

Gathering of fungi as a tool for biodiversity conservation

Plitvice Lakes National Park - Croatia



Alfred Toepfer Natural Heritage Scholarships

Study tour report

Eduardo Batista - 2017



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Abstract

The Plitvice lakes National Park is well known worldwide for the unique lakes and waterfalls. The fauna and flora of the park enrich even more the uniqueness of this protected area. With almost 1500 plant taxa and with a rich local animal life, the Plitvice National Park is an example of environmental education for more than one million visitors per year.

With this study visit I aimed to understand how the macro fungi community can help to enrich the educational value of the existing trails in the park and what a normal visitor can expect and learn from the mycological resources.

To do that during eight days, all the existing trails were analysed based on an evaluation framework and five patches are discussed regarding the mycological interest and recommend management practices.

In the five selected trails, 45 different macro fungi species were identified and with this visit I expect to raise the awareness of local staff and visitors to the mycologic resources existent on the park as well to create a framework of discussion for new management and conservation practices respecting the fungi biodiversity.

Introduction

The fungi erstwhile nominated as “Type of Plant” nowadays belong to the Fungi Kingdom. This kingdom of eukaryotic beings, houses a huge diversity of organism, which include the mushrooms, the moulds and yeasts. It’s estimated that only in Europe exist at least 75.000 species of which 15.000 can generate sporocarps also known as mushrooms. Depending on other organisms for carbon, fungi can be saprophytes, mutualists and parasites. In the mutualists group are include one of the most important symbiotic relations, the mycorrhizal fungi living together with vascular plants. In forest management, mycorrhizal associations are used to improve the forest sustainability. With commercial and non-commercial value fungi gathering in Europe is a resource for food, medicine, ornaments, genetics and others.

In 2007, the European Council for Conservation of Fungi (ECCF) presented a document entitled “Guidance for the Conservation of Mushrooms in Europe” where were evaluated the efforts to identify and report conservation actions of the European macro fungi community. According to this document most European countries have produced fungal Red-list and more than 5 500 different macro fungi are red-listed in at least one European country. These numbers show us that 10-20% of European mushrooms may be threatened, putting the fungi conservation as a priority.

This project was writing based on the “European Charter on Fungi- Gathering and Biodiversity -2013” prepared by Mr Scott Brainerd and Ms Sarah Doornbos on behalf of the Bern Convention with the main objective to ensure that the gathering of fungi in Europe is practised in a sustainable way based on the conservation value of biodiversity and the needs of society.

General objectives:

- Monitoring, mapping and inventory the macro fungi community of Plitvice Lakes National Park.
- Correlate different flora habitats with macro fungi abundance and diversity for research purpose improving the list of European species.
- Promote cooperation between gatherers, general population and stakeholders in the conservation and management of fungal biodiversity.
- Promote education, awareness and information measures directed to the public.

Outputs evaluation:

The main outputs of this project are divided by three different fields: Conservation; Education and Recreation; Strengthening the local community.

At the end of project, it will be expected that the follow objectives will be achieved:

1 – Conservation

- Elaboration the fungi check list of Plitvice Lakes National Park.
- Draw up the “Guide for best practices of fungi gathering and conservation” for each conservation zone.
- Share and implement the Guide for Best practices of fungi gathering and conservation in others EUROPARC members.

2 - Education and Recreation

- Draw up an identification guide for the most relevant species.
- Mapping hot spots of fungi population to be include on the existing visitor system.
- Mycology tour during the highly season for visitants.
- Set a photographic exhibition of “Fungi from Plitvice Lakes National Park”.
- Release all the information achieved for all EURPARC members.

3 - Strengthening the local community

- Draw up “Guide for forest management and fungi utility for locals”
- Set up a study group of local students to secure the continuation of this work.
- Open day with Hands on activity’s for mushrooms gathering.

Study area

Plitvice Lakes National Park

The Plitvice lakes was officially proclaimed as National Park in 1949 and is part of the UNESCO World Heritage List since 1979. Being the oldest national park in Croatia, the Plitvice park is recognized worldwide by the exceptional natural lakes and waterfalls that cross the inland mountain region of Croatia.

With a specific geological and hydrological karst landscape is possible to observe sixteen lakes interconnected with foaming cascades and waterfalls. However, the lakes and waterfalls are only one part of the extraordinary things that we can find here. Over the time, almost 1500 plant taxa have been recorded with many endemic and rare species like the rayflower (*Ligularia sibirica*) and the round-leaved sundew (*Drosera rotundifolia*). On the forest level, is impossible to not enjoy the beech and fir forest and many other tree species that serve as house to the four large carnivores in the region: brown bear, lynx, wolf and wild cat. In a smaller scale, other animals may attract the curiosity of the visitors like the Italian crested newt (*Triturus carnifex*), the striped field mouse (*Apodemus agrarius*) or the whiskered bat (*Myotis alcaethoe*) that in Croatia can be only founded here.

Along the park the cultural and architectural heritage is characterized by several house yards, hamlets and memorial sites. The park provides also several infrastructures like hotels and restaurants that allow the visitor to have an enjoyable experience.

The management division of the park has the vision to be a “national leader in the conservation and promotion of unique natural and cultural resources in their valorisation by means of sustainable tourism to the benefit of the region and local communities and to the satisfaction of visitors”.

During this study visit, it was notorious the effort of the management division in promoting good practices of conservation, education/recreation and to reinforce the cooperation with local communities. The Plitvice lakes national park is a great example of good practices inside protected areas and deserve the international attention on the future management challenges.

Methodology

To analyse the pedagogical and recreational potential for activities with a mycological interest to visitors, it was defined a framework of criteria's and indicators to keep a uniform description of each trail. This framework only reflects my own experience in the trails and tries to quantify several indicators that I feel are essential to offer a good experience to the visitors. Also, this framework only reflects the trails from a mycologist view and other indicators could and must be used with different proposes. Is not my objective to create a specific trail with a mycological interest because most visitors are only interested to observe the lakes and waterfalls. Although this framework can be an interesting tool to adapt the existing trails and to improve the staff knowledge. The framework is described in table 1 and each criterion will be analysed below.

Trail experience is the most limiting factor on this list. Is important to choose a trail that the visitor can easily do without affecting the recreational experience. Not all visitors share the same adventurous spirit and for a better “knowledge diffusion” is important to have an enjoyable experience.

The **trail duration** defines the number of topics that can be explored during the trail. Although for a normal visitor 2-3 hours' contact is enough other enthusiastic visitors may require a longer experience.

Mushroom interest – There are several ways to explore the topic “Mushrooms”. In my opinion for the general public is important to divide them by feeding strategy: saprophytes, mutualists and parasites. Along the trail, mushrooms with different feeding strategies allows several discussions. The saprophytes fungi are responsible to decompose organic matter by extracellular digestion and the final products can be absorbed again by plants. This process can be affect by several factors like: temperature, Ph, level of water and oxygen. The Mutualists are those that can maintain a beneficial relationship with other living beings. (i.e, Mycorrhiza and lichens). Parasites are fungi that uses as a source of food live tissues from other organisms, some of them can be even pathogenic and cause plant diseases.

Taxonomic interest – Most macro fungi species require more details techniques to identify the exact species taxa (i.e spore analyses and others). However, it may be easier to reach the family taxa only with a morphological observation.

Mushroom potential – To keep a balanced visit with different stops along the trail is important to have a good distribution of mushrooms over the trail. In general, for 30 minutes of walking the number of mushrooms observed can serve as a good indicator. The idea is to not overload the visitor with a lot of information in one period but to allow the visitor to assimilate the different species and functions through the trail.

The **fungal biodiversity** can be stimulated with some management practices. For example: stands with dominant plant species in the tree and grass layer tend to have less diversity of mushrooms. Also, the removal of dead trees reduces the amount of organic matter available for decomposition.

General interest for recreation – as mention before is not my aim to create a specific trail for mycology activities and the experience of hiking a trail should incorporate different the components of nature, landscape and cultural heritage.

These indicators may be target of changes, is important to mention that one season experience do not reflect the diversity and abundance of mushrooms over the year. A trail evaluated with low potential for mushrooms in autumn can have a high potential in spring. For a concise analyses this framework should be used at least once per season. A good macro fungi description requires long term studies (minimum 2 years).

The trails evaluation took placed between 22nd and 30th October 2016 and all trails were done although I will only present 5 examples. Macro fungi were identified in situ and photographic record was performed. The following suggested trails are part of existing paths and to diversify the offer to different types of visitors sometimes only a stretch was analysed.

In annexes a list with all species per trail is present as well with a photo description. For some specimens was not possible to found the species taxa and for that reason it was described as unknown sp.

Table 1 – Description of the evaluation criteria used to describe and compare the hiking trails in the Plitvice Lakes National Park.

Criteria	Evaluation	Indicators	Description / examples
Trail experience	Hard	More than 10km with difficult accessibility	(i.e Fallen trees on trails) It is required to have a clear path.
	Medium	Between 5 and 10 km	
	Easy	Less than 5 km	
Duration of the trail	Long	More than 4 hours	
	Medium	Between 2 and 4 hours	
	Short	Less than 2 hours	
Mushroom interest	High	3 different types of feeding strategy	i.e. Mycorrhizal, Saprophyte or Pathogen
	Medium	2 different types of feeding strategy	
	Low	1 different types of feeding strategy	
Taxonomic interest	High	More than 10 different taxonomic families	
	Medium	Between 5 and 10 different taxonomic families	
	Low	Less than 5 different taxonomic families	
Mushroom potential	High	More than 10 macro fungi per 30 min of walking	
	Medium	Between 5 and 10 macro fungi per 30 min of walking	
	Low	Less than 5 macro fungi per 30 min of walking	
Biodiversity potential for fungi	High	At least three co-dominant tree species and at least 10 dead trees along the trail	
	Medium	At least two co-dominant tree species and at least 10 dead trees along the trail	
	Low	One dominant tree species	
General interest for recreation	High	At least three different types of landscape	i.e. coniferous forest, grassland, lakes view
	Medium	At least two different types of landscape	
	Low	One type of landscape	

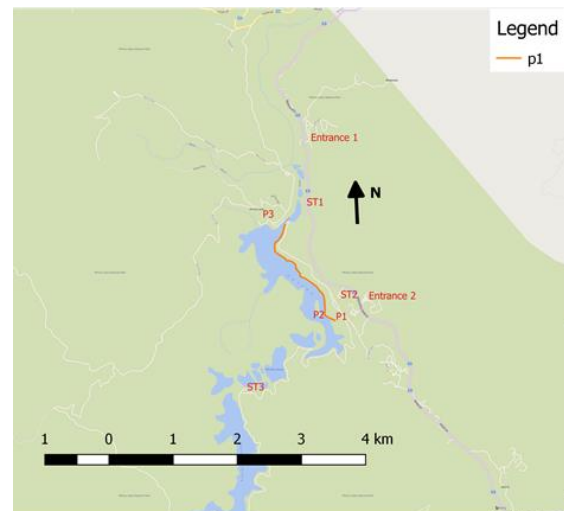
Results

Trail P1

The trail number one is the shortest trail with the easiest hiking experience, recommend to people not used to big walking distances. It can start in both entrances, one or two, and goes over the margin of the Jezero Kozjak lake. The forest cover near this trail is very rich and diversify with tree species like the European beech, the common maple, the sticky alder, the common spruce, oaks and others. There is a considerable amount of dead wood near the trail that allows several saprophytic and parasite fungi to grow. Is possible to find mushrooms like *Fomes fomentarius*, *Hypholoma fasciculare* and many others.

For mycorrhizal fungi, it was only found *Laccaria laccata*, it's possible that due to the end-season period other mycorrhizal species were not found but are present. However, it may be an easy solution to preserve and improve the natural regeneration of *Quercus petrea* to increase the chances of having more mycorrhizal fungi nearby.

This trail is a very good path for mycological observations and the visitors can combine the magical view of Jezero Kozjak with a full hand of mushroom observations.

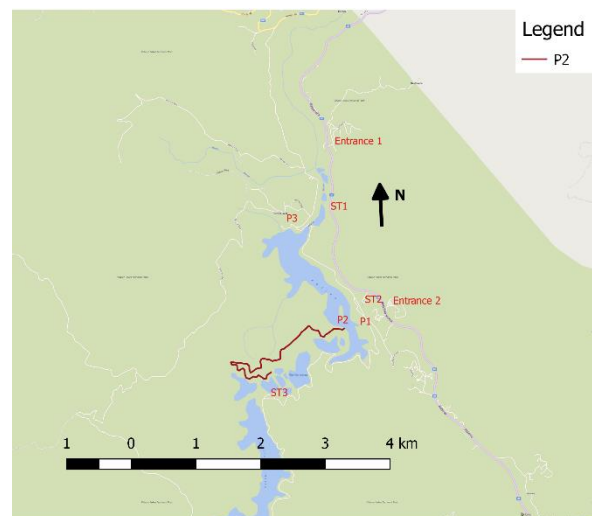


Criteria	Evaluation
Trail experience	Easy
Duration of the trail	Short
Mushroom interest	High
Taxonomic interest	Medium
Mushroom potential	High
Biodiversity potential for fungi	High
General interest for recreation	Medium

Trail P2

The trail number two is perfect for new enthusiastic hikers that want to test their capacities and have an enjoyable experience in Plitvicka Jezera. With a high interest for visitors willing to learn more about the fungi world is possible to observe mushrooms with the three different feeding strategies. In the mycorrhizal category, the visitors can observe species from different genera like *Russula*, *Lactarius* and *Ramaria*. In the saprophytic category, the lucky visitors can have the opportunity to observe the amazing *Hericium Coralloides* usually growing in dead wood. Also in the parasitic category, the *Fomes fomentarius* is a constant presence in this trail.

From a management perspective, this trail can be optimized because it offers a good alternative for visitors that want to avoid the busy trails around the lakes without losing the opportunity to observe the waterfalls and lakes. *Fagus sylvatica* is the dominant tree species in this trail. In the grass layer, it seems that *Festuca sp* is having an invasive behaviour. It's recommend to analyse if there are any biodiversity constraints when these two species are together. To increase the number of visitor in these trails should add a map suggestion with good spots for photography and more educative boards along the trail.

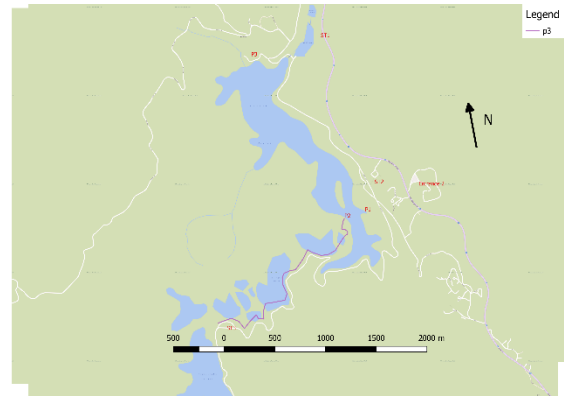


Criteria	Evaluation
Trail experience	Medium
Duration of the trail	Medium
Mushroom interest	High
Taxonomic interest	High
Mushroom potential	Medium
Biodiversity potential for fungi	Medium
General interest for recreation	Medium

Trail P3

The trail number three goes from ST3 to P2 passing through the lakes Bationovac, Galovac and Gradinsko. Is a trail with a medium recreational value and in general with a low potential for mushrooms observations. The unique species observed are *Hypholoma fasciculare* and *Fomes fomentarius*, that are also common in other trails. This low score in general it may be explained by the low amount of dead wood near the trails and by the low diversity of trees.

Increasing the amount of dead wood near the trails it's a solution although when compared with the existing fungi biodiversity in other trails there is no add value in advertise this trail with a mycological interest.



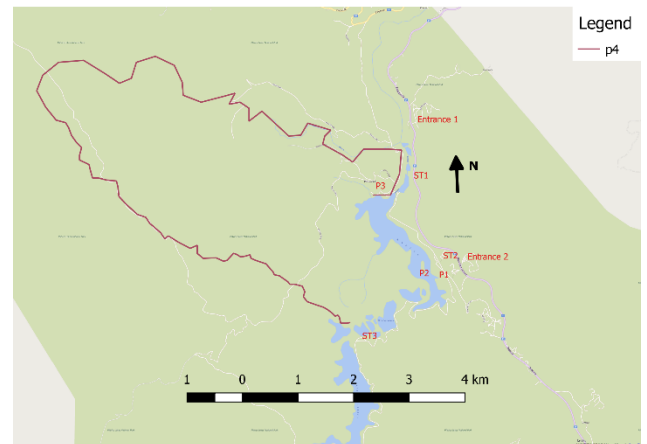
Criteria	Evaluation
Trail experience	Easy
Duration of the trail	Short
Mushroom interest	Low
Taxonomic interest	Low
Mushroom potential	Low
Biodiversity potential for fungi	Low
General interest for recreation	Medium

Trail P4

From ST3 to P3 the trail number four is the longest and hardest trail in the park. With more than 20km is only recommend for experienced hikers. When compared with other trails (i.e. trail P1) the big extension does not reflect in more biodiversity, at least during the time of my visit. Although the different landscapes and ecosystems may offer through the year more and different opportunities for macro fungi observation.

This trail is well organized with several educational boards that can be updated with more information to the fungi enthusiastic.

Although gathering mushrooms is not allow in the park this trail offers a good opportunity to collect some edible mushrooms like *Lactarius deliciosus*. I believe in the beginning of autumn may also be possible to find *Boletus sp.*



Criteria	Evaluation
Trail experience	Hard
Duration of the trail	Long
Mushroom interest	High
Taxonomic interest	High
Mushroom potential	High
Biodiversity potential for fungi	High
General interest for recreation	High

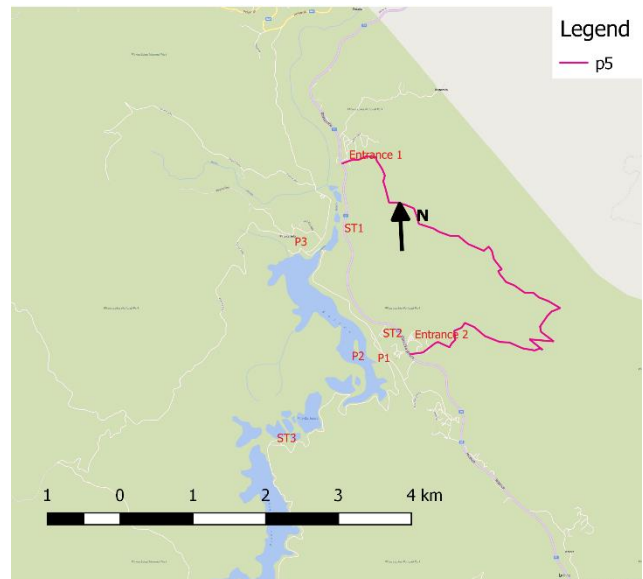
Trail P5

The trail number five also known as the Staza trail have 9 km distance and is mainly characterized by a forest cover with beech and maple. Recommend for enthusiastic hikers can be a good way to go from entrance 2 to entrance 1 in less than 5 hours even if when compared with other trails doesn't bring any new add value to the visitor in terms of new landscapes.

In general, is a trail with a medium potential for mushrooms observations where is possible to observe several saprophytic fungi species. The amount of dead wood in this trail is significant and allows a good fungi saprobic activity.

As in trail number 2 the *Festuca sp* also shows an invasive behaviour in the grass layer decreasing the biodiversity potential for fungi and other grass species.

In this trail is notorious the board information regarding forest management skills and operations. I believe that is a good choice and brings a new perspective to visitor although the information presented in the white board is very technical and it may be difficult to be understood by the general public. An updated board dedicated to forest management practices with an appellative design is highly recommend.



Criteria	Evaluation
Trail experience	Medium
Duration of the trail	Medium
Mushroom interest	Medium
Taxonomic interest	Medium
Mushroom potential	Medium
Biodiversity potential for fungi	Medium
General interest for recreation	Low

Outputs evaluation

1 – Conservation

- Elaboration the fungi check list of Plitvice Lakes National Park. **Done**
- Draw up the “Guide for best practices of fungi gathering and conservation” for each conservation zone. **Done – Consult Annexes.**
- Share and implement the Guide for Best practices of fungi gathering and conservation in others EUROPARC members. **This document will be available in the EUROPARC website.**

2 - Education and Recreation

- Draw up an identification guide for the most relevant species. **Done**
- Mapping hot spots of fungi population to be include on the existing visitor system. **Done**
- Mycology tour during for visitants. **Was not possible to organize due to logistical limitations.**
- Set a photographic exhibition of “Fungi from Plitvice Lakes National Park”. **Best photos available [here](#), a physical exhibition will be organized with the park in a near future.**
- Release all the information achieved for all EURPARC members. **All information available [here](#).**

3 - Strengthening the local community

- Draw up “Guide for forest management and fungi utility for locals” **Inside the park is not allowed to collect mushrooms and due to the high number of visitors is not viable to do that.**
- Set up a study group of local students to secure the continuation of this work. **Right now, there is a healthy communication with the management division, new developments may occur soon.**
- Open day with Hands on activities for mushrooms gathering. **Was not possible to organize due to logistical limitations.**

Potential gaps with objectives and expectations

In general, most of the objectives were achieved. The idea to harvest mushrooms to promote conservation is difficult to implement on this park due to the high number of visitors (more than one million per year). Although moderate fungi harvesting can increase spore dispersion, overexploitation can affect fungi abundance and diversity. It is very difficult to implement a free access of fungi resources for locals and visitors because the extension of trails is limited and the access to other areas outside of the trails it will impact mostly the diversity of the grass layer composition. Isolated activities with instructed staff members should be considered to increase the visitor offer in the low season.

Difficulties, limits

During the year 2016 the conservation manager changed and only in October 2016 was possible to establish contact with the new manager. The new manager, Mr Krešimir was a very open person however it was already late to improve and develop my action plan. The bureaucracy in Croatia is quite tight and there is a need to get permission from the National government to do research inside protected areas. For that reason, no samples were collected in the field and the macro fungi analyses were limited. I think this document can be used to construct a new solid research line for a future long-term study to the macro fungi species of the Plitvice Lakes National Park.

Final remarks

During my visit to the Plitvice lakes I had the opportunity to contact different staff members and to face the reality and the management challenges of this national park. The park has an exceptional natural beauty that every year attracts more than one million visitors from different nationalities. The main goal of these visitors is mainly to observe the majestic lakes and waterfalls. It is difficult to catch the visitor attention to other topics and divide the flux of people for other trails, that do not contact directly with the lakes. And for that reason, there is a huge need to develop and advertise other educational or recreational topics inside the Plitvice lakes national park.

The biodiversity in the park is huge, when compared with other parks in Europe, and there is still space to improve the environmental education in the park. The macro fungi can be a good solution to improve the guided tours and to catch the visitor attention to other topics. As mentioned before the idea is to improve the existing guided tours with more information about

the fungi world. It may be interesting to have specific flyers for macro fungi and to instruct the staff members to identify and recognize the ecological value of different mushrooms species.

The macro fungi community in the park is huge. In only 8 days of field work was possible to identify 45 different species without leaving the trails. Is important to mention that this diversity changes through the year and different species may occur. Also, some specimens were not possible to identify due to technical limitations. During this visit any mushroom was collected to respect the park laws although for future research is recommend a long-term study and some species may require spores' classification and other laboratory analysis.

From a management perspective, the park implemented a “non-dead wood removal policy” that allows a significant decomposition along the park. This dead wood is essential to maintain and promote several ecological processes. However, if this “dead wood” is located near the trails it will allow the visitor to have more contact with several saprophytic fungi. Is important to create an enjoyable experience without the need of leaving the trails. This action of promoting biodiversity near the trails is very important taking in consideration the huge number of visitors per year.

How this study will be used by the author and his/her employer

This study should be used as a discussion framework for a general evaluation of forest management practices and fungi conservation. At the moment, there is no general guidelines for fungi conservation that can be used as a model for different study areas. Criteria and indicators should be improved and tested in different areas. The employer has the opportunity to review the next management plan and include some recommendations as well to include more studies and activities on this topic.

What recommendations can be made to protected areas and EUROPARC

All protected area should describe their fungi community and in case of forest management activities the impact should be studied. Only after a long-term study it will be possible to analyse if there are some endangered species and which factors are leading to that. After that conservative measures regarding fungi diversity should be included in the management plan of each organization/protected area.

Annexes

	Species	P1	P2	P3	P4	P5
1	<i>Amanita</i> sp				x	
2	<i>Armillaria mellea</i>				x	
3	<i>Bulgaria inquinans</i>	x	x		x	
4	<i>Cantarellus</i> sp				x	
5	<i>Clavaria</i> sp	x				
6	<i>Clitocybe delbata</i>	x	x			
7	<i>Clitocybe</i> sp 1		x			
8	<i>Coprinellus micaceus</i>				x	
9	<i>Coprinus comatus</i>				x	
10	<i>Cortinarius anthracinus</i>	x				
11	<i>Cortinarius</i> sp1		x			
12	<i>Entoloma vernum</i>		x			
13	<i>Fomes fomentarius</i>	x	x	x	x	x
14	<i>Ganoderma applanatum</i>					x
15	<i>Ganoderma lucidum</i>				x	
16	<i>Geoglossum</i> sp		x			
17	<i>Helotium citrinum</i>	x				
18	<i>Hericium Coralloides</i>		x			
19	<i>Hypholoma fasciculare</i>	x		x	x	
20	<i>Laccaria amethystina</i>		x			x
21	<i>Laccaria laccata</i>	x	x			
22	<i>Lactarius deliciosus</i>				x	
23	<i>Lactarius</i> sp 1		x		x	
24	<i>Lycoperdon molle</i>		x			
25	<i>Marasmius</i> sp	x				
26	<i>Multiclavula mucida</i>	x				
27	<i>Mycena seynesii</i>	x				
28	<i>Mycena</i> sp 1	x				
29	<i>Oudemansiella mucida</i>	x	x			
30	<i>Pleotus ostreatus</i>	x				
31	<i>Psilocybe</i> sp 1		x			

32	Ramaria sp		x		x
33	Russula sp		x		x
34	Schizophyllum commune	x			x
35	Stereum hirsutum	x			
36	Stropharia aeruginosa		x		
37	Trametes versicolor	x			x
38	Tubaria furfuracea	x			
39	Unknown sp 1	x			
40	Unknown sp 2		x		
41	Unknown sp 3		x		
42	Unknown sp 4				x
43	Unknown sp 5				x
44	Unknown sp 6				x
45	Unkown sp 7				x



- 1 *Amanita sp*



- 4 *Clavaria sp*



- 2 *Armillaria mellea*



- 5 *Clitocybe sp1*



- 6 *Clitocybe delbata*



- 3 *Bulgaria inquinans*



- 7 *Coprinellus micaceus*



- 8 *Coprinus comatus*



- 9 *Cortinarius anthracinus*



- 10 *Cortinarius spl*



- 11 *Entoloma verum*



- 12 *Fomes fomentarius*



- 13 *Ganoderma applanatum*



- 14 *Ganoderma lucidum*



- 15 *Geoglossum sp*



- 16 *Helotium citrinum*



- 20 *Laccaria laccata*



- 17 *Hericium coralloides*



- 21 *Lactarius deliciosus*



- 18 *Hypholoma fasciculare*



- 22 *Lactarius sp1*



- 19 *Laccaria amethystina*



- 23 *Lycoperdon molle*



- 24 *Marasmius* sp



- 28 *Mycena* sp2



- 25 *Multiclavula mucida*



- 29 *Oudemansiella mucida*



- 26 *Mycena seynesii*



- 30 *Pleurotus ostreatus*



- 27 *Mycena* sp1



- 31 *Psilocybe* sp1



- 32 *Ramaria sp*



- 36 *Stropharia aeruginosa*



- 33 *Russula sp*



- 37 *Trametes versicolor*



- 34 *Schizophyllum commune*



- 38 *Tubaria furfuracea*



- 35 *Stereum hirsutum*



- 39 *Unknown sp1*



- 40 Unknown sp2



- 44 Unknown sp6



- 41 Unknown sp3



- 45 Unknown sp7



- 42 Unknown sp4



- 43 Unknown sp5

Guide for best practices of fungi gathering and conservation

Plitvice Lakes National Park – Study case

The fungi erstwhile nominated as “Type of Plant” nowadays belong to the Fungi Kingdom. This kingdom of eukaryotic beings, houses a huge diversity of organism, which include the mushrooms, the moulds and yeasts. It’s estimated that only in Europe exist at least 75.000 species of which 15.000 can generate sporocarps also known as mushrooms. Depending on other organisms for carbon, fungi can be saprophytes, mutualists and parasites. In the mutualists group are include one of the most important symbiotic relations, the mycorrhizal fungi living together with vascular plants. In forest management, mycorrhizal associations are used to improve the forest sustainability. With commercial and non-commercial value fungi gathering in Europe is a resource for food, medicine, ornaments, genetics and others.

In 2007, the European Council for Conservation of Fungi (ECCF) presented a document entitled “Guidance for the Conservation of Mushrooms in Europe” where were evaluated the efforts to identify and report conservation actions of the European macro fungi community. According to this document most European countries have produced fungal Red-list and more than 5 500 different macro fungi are red-listed in at least one European country. These numbers show us that 10-20% of European mushrooms may be threatened, putting the fungi conservation as a priority.

In these guidelines, we aim to define best practices for fungi gathering and conservation inside protected areas and national parks using the Plitvice Lakes National Park as a study case.

This project was writing based on the “European Charter on Fungi- Gathering and Biodiversity -2013” prepared by Mr Scott Brainerd and Ms Sarah Doornbos on behalf of the Bern Convention with the main objective to ensure that the gathering of fungi in Europe is practised in a sustainable way based on the conservation value of biodiversity and the needs of society.

Defining the open access area and analyse hiking trails

Plitvice Lakes National Park offers four different trails to visitors (Figure 1). Each trail can give a different experience and is important to characterize each of them from different perspectives. The biggest misconception in field characterization is the definition of clear criteria and indicators to achieve a standard analyse. For that reason, is important to establish, *a priori*, an evaluation framework (table 1 page 9) to allow different people to get a common evaluation. Of course, these criteria's can have some subjectivity and may not be applied in other protected areas but specific evaluation framework must be created for different proposes.

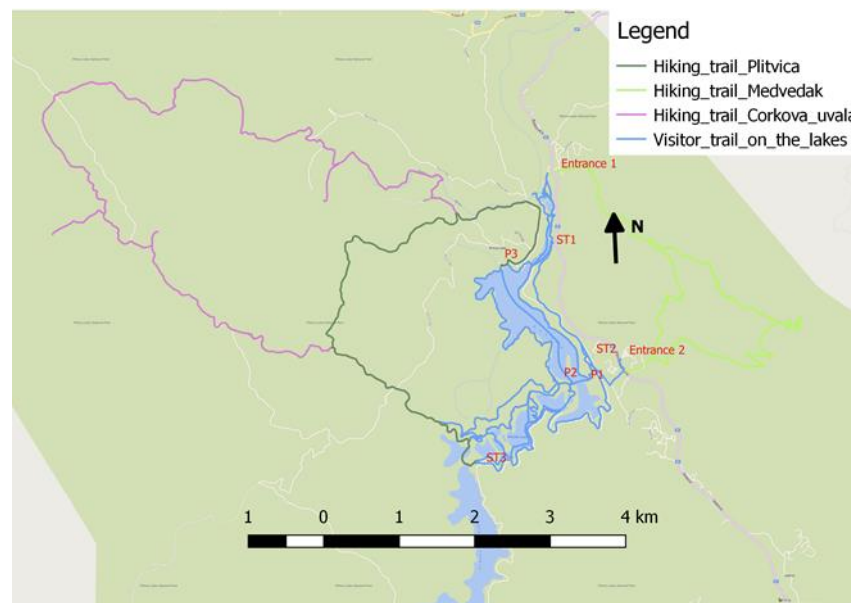


Figure 1 – Hiking trails inside the Plitvice Lakes National Park.

From a management perspective is not important that each trail scores a high value in all criteria because the most relevant is the overall evaluation. A trail with good conditions to fungi conservation can be not ideal for plant conservation and so on. A good management plan is the one that recognize and define different criteria to analyse and improve different factors. (i.e., local fauna, flora, landscape, other biota like fungi and microbial activity, human activity and others).

In protected areas, the “share or spare” topic is already an old discussion where in both scenarios is possible to identify different advantages or disadvantages as well as good and bad examples. In my opinion, the optimal solution is the one where humans and nature can co-exist in the same space. The best way to promote conservation should be through education, and is impossible to educate if people cannot experience it. However, with such a high number of

visitors and with the fragile ecosystems of the Plitvice's lakes is impossible, for now, to achieve a perfect "share" solution. In that sense, the management division do not allow visitors to walk outside of the trails and it's a reasonable solution. In this way, to optimize the visitor experience is important to allow the visitor to have as much contact as possible with nature without leaving the trails.

In parks where then number of visitors are not a limitation, other open access area schemes can be defined. After defining the open access area and the evaluation framework the next step is to describe the macro fungi community.

Macro fungi description of the selected areas

All the mushrooms should be recorded with GPS coordinates, photographed in several angles and tagged with a unique collection number with extra information about the habitat, zone description and other useful information.

Samples of the mushrooms should be taken according to the best practices of fungi gathering and extra analyses should be performed in the lab (i.e., spore characterization).

To identify the collected mushrooms, it should be used a dichotomous key (example: authors Robert and Evans, 2011) together with the online database: Mycokey 4.0; Roger Mushrooms and Mushrooms Expert. The geographical data can be analysed and processed with the any geographical system software (Arcgis or Quantum gis).

Macro fungi are common in autumn but some species also occur in other seasons. A good macro fungi description should be done for the whole year. If it is possible for each species should be conserved a specimen in a local herbarium.

Best practices of fungi gathering

Each country has a specific regulation for fungi gathering activities please contact your government to understand what are the limitations and laws that regulate this activity. However national regulation sometimes do not reflect the reality of specific protected areas. Please check if the national regulation is in line with your management goals of your national park.

For more information, you can consult the "European Charter on Fungi- Gathering and Biodiversity -2013" prepared by Scott Brainerd and Sarah Doornbos on behalf of the Bern Convention. In this section I will just highlight the proposed code of conduct for gathering fungi in Appendix 5 of the previous mention document.

“Nature, people and your own long-term enjoyment will be enhanced if you:

Identify fungi: take a field guide and know the protected species as well as the toxic ones; don't pick what you cannot identify; collect species that are locally common in preference to rare ones.

Respect regulations: be aware of and respect “no picking” areas, which may be necessary where human population density is high; consult land-managers, especially at nature reserves.

Respect nature: respect the need to leave soil and leaf litter undisturbed; allow fungi to open and release spores; avoid picking of immature fruiting bodies, not picking more than can be used; leave those past their best; teach others to use these and other best practices.

Consider others: always leave some fruiting bodies for other humans (e.g. photographers and those monitoring species), for other species that need food (e.g. insects) and for fungal reproduction.

Avoid waste: don't pick more than you need; scatter trimmings where you pick; discourage others from wasteful damage to fungi, such as ‘off piste’ running, cycling and riding in woods where fungi are fruiting.

Pay your way: reward landowners, with thanks if not a small gift, for preserving the habitats that benefit you; if required, pay fees or make other contributions.

Help to conserve: assist with monitoring and restoring fungi and their habitats if asked; if possible, join organisations that provide guidance and organise conservation.”

Forest management and fungi conservation

Different forest management activities, like pruning or plough, may impact the fungi community in different ways. There is no clear solution in forest management to promote fungi conservation and results can vary from one place to another. After the macro fungi description is important to evaluate changes in diversity and abundance of the fungi community. In general, from this study case I can highlight three recommendations:

- Maintain a diversify forest cover. Different tree species allow different mycorrhizal colonization and different plant pathogens.
- Reduce any invasive grass species. A tight occupation of the soil by some grass species reduces the fungi diversity. (Figure 2).

- Apply a non-dead wood removal policy. Even a dead tree is an important part of the ecosystem that allow the fungi colonization by several saprophytic species.



Figure 2 - Festuca sp colonization in a beech forest.

Identification guide for the most relevant species

It's recommend after the macro fungi description to comprise the most relevant species in a mini guide for visitors. The following mini guide is just an example. In case of edible species is important to highlight possible similarities to other poison species. It's always important to mention **the gathering edible fungi should be only allowed by instructed people.**



Fomes fomentarius, commonly known as ice man fungus is a fungal plant pathogen. This species produces a large polypore fruit body which are shaped like a horse hoof. Can vary in colour, usually silvery grey, brown or black.



Hericium coralloides, commonly known as the coral tooth fungus, can be found in dead hardwood trees. When is young is edible after ageing, spines become brittle and brown.



Oudemansiella mucida, commonly known as the porcelain fungus is a slimy wood-root fungus that usually grows in clusters. Appears in the late autumn most of the times in Beech trees.



Ramaria sp, this common coral fungus comprises almost 200 different species. Colour may vary from yellow, red to purple and white.