

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| Predmet: | BIOINDIKACIJA IN BIOMONITORING |
| Course title: | BIOINDICATION AND BIOMONITORING |

| Študijski program in stopnja Study programme and level | Študijska smer Study field | Letnik Academic year | Semester Semester |
|-------------------------------------------------------------------------|-------------------------------|-------------------------|----------------------|
| Varstvo okolja in ekotehnologije, 2. stopnja | / | 2. | / |
| Environmental Protection and Eco-technologies, 2 nd level | / | 2 nd | / |

Vrsta predmeta / Course type Izbirni predmet / Optional course

Univerzitetna koda predmeta / University course code: BB

| Predavanja Lectures | Sem. vaje Tutorial | Lab. vaje Laboratory work | Teren. vaje Field work | Samost. delo Individ. work | ECTS |
|------------------------|-----------------------|------------------------------|---------------------------|-------------------------------|------|
| 20 | 20 | / | / | 80 | 4 |

Nosilec predmeta / Lecturer: doc. dr. Samar Al Sayegh Petkovšek; prof. dr. Boštjan Pokorny

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| Jeziki / | Predavanja / Lectures: | Slovenščina / Slovenian |
| Languages: | Vaje / Tutorial: | Slovenščina / Slovenian |

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| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisites: |
| Pogojev ni. | No formal prerequisites. |

Vsebina:

Poglavitne teme:
Opredelelitev in koncept bioindikacije in biomonitoringa:

- namen, strategija, principi, prednosti in slabosti;
- okoljski stres, onesnaževanje okolja in bioindikacija;
- pomen bioindikacije za okoljsko zakonodajo.

Načini, metode in ravni bioindikacije/biomonitoringa:

- akumulacijska in odzivna (reakcijska) bioindikacija.
- aktivna in pasivna bioindikacija.
- retrospektivna (zgodovinska) bioindikacija.

Značilnosti in možnosti uporabe različnih bioindikatorskih organizmov ter primeri dobre prakse v Sloveniji:

- lišaji in mahovi kot bioindikatorji onesnaženosti zraka;
- glive kot bioindikatorji onesnaženosti tal;
- višje rastline kot bioindikatorji onesnaženosti okolja.

Content (Syllabus outline):

Main topics:
Definition and concept of bioindication/biomonitoring:

- purpose, strategy, principles, advantages and drawbacks;
- environmental stress, pollution and bioindication;
- importance of bioindication for environmental legislation.

Methods and levels of bioindication/biomonitoring:

- accumulative and sensitive (reactive) bioindication;
- active and passive bioindication;
- retrospective (historical) bioindication.

Characteristics and employability of different bioindicator organisms with emphasis on Slovene case studies:

- lichens and mosses as bioindicators of air pollution;
- fungi as bioindicators of soil pollution;
- higher plants as bioindicators of environmental pollution;

- nevretenčarji kot bioindikatorji onesnaženosti okolja;
- vretenčarji (ptice, sesalci) kot bioindikatorji.

- invertebrates as bioindicators of environmental pollution;
- vertebrates (birds, mammals) as bioindicators.

Temeljna literatura in viri / Textbooks:

Obvezna / Required:

- Markert, B.A., Breure A.M., Zechmeister, H.G. (eds), 2003. Bioindicators & Biomonitors: principles, concepts and applications. Elsevier, Amsterdam, 997 str.
- Izbrani znanstveni članki, ki obravnavajo bioindikatorje kot pokazatelje onesnaženosti oz. stanja okolja (glej poglavje izbrani znanstveni članki) / Selected paper from the field bioindication and biomonitoring.
- Študijsko gradivo, posredovano v obliki izročkov / Study materials provided as PowerPoint slides

Priporočena / Recommended:

- Tiwari, S., Agrawal S., B., (2022). New paradigms in Environmental biomonitoring using plants Elsevier.
- Markert, B. (ed.), 1993. Plants as biomonitors: Indicators for heavy metals in the terrestrial environment. VCH Verlagsgesellschaft, Weinheim, 642 str.

Cilji in kompetence:

Predmetno specifični cilji in kompetence:

- Študente seznaniti z osnovami in konceptom bioindikacije/biomonitoringa ter osnovami ugotavljanja stanja/ onesnaženosti kopenskih ekosistemov s pomočjo rastlin, gliv in vretenčarjev kot indikatorskih organizmov.
- Študente seznaniti s primeri dobre prakse uporabe različnih bioindikatorjev v slovenskem prostoru.
- Študente usposobiti za samostojno izvajanje nekaterih preprostih metod bioindikacije.
- Študente spodbuditi za nadaljnje razvijanje področja bioindikacije/biomonitoringa v slovenskem prostoru.

Splošne kompetence:

- sposobnost razumevanja pomena bioindikacije in biomonitoringov;
- sposobnost ovrednotiti stanje okolja z uporabo različnih metod bioindikacije.

Objectives and competences:

Specific competences:

- To acquaint students with backgrounds and concepts of bioindication/biomonitoring as well as with basis for determination of stage/pollution of terrestrial ecosystems by using plants, fungi and vertebrates as bioindicators.
- To acquaint students with examples of good practices of employment of different bioindicator organisms in Slovenia.
- To qualify students for autonomous executing of some simple bioindicative methods.
- To encourage students for up-following development of bioindication/biomonitoring in Slovenia.

General competences:

- ability to understand the importance of bioindication and biomonitoring;
- ability to assess the quality of the environment, obtained by usage of different bioindication methods.

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent bo ob zaključku tega predmeta sposoben:

(i) razumeti principe in metodologijo biomonitoringa;

(ii) povezovati podatke, informacije in znanja s področja biologije in bioindikacije z različnimi tehnološkimi procesi in drugimi metodami spremljanja stanja okolja ter uporabiti kompleksno znanje v različnih oblikah in situacijah;

(iii) uporabiti in izbrati ustrezne metode bioindikacije za ugotavljanje antropogenih vplivov na ekosisteme;

(iv) analizirati in razumeti rezultate, dobljene z uporabo izbranih bioindikacijskih metod; (v) ovrednotiti stanje okolja, pridobljeno s pomočjo različnih metod bioindikacije, in presojati vrednost ter zanesljivost

Intended learning outcomes:

Knowledge and Understanding:

The student will be able at the completion of this course to: (i) understand principles and methodology of biomonitoring; (ii) link data, information and knowledge from biology-bioindication with different technological processes as well as with other methods for assessment of environmental quality, and use this comprehensive knowledge in various possibilities and/or situations; (iii) apply and select adequate bioindicative methods for determination of the influence of anthropogenic activity on the environment; (iv) analyse and understand data, obtained by several bioindicative methods; (vi) evaluate the quality of the environment, obtained by usage of different

akonsko predpisanih fizikalno-kemijskih meritev v okolju.

Prenosljive/ključne spretnosti in drugi atributi:

- prenosljive/ključne spretnosti in drugi atributi;
- spretnosti uporabe domače in tuje literature;
- sposobnost zbiranja in interpretiranja podatkov;
- prepoznavanje in reševanje okoljskih problemov;
- kritična analiza in sinteza podatkov.

bioindication methods, and thereby criticise reliability of other data, obtained by mandatory physical and chemical measurements of different environmental media.

Transferable/Key Skills and other attributes:

- usage of Slovene and foreign literature;
- ability for collecting and interpretation of data;
- recognising and solving environmental issues;
- reliable analyses and syntheses of data/information.

Metode poučevanja in učenja:

- predavanja;
- seminar;
- seminarska naloga (študent/ka izbere določeno temo, ki jo samostojno obdelava in predstavi)....

Learning and teaching methods:

- lectures;
- seminar work;
- tutorial (each student autonomously selects, prepares and presents one topic)....

| Načini ocenjevanja: | Delež (v %) / Weight (in %) | Assessment: |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Pogoj za pristop k izpitu je oddana seminarska naloga.</p> <p>Končna ocena se sestoji iz: (i) seminarske naloge, (ii) pisnega izpita.</p> <p>Ocenjevalna lestvica:</p> <ul style="list-style-type: none"> ▪ zadostno 6: 60–67 % ▪ dobro 7: 68–75 % ▪ prav dobro 8: 76–83 % ▪ prav dobro 9: 84–90 % ▪ odlično 10: 91–100 % | <p>20 %</p> <p>80 %</p> | <p>A prerequisite for access to the exam: ...</p> <p>Final evaluation consists of ...</p> <p>Grading scale:</p> <ul style="list-style-type: none"> ▪ Sufficient D (6): 60–67% ▪ Good C (7): 68–75% ▪ Very good B (8): 76–83% ▪ Very good B+ (9): 84–90% ▪ Excellent A (10): 91–100% |

Materialni pogoji za izvedbo predmeta :

- Predavanja: predavalnica z multimedijско opremo.

Material conditions for subject realization:

- Lectures: classroom with the multimedia equipment.

Obveznosti študentov:

- Izdelava in predstavitev seminarske naloge.
- Pisni izpit.

Student's commitments:

- Preparation and presentations of seminar work.
- Written examination.

Reference nosilca predmeta:

Pedagoško delo:

- Nosilka predmetov »Okoljska tveganja in varstvo pri delu« in »Okoljski projektni praktikum« ter soizvajalka predmetov »Okoljski monitoring« in »Bioindikacija in biomonitoring«, ki se izvajajo na *Fakulteti za varstvo okolja*.

Lecturer's references:

Pedagogic activities:

- Holder of the subjects: "Ecological risks and work safety", "Environmental project practicum« and co-holder of subjects: "Environmental monitoring" and "Bioindication and biomonitoring" at *Faculty of Environmental Protection*.

- Nosilka dveh predmetov magistrskega študija: »Projektno delo v biologiji in ekologiji« in »Bioindikacija in biomonitoring« na Univerzi v Mariboru (*Fakulteta za naravoslovje in matematiko*, Oddelek za biologijo, II. stopnja).
- Soizvajalka predmeta »Biološki monitoring« na Univerzi na Primorskem (*Fakulteta za matematiko, naravoslovje in informacijske tehnologije* (Famnit), Varstvo narave, II. stopnja).

Znanstveno-raziskovalno in strokovno delo:

- bioindikacija onesnaženosti vodnih in kopenskih ekosistemov z uporabo izbranih bioindikatorskih organizmov;
- okoljski monitoringi ob prometnicah;
- vpliv linijske infrastrukture na prostoživeče živali;
- monitoringi učinkovitosti ukrepov za zmanjšanje povezovalnih prostoživečih živali;
- ocene tveganja za okolje z uporabo receptorskih organizmov (npr. mali sesalci, ptice pevke);
- raziskave vplivov vojaške dejavnosti na okolje z oceno tveganja zaradi okoljskih in naravnih nesreč na območjih delovanja Slovenske vojske;
- raziskave vpliva onesnaženega zraka (prašnih delcev) na zdravje ljudi.

Izbrane strokovne publikacije:

- Al Sayegh Petkovšek in sod. Monitoringi dvoživk na izbranih odsekih državnih cest v obdobju 2019–2025. Fakulteta za varstvo okolja.
- Al Sayegh Petkovšek, S., Kotnik, K., Pokorny B., 2022. Strokovne podlage za načrtovanje in izvajanje ukrepov za zmanjšanje povozov divjadi. Fakulteta za varstvo okolja, Velenje.
- Al Sayegh Petkovšek S., Kunej U., Alagić A., Flajšman K., Levanič T., Pokorny B., 2021. Namestitve zvočnih in svetlobnih (modrih) za divjad na odsekih državnih cest v letih 2018–2020. Zaključno poročilo monitoringa za sklopa 1 in 2. Fakulteta za varstvo okolja, Gozdarski inštitut Slovenije.
- Al Sayegh Petkovšek, S., Kotnik, K., Pokorny B., 2021. Odvrčanje divjadi iz AC in HC. Zaključno poročilo. Fakulteta za varstvo okolja, Velenje.
- Al Sayegh Petkovšek, S., Triglav Brežnik, G., Šešerko, M., Kugonič, N., Rošer-Drev, A., Bole, M., 2017. Okoljski monitoring v času obratovanja za hitro cesto Koper - Izola. Velenje, ERICo.

- Holder of two subjects (master's degree programme): "Bioindication and biomonitoring" and "Project work in biology and ecology" at the University of Maribor (*The Faculty of Natural sciences and Mathematics, Department of Biology*).
- Co-holder of subjects: "Biomonitoring" at the University of Primorska. (*The Faculty of Mathematics, Natural Sciences and Information Technologies* (Famnit), master's degree programme).

Scientific, research and professional work:

- bioindication of pollution in aquatic and terrestrial ecosystems through selected bioindicator species;
- environmental monitoring along transportation routes;
- assessment of the effects of linear infrastructure on wildlife;
- evaluation of the effectiveness of measures aimed at reducing wildlife-vehicle collisions;
- environmental risk assessments using receptor organisms (e.g., small mammals, songbirds);
- studies on the environmental impacts of military activities;
- risk assessments due to environmental and natural disasters in areas impacted by military activities of Slovenian Army;
- assessment of the effects of linear infrastructure on wildlife;
- studies on the effects of air pollution (particulate matter) on human health.

Selected professional publications:

- Al Sayegh Petkovšek in sod. Monitoring of amphibians on selected state roads in the period 2019–2025. Faculty of environmental protection, Velenje.
- Al Sayegh Petkovšek, S., Kotnik, K., Pokorny B., 2022. Professional guidelines for the planning and implementation of measures to reduce wildlife-vehicle collisions. Faculty of environmental protection, Velenje.
- Al Sayegh Petkovšek S., Kunej U., Alagić A., Flajšman K., Levanič T., Pokorny B., 2021. Installation of acoustic and light (blue) wildlife deterrents on sections of state roads in the period 2018–2020. Final monitoring report for Lots 1 and 2. Faculty of environmental protection, Slovenian Forestry Institute.
- Al Sayegh Petkovšek, S., Kotnik, K., Pokorny B., 2021. Deterrence of wildlife from motorways and expressways. Final report. Faculty of environmental protection, Velenje.
- Al Sayegh Petkovšek, S., Triglav Brežnik, G., Šešerko, M., Kugonič, N., Rošer-Drev, A., Bole, M., 2017. Environmental monitoring during the operational phase of the Koper–Izola expressway. ERICo Institute, Velenje.

Izvirni znanstveni članki:

- Al Sayegh Petkovšek, S., Kotnik, K., Brežnik, K., Pokorny, B., 2024. Wildlife mortality on the Slovenian highways: monthly patterns, identification of hotspots and effectiveness of acoustic deterrents. *Urban Ecosystems*, 28, str. 1-12.
- Al Sayegh Petkovšek, S., 2024. Planning for wildlife corridors in the area of railway infrastructure : a case study in Slovenia. V: Mohebbi, Masoud (ur.). *Railway transport and engineering: a comprehensive guide*. London: Intech Open, 2024. Str. 107-125, ilustr. Civil engineering book series, vol. 11.
- Al Sayegh Petkovšek, S., Sterže, T., Poličnik, H., 2023. Ocenjevanje kakovosti zraka na izbranih lokacijah v Mežiški dolini z uporabo epifitskih lišajev = Assessment of air quality at selected locations in the Meža Valley using epiphytic lichens. *Acta Silvae et Ligni*, 132, str. 13-28.

- Al Sayegh Petkovšek, S., 2019. Analiza uspešnosti vzpostavitve nadomestnega habitata Črni log - Hotiška gmajna s poudarkom na rastni uspešnosti sadik = Analysis of the success of introduction of replacement habitat Črni log % Hotiška gmajna with emphasis on growth efficiency of planted seedlings. *Gozdarski vestnik: Slovenska strokovna revija za gozdarstvo*, letn. 77, št. 5/6, str. 211-231.
- Al Sayegh-Petkovšek S., Kopušar N., Pokorny B., Tome D., Kryštufek B., 2017. Prehod kovin iz tal v tkiva izbranih vrst prostoživečih živali: primer Velikega Vrha = Transfer of metals from soil to tissues of selected free-living animals: a case study for Veliki Vrh. *Acta silvae et ligni*, 114:1-20.
- Al Sayegh Petkovšek S., Kopušar N., Kryštufek B., 2015. Small mammals as biomonitors of metal pollution: a case study in Slovenia. *Environmental monitoring and assessment*, 186:4261-4274.
- Al Sayegh Petkovšek S., Kopušar N., Tome D., Kryštufek B., 2015. Risk assessment of metals and PAHs for receptor organisms in differently polluted areas in Slovenia. *Science of the total environment*, 532:404-414.
- Al Sayegh Petkovšek S., Kopušar N., 2013. Deževniki kot kazalniki onesnaženosti tal = Earthworms as bioindicator organisms of soil pollution. *Acta silvae et ligni*, 101:1-12.
- 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*, 185:1809-1823.
- 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*, 443:944-954.
- 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 consumption. *Environmental monitoring and assessment*, 184:2647-2662.
- Al Sayegh-Petkovšek S., Poličnik H., Ramšak R., Mavec M., Pokorny B., 2010. Ecological remediation of the Šoštanj thermal power plant with respect to sustainable development of the Šalek Valley, Slovenia. *Thermal science*, 14:773-782.
- Mazej Z., Al Sayegh-Petkovšek S., Pokorny B., 2010. Heavy metal concentrations in food chain of lake Velenjsko jezero, Slovenia: an artificial lake from mining. *Archives of environmental contamination and toxicology*, 58:998-1007.
- Jelenko I., Pokorny B., 2010. Historical biomonitoring of fluoride pollution by determining fluoride contents in roe deer (*Capreolus capreolus* L.) antlers and mandibles in the vicinity of the largest Slovene thermal power plant. *Science of the total environment*, 409:430-438.
- Jelenko I., Jerina K., Pokorny B., 2010. Vplivi okoljskih dejavnikov na pojavljanje in prostorsko razporeditev zobne fluoroze pri srnjadi (*Capreolus capreolus* L.) v vzhodni Sloveniji = Impact of environmental factors on the appearance and distribution of dental fluorosis in roe deer (*Capreolus capreolus* L.) in eastern Slovenia. *Zbornik gozdarstva in lesarstva*, 92:21-32.
- Jelenko I., Bienelli-Kalpič A., Pokorny B., 2010. Bioindikacija onesnaženosti okolja s fluorida z uporabo čeljusti srnjadi (*Capreolus capreolus* L.): stanje in perspektive = Bioindication of fluoride pollution by the use of roe deer (*Capreolus capreolus* L.) mandibles: situation and perspectives. *Zbornik gozdarstva in lesarstva*, 92:3-20.
- Pokorny B., Jelenko I., Kierdorf U., Kierdorf H., 2009. Roe deer antlers as historical bioindicators of lead pollution in the vicinity of a lead smelter, Slovenia. *Water, air and soil pollution*, 203:317-324.
- 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.
- Kraigher H., Al Sayegh Petkovšek S., Grebenc T., Simončič P. 2007. Types of ectomycorrhiza as pollution stress indicators: case studies in Slovenia. *Environmental monitoring and assessment*, 128: 31-45.