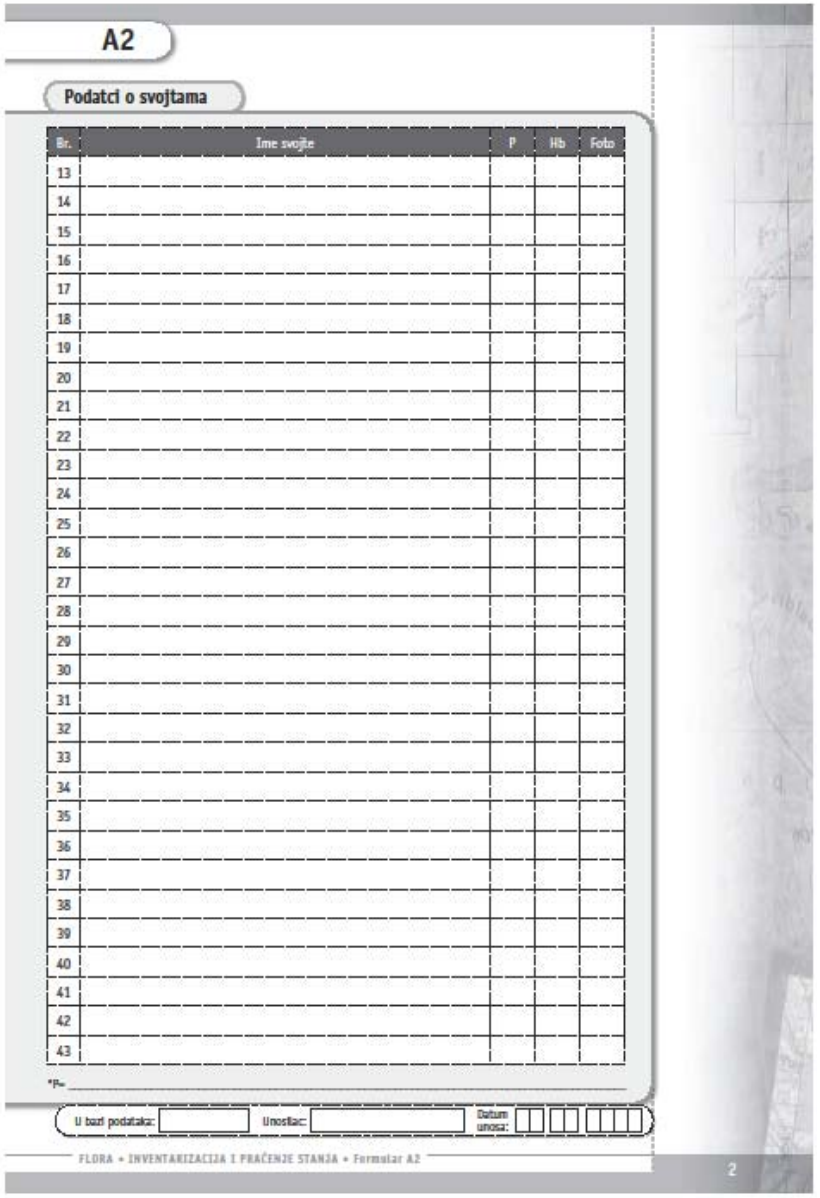
Ostalo:

Fotografija lokaliteta: ☐ Da ☐ U prilogu

Datoteka:

Podatci o svojtama

Br.	Ime svojte	P	Hb	Foto
1				
2				
3				
4				
5				
6				
7				
8				



A2

Podatci o svojtama

Br.	Ime svojte	P	Hb	Foto
13				
14				
15				
16				
17				
18				
19				
20				
21				
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23				
24				
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26				
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28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				

*P=

U bazi podataka: Unositac: Datum unosa:

FLORA • INVENTARIZACIJA I PRAĆENJE STANJA • Formular A2

2

A3

Formular za procjenu stanja populacije

Podatci o promatraču

Ime i prezime: | Datum:

Adresa za kontakt:

Tel., faks, e-mail:

Podatci o plohi

Tip plohe: ☐ Trajna ☐ Privremena Oznaka plohe:

Obilježena: ☐ Ucrtana na karti M 1: ☐ ☐ Drugačije

☐ GPS koor. uglova ☐ GPS koor. središta ☐ Klinovi ☐ Bojanje

Stanište NKS: ☐ Položaj odabran ☐ Slučajan ☐ Sistematski

Opis lokaliteta:

Komentar lokaliteta/plohe:

Površina plohe: ☐ Procijenjena ☐ Izmjerena m²

Fotografija lokaliteta: ☐ Da ☐ U prilogu Datoteka

Uzroci ugroženosti:

Podatci o svojtama

Br.	Svojta	Građa	Gustoća		Učestalost		P
			G1	G2	U1	U2	
1							
2							
3							
4							
5							
6							
7							
8							

Građa: 1-jedinka, 2-busenovi, 3-jastuci, 4-gomile; **P** – pokrovnost

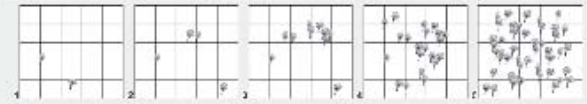
U bazi podataka: Unositelj: Datum unosa:

Molimo ispuniti čitko, velikim slovima, crnim ili plavim pisalom. Ispunjen formular poslati na: Državni zavod za zaštitu prirode, Služba za zaštitu prirode, 41/II, p.p.50, 10 144 Zagreb, e-mail: info@dzzp.hr, website: www.dzzp.hr

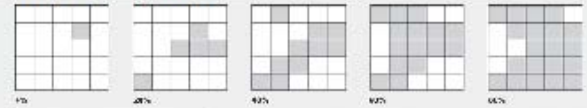
A3

Skica lokaliteta/plohe

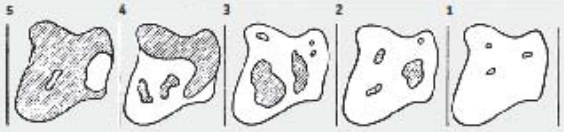
Procjena gustoće (G2)



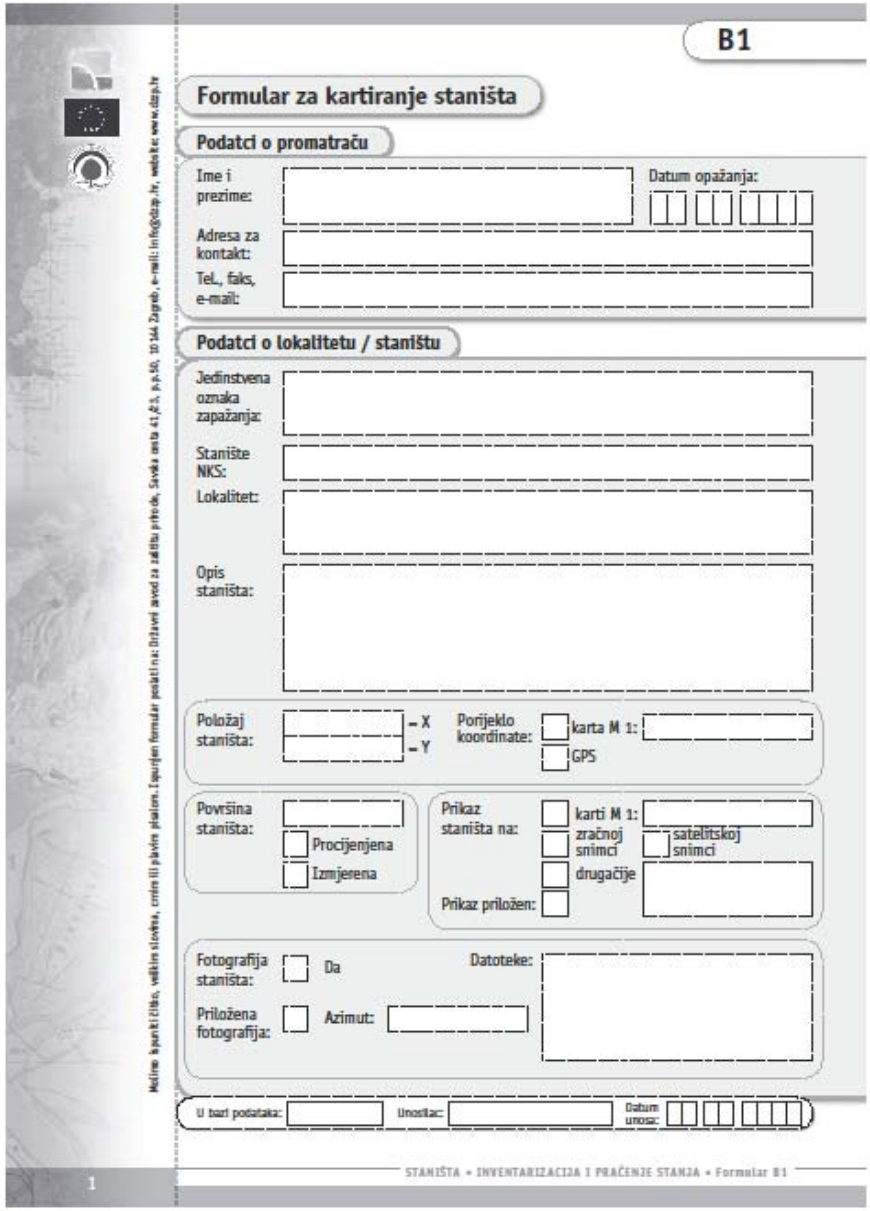
Procjena učestalosti (U2)



Procjena pokrovnosti (P)



B1 Form for mapping habitat	B2 Form to track habitat	B2 Data on taxa
Name and	Name and	In the database:
Date of observations:	Date of observations:	Date:
Owner:	Owner:	Input:
Contact address:	Contact address:	No - Name species - Braun-Blanquet Scale Level / Description 1. Plant is rarely present (up to ten copies of the surface and slight coverage) the number of copies of the same type more, but coverage is low (5 to 0%) 2. Plant is more numerous, or, regardless of the number of copies, covers (parts of the overhead projection surface soil) 0 to 25% surface 3. regardless of the individual plant covers 25 to 50% surface 4. regardless of the number of instances of coverage is 50 to 75% surface 5. regardless of the number of instances of coverage is 75 to 00% (r) sometimes used (rarus = rare) when plant occurs with very little coverage.
Tel., Fax, e-mail:	Tel., Fax, e-mail:	
Data on the observer	**Data on the observer**	
Data on the locality/habitat	**Data on the locality/habitat**	
Unique mark observations:	Locality:	
map M:	NCS Habitat:	
GPS coordinates:	Description Habitats:	
In the database:	State surfaces:	
Input date:	Random	
Locality:	Systematic	
NCS Habitat:	Permanent Surfaces:	
Description Habitats:	Marked on the map M:	
State Habitats:	GPS co. angles:	
Area Habitats:	Tagging surfaces:	Photo
Estimated Measured Display habitats to:	Select Area surfaces:	Habitats:
map M:	Measured	Attached To:
Air recordings:	Estimated	Azimuth:
Satellite recordings:	Temporary Surfaces:	Filename database:
Review attached:	Designation surfaces:	
Photo:	Wedges GPS co. center:	
Habitats:	Painting:	
Attached Characters:	Otherwise	
Azimuth:	N	
Files:	Sketch sites / plots:	



B1

Formular za kartiranje staništa

Podatci o promatraču

Ime i prezime:

Datum opažanja:

Adresa za kontakt:

Tel., faks, e-mail:

Podatci o lokalitetu / staništu

Jedinstvena oznaka zapažanja:

Stanište NKS:

Lokalitet:

Opis staništa:

Položaj staništa: – X – Y

Porijeklo koordinate: karta M 1: GPS

Površina staništa: Procijenjena Izmjerena

Prikaz staništa na: karti M 1: zračnoj snimci satelitskoj snimci drugačije

Prikaz priložen:

Fotografija staništa: Da

Priložena fotografija: Azimut:

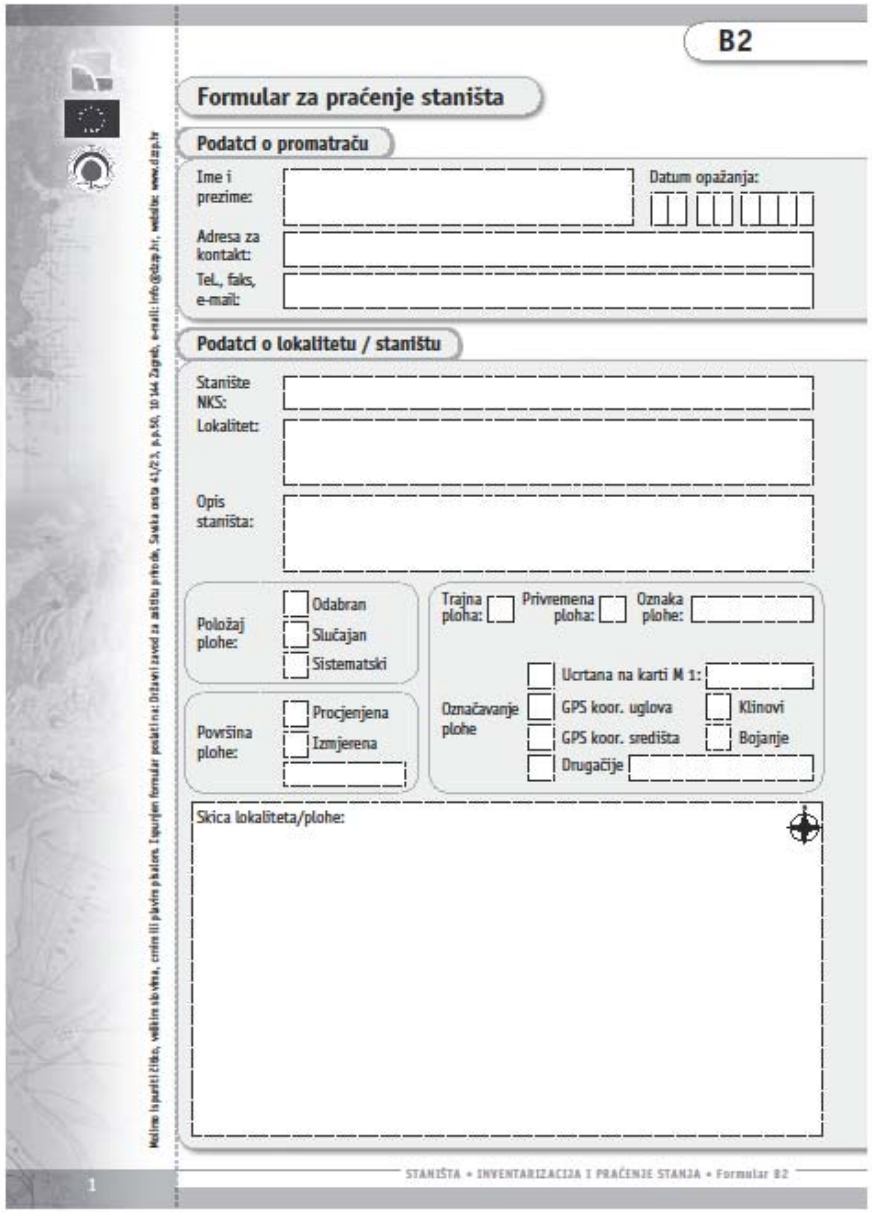
Datoteke:

U bazi podataka: Unositac: Datum unosa:

Molimo ispunite čitko, velikim slovima, crnim ili plavim plaštom. Ispunjen formular poslati na: Državni zavod za zaštitu prirode, Savska cesta 41/21, p.p.50, 10144 Zagreb, e-mail: info@dzzp.hr, website: www.dzzp.hr

STANIŠTA • INVENTARIZACIJA I PRAĆENJE STANJA • Formular B1

1



B2

Formular za praćenje staništa

Podatci o promatraču

Ime i prezime:

Datum opažanja:

Adresa za kontakt:

Tel., faks, e-mail:

Podatci o lokalitetu / staništu

Stanište NKS:

Lokalitet:

Opis staništa:

Položaj plohe: Odabran Slučajan Sistematski

Trajna ploha: Privremena ploha: Oznaka plohe:

Površina plohe: Procjenjena Izmjerena

Označavanje plohe: Ucrtana na karti M 1: GPS koor. uglova Klinovi GPS koor. središta Bojanje Drugačije

Skica lokaliteta/plohe:

Molimo ispunite čitko, velikim slovima, crnim ili plavim plaštom. Ispunjen formular poslati na: Državni zavod za zaštitu prirode, Savska cesta 41/21, p.p.50, 10144 Zagreb, e-mail: info@dzzp.hr, website: www.dzzp.hr

STANIŠTA • INVENTARIZACIJA I PRAĆENJE STANJA • Formular B2

1

B2

Podatci o svojtama

Br.	Ime svojte	P
1	Chouardia litardierei (= Scilla pratensis, ss. litardierei)	4
2	Sanguisorba officinalis	3
3	Potentilla erecta	3
4	Molinia caerulea	2
5	Centaurea jacea	2
6	Leontodon autumnalis	2
7	Lathyrus pannonicus	1
8	Succisa pratensis	1
9	Betonica officinalis	1
10	Trifolium montanum	1
11	Serratula tinctoria	1
12	Trifolium pratense	1
13	Taraxacum palustre	1
14	Carex distans	1
15	Allium angulosum	1
16	i dr.	
17		
18		
19		
20		
21		
22		

P: ______________________________

Ljestvica za kombiniranu procjenu brojnosti i pokrovnosti jedinka prema Braun-Blanquetu

Stupanj	Opis
+	biljka je rijetko zastupljena (do nekoliko primjeraka na plohi i neznatne pokrovnosti)
1	broj je primjeraka bilo vrlo veći, ali je pokrovnost mala (5 do 10%)
2	biljka je mnogobrojnija ili, bez obzira na broj primjeraka, pokriva (projekcijom nadzemnih dijelova na površinu tla) 10 do 25% površine
3	bez obzira na broj individua biljka pokriva 25 do 50% površine
4	bez obzira na broj primjeraka pokrovnost je 50 do 75% površine
5	bez obzira na broj primjeraka pokrovnost je 75 do 100% površine
(r)	ponekad se koristi i slovo „r" (rarus = rijedak) kad je biljka na plohi samo pojedinačna, a ima vrlo malu pokrovnost

Fotografija staništa: [X] Da U prilogu: [X] Azimut: 35° Datoteka: Kolin-potok-01.jpg

U bazi podataka: Unosilac: Datum:

Annex 3B EBONE field form for Annex I Habitats

Below gives an example of an EBONE-field form and description of codes. The EBONE manual is still under construction and will be published on the EBONE-website[26]. Field forms and manuals are expected to be downloadable at time of publication.

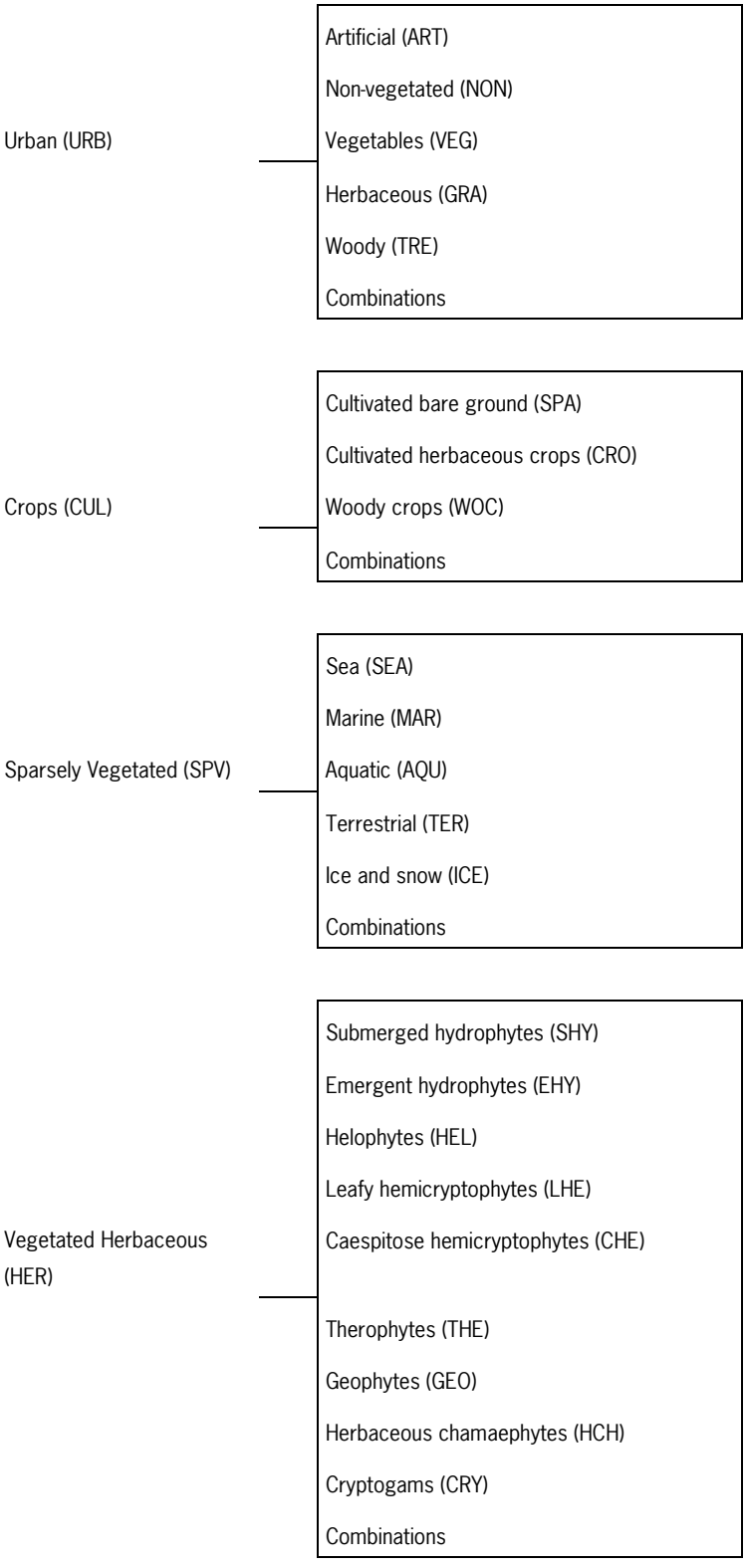
Square name: **Observer:** **Date:**

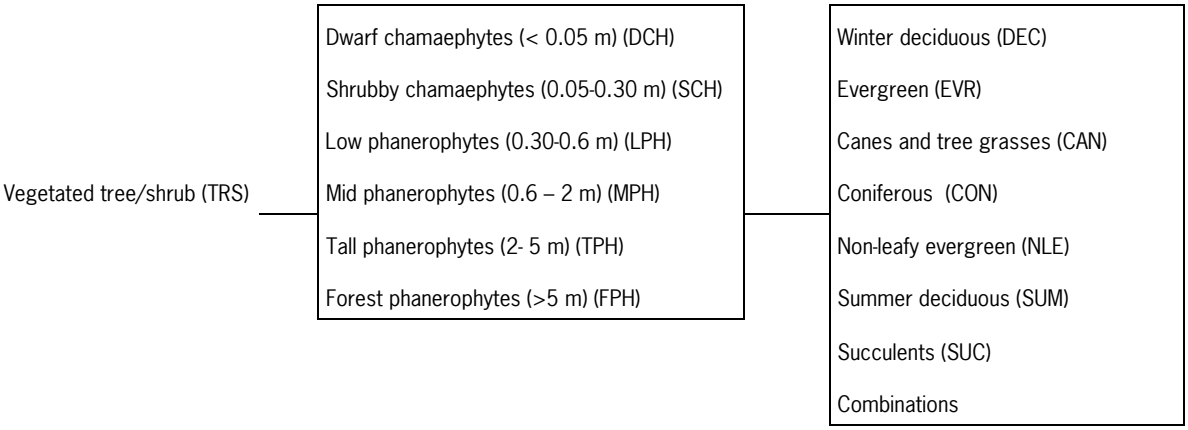
code	Field 1	Field 2	Field 3	Field 4	Field 5				Field 6	Field 7	Field 8
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Man. Qualifier	Life form/Species				Pan Europ class	Regional-Class	Phyto-socio-logy
					Life form	%	Species	%			
A	TPH/DEC/CON	NEW	0	421	TPH/DEC	20	Sor auc	80	-1	-1	-1
		5.3		429	TPH/CON	10	Pic abi	100			
					MPH/EVR	60	Rub fru	100			
					FPH/CON	10	Pic abi	100			
B	FPH/CON	5.3	0	423	FPH/CON	100	Pic abi	50			
				425			Abi alb	50			
				347							
C	CHE/LHE	5.3	0	416	CHE	60	Lol per	80			
					LHE	40	Tri rep	80			
D	CHE	5.3	0	416	CHE	80	Lol per	40			
					LHE	20	Tar off	10			
E	WOC	0	0	329	WOC	80	5 2 0	100			
					CHE	20	Lol per	80			
F	ART	0	0	357	ART	80	0				

[26] http://www.ebone.wur.nl/UK/

code	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	code	Field 1	Field 2
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Man. Qualifier	Life form/ Species	Pan Europ class	Regional-Class	Phyto-socio-logy	α	General Habitat Category	Global/ Env. Qualifier
					GRA	10	0				
					VEG	10	0				
G	CHE	5.3	0	329	CHE	80	Lol per	90			
				369	LHE	20	Tri rep	50			
				416							
H	CHE/LHE	5.3	0	418	LHE	30	Tri pra	10			
					CHE	70	Fes rub	10			
J	CHE	5.3	0	0	LHE	20	Ran acr	10			
					CHE	80	Lol per	50			
K		NOL	0	450	0		0				

Unique Codes/Species Numbers			
	450: Canopy now closed	C=5	D=4
G=6	H=14	J=8	


Urban (URB)
Artificial (ART)
Non-vegetated (NON)
Vegetables (VEG)
Herbaceous (GRA)
Woody (TRE)
Combinations
Crops (CUL)
Cultivated bare ground (SPA)
Cultivated herbaceous crops (CRO)
Woody crops (WOC)
Combinations
Sparsely Vegetated (SPV)
Sea (SEA)
Marine (MAR)
Aquatic (AQU)
Terrestrial (TER)
Ice and snow (ICE)
Combinations
Vegetated Herbaceous (HER)
Submerged hydrophytes (SHY)
Emergent hydrophytes (EHY)
Helophytes (HEL)
Leafy hemicryptophytes (LHE)
Caespitose hemicryptophytes (CHE)
Therophytes (THE)
Geophytes (GEO)
Herbaceous chamaephytes (HCH)
Cryptogams (CRY)
Combinations



Diagrammatic representation of the BioHab key.

Annex 4A Bats mist netting field form

Page _____

Location _____ Date _____
Personnel _____

Time net opened _____: Air temperature _____ Humidity (%) _____ Wind speed _____

Time net closed _____ : Air temperature _____ Humidity (%) _____ Wind speed _____

Moon phase _____ Cloudy (%) _____ # of nets _____ (Sketch on back)

#	Time	Species	Net #	Age	Sex	Reproductive status	FA (mm)			Weight (g)			Additional measurements and notes
										W+b	b	W	

Additional measurements should be taken depending the captured species: *Myotis blythii*: ear lenght; *Plecotus sp.*: hind foot and tibia length, tragus length and width, length of the upper tooth row. Sex: F=female, M=male, N=unknown; Age: A=adult, J=juvenile; Reproductive status: P=pregnancy, L=lactation, N=unknown, T=pronounced testicles
FA-forearm length, W-weight, b-bag weight

Annex 4B Bats underground object survey field form

Name of object _____ Date _____ Page _____

Personnel_____

Description of the object:

Type of object (cave/pit) _____ Coordinates _____

Air temperature: inside _____ entrance _____ outside _____

Humidity: inside_____ entrance _____ outside _____

Additional notes: _____

Species	Determination method	Size estimation (m^2)	Position of the colony or individuals	Additional notes

Remaining (guano, skeletal remains etc.) _____

Captured individuals (when it is not the case of hibernating or maternity roost that mustn't be disturbed)

#	Time	Species	Age	Sex	Reproductive status	FA (mm)			weight (g)			Dodatna zapažanja i mjere
									W+b	b	W	

Additional measurements should be taken depending on captured species: *Myotis blythii*: ear lenght; *Plecotus sp.*: hind foot and tibia length, tragus length and width, length of the upper tooth row. Sex: F=female, M=male, N=unknown; Age: A=adult, J=juvenile; Reproductive status: P=pregnancy, L=lactation, N=unknown, T= pronounced testicles FA-forearm length, W-weight, b-bag weight.

Annex 4C Bat detector transect field form

Location _____ Date _____

Personnel _____

Habitat:_____

Time start of the transect _____ : Air temperature _____ Humidity (%) _____ Wind speed _____

Time finish of the transect _____ : Air temperature _____ Humidity (%) _____ Wind speed _____

Moon phase _____ Cloudy (%) _____

#	GPS coordinates, START	GPS coordinates, END	Transect Lenght/ m	Transect duration/ min	Number of stop points

Annex 5 Birds field form

Currently the State Institute for Nature Protection is in the process to develop a standard field form for bird monitoring. So far, it's recommended to use the A2 field form for mapping a small number of (flora!) species of an area (pers. commend T. Mikuska; Croatian Society for Protection of Birds and Nature). See annex 3A.

Annex 6 Reptiles and amphibians field form

Form for the inventorying and mapping of amphibians and reptiles of Croatia F1												
Data about the observer:									Number:			
Name and surname:									Date of the observation:			
Contact person:												
Address:									Telephone:			
									e-mail			
Locality data												
Locality:												
Short description of the locality:												
Photography of the locality:			Appendix						File number			
Origin of the coordinates:			GPS		TK100				TK 50		TK25	Other (fill in)
Weather:												
Observation time:			From:						Until:			
Data about taxa												
Research methods:				1. accidentally			2.observation				3. road observation method	
				4. confirmed vocalization			5. caught by hand				6. caught by net	
				7. caught by loop			8. caught by trap				9. other (fill in)	
Other:												
Species	Number of individuals	Age	Coordinates						Photography number			
			X		Y		Z					
Note:												
In database:			Input person:									
			Date of input:									

Form for the monitoring of amphibians and reptiles on specific area in Croatia F2									
Data about the observer:							Number:		
Name and surname:							Date of the observation:		
Contact person:									
Address:							Telephone:		
							e-mail		
Locality data							Coordinates		
							X		
Locality:							Y		
Short description of the locality:							Z		
							UTM		
Photography of the locality:	Appendix						File number		
Origin of the coordinates:	GPS		TK100		TK50		TK25		Other (fill in)

Aquatic habitat:			**Terestric habitat:**			
(including the presence of nearby waters)						
Flowing water:			**Slope**		1-flat	3-steep
No flow		0- doesn't mach			2-middle slope	
		1-spring	**Exposition**		1. S	5. N
Slow flow		2-stream			2. SW	6. NE
		3- river			3. W	7. E
Fast flow		4- channel			4. NW	8. SE

Aquatic habitat:		**Terestric habitat:**	
Still water		**Substrate**	1- stone or rocks
With affluent	0- doesn't mach	2-peebles	4-humus/earth
Without affluent	1- mach	3-sand	5-clay
Unknown			

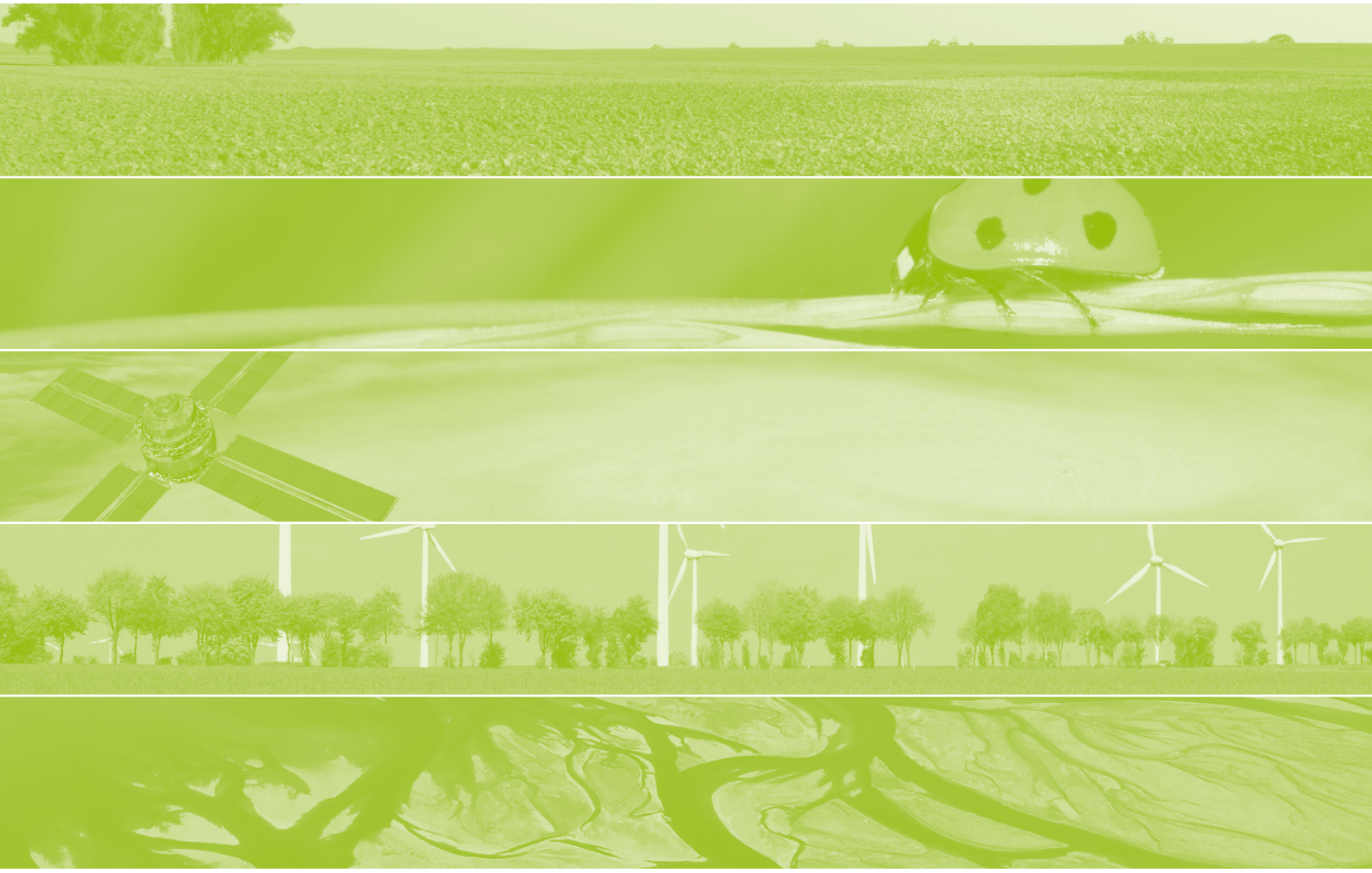
Type	1-lake	8-channel	**Type**	0-bare areas	10-yard, garden
	2-gravel digging	9-swampy meadow		1-dry grassland	11-scrub
	3-accumulation	10-swampy forest		2-wet grassland	12-hardwood forest
	4-fish pond	11-flooded area		3-meadow with bushes	13-coniferous forest
	5-pond	12-well		4-rocky grassland	14-mixed forest
	6-wheel pond	13-other		5-Coppiced wood[27]	15-swampy forest
	7-cret			6-rocky	16-park
Size: ___ x ___ m or _____ m^2				7-orchard	17-settlement
				8-arable land	18-other (fill in)
Depth:	1- <30 cm			9- vineyard	
2- 30-100 cm	3- >100 cm	4-unknown	**Microhabitat ***		
Description:			1-embankment/dam		10-trees by the river

[27] Coppiced wood develops after cutting mixed oak and chestnut forest on very acid and clay soil. Coppice is used as pasture (or for honey bees), if grazing is abandoned it develops into scrubland. Characteristic species are: Common Heather (*Calluna vulgaris*), Silkyleaf Woadwaxen (*Genista pilosa*), Chiltern gentian (*Gentianella germanica*), Winged Broom (*Chamaespartium sagittale*) and Bracken (*Pteridium aquilinum*).

Substrate			2-pebbles	11-forest edge/clearing
1-sand or pebbles	5-dirt/earth		3-rock	12-cut trees
2-rock	6-concrete		4-tree	13-pile of branches
3-mud	7-plastic		5-path edge	14-grove
4-leaves	8-plants (algae, grass)		6-canyon	15-building
Durability			7-stone wall	16-path/country road
1-temporary	2-permanent	3-unknown	8-hedge	17-asphalt road
Pollution			9-stone pile	18-cave entrance
1-unnoticable	2-polluted	3-very polluted	19- other (fill in)	
Water vegetation			**Vegetation density**	0-missing
1-no vegetation	2-medium	3-dense	Green plants	1- <20%
Structure of vegetation			Bushes	2- 20-80%
1-horizontal, on water surface	2-submerged, in water column		Trees	3- >80%
3-vertical, partially out of water	4-combination (1+2+3)		**Locality photo**: 0-doesn't exist; 1-exist	Photo: Appendix:
Shore *	3-pebbles		File name (photo):	
1-steep	4-sand, mud		**Space usage ***	
2-shallow coastal zone	5-with vegetation		1-not visible	8-stone pit
			2-garden/park	9-fishpond
Locality photo			3-agriculture	10-cemetery
Photo:	0-doesn't exist		4-cattle grazing	11-sport/recreation
Appendix:	1-exist		5-mowing meadow	12-urban use
File name:			6-protected area	13-military area
			7-forestry	14-other (fill in)
* Several values can be chosen				
In database:	Input person:		Date of input:	

Threatened		**Threats ***	
0-not visible	3-severely	1-road construction	9-afforestation
1-slightly	4-habitat destroyed	2-industry	10-change of space use
2-medium		3-urban area	11-fertilizing/pesticides
		4-drainage system	12-succesion
		5-waste	13-intensive agriculture
		6-melioration	14-traffic
		7-chanelled watercourse	15-alien species
* Several values can be chosen		8-tourism	16-other (fill in)
Species data			
Research method	1-accidentally	4-noting of calls	7-caught by loop
	2-observation	5-caught by hand	8-caught by trap
	3-road observation	6- caught by hand	9-other (describe)
	Other:		
Previous observation	0-non-existent	1-exist	FORM NO:

SPECIES	NO OF SPECIMENS						PHOTO NO	DATE	NOTE
	AD	MM	FF	juv	larvae	eggs			



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