



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Bioindikacija in biomonitoring
<b>Course title:</b>	Bioindication and Biomonitoring

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Biologija in ekologija z naravovarstvom; II. stopnja		1 ali 2	2 ali 3
Biology and ecology with nature conservation; II. level		1 or 2	2 or 3

**Vrsta predmeta / Course type**

**Univerzitetna koda predmeta / University course code:**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Terenske vaje Field work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15		15		135	180/6

**Nosilec predmeta / Lecturer:**

**Jeziki / Languages:**

<b>Predavanja / Lectures:</b>	Slovenski/Slovenian
<b>Vaje / Tutorial:</b>	slovenski/Slovenian

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

**Prerequisites:**

## Vsebina:

### A) Osnove in definicija bioindikacije in biomonitoringa:

- predstavitev in definicija vrst (akumulacijska, senzitivna in retrospektivna bioindikacija) in nivojev bioindikacije (kazalci, akumulatorji in monitorji);
- predstavitev prednosti in slabosti posamezne vrste/nivoja bioindikacije;
- biomonitoringi kot nadgradnja in dopolnitev kemijskih monitoringov onesnaženosti okolja;
- povezava z ekotoksikološkimi raziskavami (ocene tveganja za okolje in ljudi).

### B) Uporaba bioindikatorskih organizmov in primeri biomonitoringov v vodnih in kopenskih ekosistemih:

- Vodni ekosistemi: uporaba različnih vrst bioindikatorskih organizmov kot akumulacijskih bioindikatorjev (npr. ribe, makrofiti) in predstavitev vrednotenja kakovosti površinskih voda z izračunom saprobnega indeksa življenjske združbe na osnovi pojavljanja fitobentosa in makrozoobentosa.
- Kopenski ekosistemi: uporaba različnih bioindikatorskih organizmov za določitev stanja oziroma onesnaženosti okolja (npr. nevretenčarji, vretenčarji, iglice smreke, tipi ektomikorize, gozdni sadeži (trosnjaki višjih gliv, plodovi lesnatih vrst, jagodičje), drevesne branike, višje rastline in lišaji).

### C) Primeri biomonitoringov v okolici večjih emisijskih virov:

- Ribe kot bioindikatorji obremenjenosti šaleških jezer s kovinami;
- Biomonitoring gozdnega ekosistema vplivnega območja Termoelektrarne Šoštanj z uporabo iglic smreke, trosnjakov višjih gliv, epifitskih lišajev in drevesnih branik;
- Mali sesalci kot bioindikatorji onesnaženosti okolja v okolici različnih emisijskih virov (TEŠ, bivša topilnica svinca v Zgornji Mežiški dolini, promet);
- Deževniki kot bioindikatorji onesnaženih tal;
- Trosnjaki višjih gliv (gobe) kot akumulacijski in senzitivni akumulatorji onesnaženosti gozdnih rastišč;
- Plodovi lesnatih vrst in jagodičje kot akumulacijski bioindikatorji onesnaženosti gozdnih rastišč.

## Content (Syllabus outline):

### A) Fundamentals and definition of bioindication and biomonitoring:

- presentation and definition of types of bioindications (accumulative, sensitive, retrospective) and bioindicative levels (indicators and monitors);
- presentation of the strengths and weaknesses of different type/level of bioindication;
- biomonitoring as an upgrade and supplement of the chemical monitoring of environmental pollution;
- connection to the ecotoxicological studies (environmental risk assessment and public health).

### B) The use of bioindicator organisms and presentation of biomonitoring carried out in aquatic and terrestrial ecosystems:

- Aquatic ecosystems: the use of different types of bioindicator organisms as accumulative bioindicators (eg., fish, macrophytes) and presentation of the evaluation of the surface water quality by calculating the saprobic index of biotic communities on the basis of the occurrence of phytobenthos and macrozoobenthos.
- Terrestrial ecosystems: the use of different bioindicator organisms to determine the status or environmental contamination (eg., invertebrates, vertebrates, spruce needles, types of mycorrhizae, forest fruits (fruiting bodies of higher fungi, wild berries and fruits of woody species), tree rings, higher plants and lichens).

### C) Examples of biomonitorings in the vicinity of large emission sources:

- Fish as bioindicators metal pollution of the Šalek lakes;
- Biomonitoring of forest ecosystem in the emission area of the Šoštanj thermal power plant using spruce needles, fruiting bodies, epiphytic lichens and tree rings;
- Small mammals as bioindicators of environmental pollution in the vicinity of different emission sources (thermal power plant, former lead smelter in the Upper Meža Valley, roads);
- Earthworms as bioindicators of polluted soil;
- Fruiting bodies of higher fungi (mushrooms) as accumulative and sensitive bioindicators of forest site pollution;
- Wild berries and fruits of woody species as accumulative bioindicators of forest site pollution.

## Temeljni literatura in viri / Readings:

- Markert, B.A., Breure A.M., Zechmeister, H.G. (Eds), 2003. Bioindicators & Biomonitors, Principles, Concepts and Applications (Trace Metals and Other Contaminants in the Environment 6), 997 str., Elsevier
- Beyer, W.N., Heinz, G.H., Redmon-Norwood, A.W. (Eds), 1996. Environmental contaminants in wildlife. SETAC Special Publications Series, Lewis Publisher.
- Batič, F., 2002. Bioindication of sulphur dioxide pollution with lichens. In: Kranner I, Beckett RP, Varma AK, editors. Protocols in Lichenology. Springer Lab Manual. p 484-503.

### **Cilji in kompetence:**

Cilji predlaganega izbirnega predmeta so:

- seznanitev z metodami spremljanja in nadziranja onesnaženosti vodnih in kopenskih ekosistemov;
- poznavanja različnih vrst bioindikacije in razumevanje prednosti uporabe posameznih vrst bioindikacije;
- seznanitev z uporabo metod za oceno tveganja za okolje in ljudi kot dopolnitev bioindikacije;
- poznavanje prednosti biomonitoringa v primerjavi s kemijskimi monitoringi;
- seznanitev s principi uporabe različnih bioindikatorskih organizmov;
- seznanitev s primeri dobre prakse na področju izvajanja biomonitoringov;
- prenos teoretičnega znanja v prakso.

### **Objectives and competences:**

The objectives of propose course title are:

- to become familiar with the methods of monitoring of pollution of aquatic and terrestrial ecosystems;
- to acquire the knowledge of different types of bioindication and to understand the benefits of using various types of bioindication;
- to become familiar with ecological risk assessment;
- to acquire the knowledge of the advantages of biomonitoring compared to chemical monitoring systems;
- to become familiar with the principles of the use of different bioindicator organisms;
- to become familiar with examples of good practice in the implementation of biomonitoring;
- to transfer of theoretical knowledge into practice.

### **Predvideni študijski rezultati:**

Znanje in razumevanje:

- razumevanje vrednotenja antropogenih vplivov na okolje;
- razumevanje pomena bioindikacije;
- poznavanje vrst in nivojev bioindikacije;
- poznavanje uporabe različnih bioindikatorskih organizmov.

Prenesljive/ključne spretnosti in drugi atributi:

- sposobnost vključevanja pridobljenega znanja v načrtovanje aplikativnih raziskav;
- sposobnosti načrtovanja in izvedbe biomonitoringov;
- sposobnost uporabe različnih bioindikatorskih organizmov za spremljavo stanja okolja, upošteva tip in vrsto onesnaževanja;
- sposobnosti vrednotiti rezultate biomonitoringov;
- sposobnost sodelovati pri načrtovanju programov varstva okolja in ostalih poročilih o stanju okolja.

### **Intended learning outcomes:**

Knowledge and Understanding:

- understanding of evaluation of anthropogenic impacts on the environment;
- understanding of the importance of bioindication;
- understanding of the types and levels of bioindication;
- knowledge of the use of different bioindicator organisms.

Transferable / Key Skills and other attributes:

- ability to integrate acquired knowledge in the design of applied research;
- ability to design and implement biomonitoring;
- ability to use a variety of bioindicator organisms for monitoring the state of the environment, taking into account the type and nature of contamination;
- ability to evaluate the results of biomonitoring;
- ability to participate in planning programs for environmental protection and other reports regarding the state of the environment.

### **Metode poučevanja in učenja:**

- predavanje,
- seminar,
- terenske vaje.

### **Learning and teaching methods:**

- lectures,
- seminar,
- field work.

<b>Načini ocenjevanja:</b>	<b>Delež (v %) / Weight (in %)</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt): <ul style="list-style-type: none"> <li>• pisni izpit,</li> <li>• seminar.</li> </ul>	<b>60 %, 40 %</b>	Type (examination, oral, coursework, project): <ul style="list-style-type: none"> <li>• written exam,</li> <li>• seminar essay.</li> </ul>

**Reference nosilca / Lecturer's references:**

AL SAYEGH PETKOVŠEK, S., KOPUŠAR, N., KRYŠTUFEK, B., 2014. Small mammals as biomonitors of metal pollution: a case study in Slovenia. Environmental monitoring and assessment, ISSN 0167-6369, v tisku.

AL SAYEGH PETKOVŠEK, S., 2013. Forest biomonitoring of the largest Slovene thermal power plant with respect to reduction of air pollution. Environmental monitoring and assessment, vol. 185, no. 2, str. 1809-1823,

AL SAYEGH PETKOVŠEK, S., POKORNY, B., 2013. Lead and cadmium in mushrooms from the vicinity of two large emission sources in Slovenia. Science of the total environment, vol. 443, str. 944-954.

AL SAYEGH PETKOVŠEK, S., MAZEJ, Z., POKORNY, B., 2012. Heavy metals and arsenic concentrations in ten fish species from the Šalek lakes (Slovenia): assessment of potential human health risk due to fish. Environmental monitoring and assessment, vol. 184, no. 5, str. 2647-2662

AL SAYEGH PETKOVŠEK S., BATIČ F., RIBARIČ LASNIK C. 2008. Norway spruce needles as bioindicator of air pollution in the area influence of the Šoštanj thermal power plant, Slovenia. Environmental pollution, 151: 287-291.