

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	DENDROEKOLOGIJA
Course title:	DENDROECOLOGY

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: DE

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: prof. dr. Tomislav Levanič

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

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

Pogojev ni.

Prerequisites:

No formal prerequisites.

Vsebina:

Opredelevitev discipline in njena vloga oziroma namen (proučevanje gostotnega profila, izotopske zgradbe in radialnega priraščanja lesnatih vrst, zlasti drevesnih, z namenom identificirati različne okoljske signale, ki se odražajo v širinah branik, njeni gostoti ali izotopski sestavi in analizirati njihov vpliv na rast dreves; veda je v izrazito pomoč pri različnih ekoloških raziskavah, za opis klime v preteklosti in za datacijo lesenih predmetov ali objektov)...

Poglavitne teme:

- osnovni pojmi in načela discipline
- izbira objektov analize, metode pridobivanja podatkov, priprava materiala
- izvedba dendrokronološke analize (vzorčenje, meritve, kontrola in odprava napak, sinhronizacija s pomočjo vizualnih in statističnih kazalnikov - t vrednost po Baillie-Pilcherju, koeficient časovne

Content (Syllabus outline):

Definition of the discipline and its role and purpose (the study of the density profile, the isotopic structure and radial increment of woody species, particularly trees, in order to identify the various environmental signals, which are reflected in tree-ring widths, its density or isotopic composition, and analyze their impact on the growth of trees; science is a distinct help in a variety of ecological studies, to describe the climate in the past and for dating wooden objects, or objects)

Main topics:

- basic concepts and principles of discipline
- selection of the objects for the analysis, methods of data acquisition, preparation of samples
- implementation of dendrochronological analysis (sampling, measurement, control and error correction, synchronization using

<p>skladnosti, indeks navzkrižnega datiranja, postopek navzkrižnega datiranja)</p> <ul style="list-style-type: none"> • analiza sinhroniziranih zaporedij širin branik (značilna leta, nenadne spremembe v rasti, srednja stopnja občutljivosti, avtokorelacijska analiza, analiza glavnih komponent, elementi analize časovnih vrst) • transformacije oziroma standardizacija časovnih vrst (z matematično statističnimi osnovami) • izdelava kronologij posameznih prostorskih kategorij (lokalne, regionalne,...) • dendroekologija - preverjanje, iskanje povezav med različnimi parametri branik in različnimi ekološkimi dejavniki • modeliranje odziva drevesa in klimatske spremembe preko response funkcij (enostavne linearne in kompleksne večkriterialne povezave) • veje in uporaba dendrokronologije (dendroklimatologija, izotopska dendrokronologija, dendrogeomorfologija, dendrohidrologija) 	<p>visual and statistical indicators - t value after Baillie-Pilcher, the coefficient of temporal coherence, an index of cross-dating, the process of cross-dating)</p> <ul style="list-style-type: none"> • analysis of synchronized tree-ring sequences (pointer years, pointer intervals, abrupt growth change, mean sensitivity, autocorrelation, principal components, basics of time-series statistics) • transformation and standardization of chrono-sequences (including mathematical background) • construction of site, local and regional chronologies • dendroecology - correlation between proxy data and different measurements of ecological data • modeling of tree-growth based on climate growth relationship • Use of dendrochronology in different sciences (dendroclimatology, stable isotope chronology, dendrogeomorphology, dendrohydrology)
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Temeljna literatura in viri / Textbooks:

Obvezna / Required:

1. Levanič, 2012 – Dendrokronologija, študijsko gradivo
2. Gradiva s predavanj v PDF obliki

Priporočena / Recommended:

1. Cook, E. R. / Kairiukstis, L. A., 1989. Methods of dendrochronology (applications in the environmental sciences).- Dordrecht, Boston, London, Kluwer academic publishers, 394 s.
2. Schweingruber, F. H., 1989. Tree rings: basics and applications of dendrochronology.- Dordrecht, Boston, London, Kluwer Academic Publisher, 276 s.
3. Schweingruber, F. H., 1990. Anatomie europäischer Hoelzer. - Anatomy of European woods.- Bern, Stuttgart, Haupt, 800 s.
4. Stokes, M. A. / Smiley, T. L., 1996. An Introduction to Tree-Ring Dating.- Tucson, The University of Arizona Press, 73 s.

In revijalni članki s področja, tekoča periodika, druga učna gradiva...

Cilji in kompetence:

Predmetno specifični cilji in kompetence:

- Spoznati se z dendrokronologijo in dendroekologijo - metodo za datiranje lesa in lesenih predmetov ter metodo za preučevanje odziva drevesa na okoljske / klimatske dejavnike

Objectives and competences:

Specific competences:

To gain knowledge about dendrochronology and dendroecology – method for dating wood and study environmental processes through radial increment of

Splošne kompetence:

Študent pridobi osnovna znanja s področja dendrokronologije in dendroekologije s posebnim poudarkom na odvzemu vzorcev, merjenju širin branik in merjenju drugih pomembnih spremenljivk katerih osnova je branika (npr. gostota branike oziroma gostote ranega in kasnega lesa, izotopska sestava (ogljik, kisik, vodik in dušik) branike oz. ranega in kasnega lesa). Na predavanjih se študent seznanja s celotnim kompleksom dendrokronologije, ki obsega spoznavanje z anatomskimi osnovami drevesne branike, prepoznavanje lesa iglavcev in listavcev, odziv drevesa na okoljske dejavnike in strese ter metodami zajema in obdelave podatkov. Študent se na predavanjih in vajah nauči izvesti dendroekološki projekt - od postavitve raziskovalnih vprašanj, preko izvedbe vzorčenja, merjenja, sinhronizacije / datacije do vrednotenja podatkov z modernimi matematično - statističnimi tehnikami. Študente seznanimo tudi z najmodernejšimi merilnimi in analitskimi tehnikami, ki se v zadnjem času vse bolj uveljavljajo v dendrokronologiji - densitometrija in merjenje vsebnosti stabilnih izotopov v branikah....

trees and their relation to climate and environmental factors.

General competences:

The student acquires basic knowledge in the field of dendrochronology and dendroecology, with a special emphasis on sample extraction, measuring tree-ring widths, and measuring other important variables based on tree rings (e.g., ring density or the density of earlywood and latewood, isotopic composition—carbon, oxygen, hydrogen, and nitrogen—of tree rings or of earlywood and latewood).

In the lectures, the student becomes familiar with the entire scope of dendrochronology, which includes understanding the anatomical fundamentals of tree growth, recognizing tree rings in conifers and broadleaves, the response of trees to environmental factors and stresses, and methods for data collection and processing.

Through lectures and practical exercises, the student learns how to carry out a dendroecological project—from formulating research questions, conducting sampling and measurements, synchronizing/dating the samples, to evaluating the data using modern mathematical and statistical techniques.

Students are also introduced to the most advanced measuring and analytical techniques that have been increasingly used in dendroecology in recent years—densitometry and the measurement of stable isotope composition in tree rings.

Predvideni študijski rezultati:**Znanje in razumevanje:**

- **poglobljeno razume teoretične osnove dendrokronologije in dendroekologije**, vključno s sodobnimi pristopi k analizi prirastka, stresnih signalov in rekonstrukciji klime na osnovi drevesnih branik;
- **obvlada napredne metode in tehnike vzorčenja, merjenja, obdelave in standardizacije dendrokronoloških podatkov;**
- **razume statistične, ekološke in fiziološke procese**, ki oblikujejo prirastek drevja, ter zna razložiti osnove zgradbe lesa;
- **pozna sodobne aplikacije na evropski in globalni ravni**, vključno s klimatskimi rekonstrukcijami, analizo ekstremnih dogodkov, ekologijo motenj in antropogenimi vplivi;

Intended learning outcomes:**Knowledge and understanding:**

- understands in depth the theoretical foundations of dendrochronology and dendroecology, including modern approaches to growth-ring analysis, stress-signal detection, and climate reconstruction based on tree-ring records;
- masters advanced methods and techniques for sampling, measuring, processing, and standardising dendrochronological data;
- understands the statistical, ecological, and physiological processes that shape tree growth, and can explain the fundamental principles of wood structure;
- is familiar with contemporary applications at the European and global levels, including climate reconstructions, analysis of extreme events, disturbance ecology, and assessments of anthropogenic impacts;

<ul style="list-style-type: none"> • razume interdisciplinarne povezave z gozdarstvom, ekologijo, geomorfologijo, fitopatologijo, arheologijo, restavratorstvom ter varstvom kulturne dediščine; <p>Prenosljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> • samostojno izvesti celoten proces od terenskega zajema vzorcev do laboratorijske obdelave in interpretacije; • uporabiti napredne statistične metode (npr. detrending, indeksacija, verifikacija, večrazsežne analize); • analizirati kompleksne časovne serije prirastka ter povezovati signale z okoljskimi dejavniki; • izvajati kritične primerjave med drevesnimi vrstami, rastišči in okoljskimi stresorji; • oblikovati in preverjati hipoteze ter izvedene rezultate ustrezno interpretirati. sposobnost integracije podatkov iz različnih virov (klima, tla, geomorfni procesi, biotski dejavniki); • samostojna priprava strokovnih in znanstvenih poročil na visoki ravni; • komunikacija rezultatov strokovni in nestrokovni javnosti; 	<ul style="list-style-type: none"> • understands interdisciplinary connections with forestry, ecology, geomorphology, phytopathology, archaeology, conservation-restoration, and the protection of cultural heritage. <p>Transferable/key skills and other attributes:</p> <ul style="list-style-type: none"> • independently carry out the entire process from field sampling to laboratory processing and interpretation; • apply advanced statistical methods (e.g., detrending, indexing, verification, multivariate analyses); • analyse complex tree-ring time series and relate detected signals to environmental factors; • perform critical comparisons among tree species, site conditions, and environmental stressors; • formulate and test hypotheses and appropriately interpret the resulting findings; • integrate data from multiple sources (climate, soils, geomorphic processes, biotic factors); • prepare high-quality professional and scientific reports independently; • communicate research results effectively to both expert and non-expert audiences.
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Metode poučevanja in učenja:

<p><u>Oblike dela:</u></p> <ul style="list-style-type: none"> • Predavanja in smiselno vključevanje vaj in demonstracij <p><u>Metode dela:</u></p> <ul style="list-style-type: none"> • Frontalna predavanja • Demonstracije različnih metod • vaje

Learning and teaching methods:

<p><u>Forms of teaching:</u></p> <ul style="list-style-type: none"> • Lectures and the meaningful integration of exercises and demonstrations <p><u>Teaching methods:</u></p> <ul style="list-style-type: none"> • frontal teaching • exercises • demonstrations
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Načini ocenjevanja:

Delež (v %) /

Weight (in %) **Assessment:**

<p>Pogoj za pristop k izpitu: ... Ni posebnih pogojev</p> <p>Končna ocena pri predmetu je sestavljena iz ocene dobljene na izpitu</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>100</p>	<p>A prerequisite for access to the exam: ... No special requirements</p> <p>Final evaluation consists entirely of the exam score</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%
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Materialni pogoji za izvedbo predmeta :

- Digitalni projektor in platno
- Tabla za pisanje

Material conditions for subject realization:

- Digital projector and
- whiteboard

Obveznosti študentov:

Prisotnost na predavanjih

Student's commitments:

Presence at the lectures

Reference nosilca predmeta:

Pedagoško delo:

- Predavatelj na Univerzi v Ljubljani (Biotehniška fakulteta, Filozofska fakulteta)
- Predavatelj na Univerzi na Primorske (FAMNIT)

Znanstveno-raziskovalno delo:

- Znanstveni svetnik na Gozdarskem inštitutu Slovenije – področje rast in prirastek, dendroekologija, stabilni izotopov v drevesnih branikah in živalskih tkivih, statistične metode in modeliranje...

Strokovno delo in izbrane strokovne publikacije:

- ...

Priznanja in nagrade:

- Nagrada Hrvaškega gozdarskega inštituta v Jastrebarskem ob praznovanju 80-letnice inštituta...

Lecturer's references:

Pedagogic activities:

- Lecturer at the University of Ljubljana (Biotechnical Faculty, Faculty of Arts)
- Lecturer at the University of Primorska (FAMNIT)

Scientific and research work:

- Research Councillor at the Slovenian Forestry Institute – specializing in tree growth and increment, dendroecology, stable isotopes in tree rings and animal tissues, statistical methods, and modelling...

Professional work and selected professional publications:

- ...

Awards:

- Award of the Croatian Forestry Institute on the occasion of the Institute's 80th anniversary
- ...

Izbrani znanstveni članki / Selected scientific papers:

1. KAŠPAR, Jakub, KRÁL, Kamil, LEVANIČ, Tom, LIPUŽIČ, Pia Caroline, ČATER, Matjaž. Climate growth limitations of European beech and silver fir along the Carpathian arc – the recent state and future

- prospects. *Agricultural and Forest Meteorology*. [Online ed.]. 2025, vol. 361, art. no. 110323, str. 1-11, ilustr. ISSN 1873-2240 [COBISS.SI-ID [217284355](#)]
2. KOSTIĆ, Saša, KEBERT, Marko, ORLOVIĆ, Saša, **LEVANIČ, Tom**. Nitrogen stable isotope ($\delta^{15}\text{N}$), PCBs, PAHs and their nitro derivatives (NPAHs) in tree rings as a reliable tool for air pollution reconstruction in urban areas: a study of CO, NO₂, PM₁₀, PM_{2.5}, and SO₂ concentrations in the air. *Environmental pollution*. 2025, vol. 390, [article no.] 127431, str. 1-15. ISSN 1873-6424. [COBISS.SI-ID [259753475](#)],
 3. KOBAL, Milan, **LEVANIČ, Tom**. Optimizing competitor definitions for the sustainable management of dominant silver fir trees (*Abies alba* Mill.) in uneven-aged mixed Dinaric forests. *Forest ecosystems*. 2025, vol. 14, article no. 100346, str. 1-10. ISSN 2197-5620. [COBISS.SI-ID [238309379](#)],
 4. LIPUŽIČ, Pia Caroline, PRISLAN, Peter, **LEVANIČ, Tom**, JEVŠENAK, Jernej, KAŠPAR, Jakub, ČATER, Matjaž. The impact of climate change on anatomical characteristics of Silver fir and European beech wood from three sites in the Carpathians, Romania. *Forests*. [Online ed.]. 2025, vol. 16, iss. 9 [article no. 1497], str. 1-26. ISSN 1999-4907 [COBISS.SI-ID [250455043](#)]
 5. KLESSE, Stefan, PETERS, Richard, ALFARO-SÁNCHEZ, Raquel, BADEAU, Vincent, BAITTINGER, Claudia, ČUFAR, Katarina, GRIČAR, Jožica, MERELA, Maks, PRISLAN, Peter, **LEVANIČ, Tom**, et al. No future growth enhancement expected at the Northern edge for European beech due to continued water limitation. *Global change biology*. Online ed. 2024, vol. 30, iss. 10, str. 1-16. ISSN 1365-2486 [COBISS.SI-ID [214529283](#)]
 6. TREYDTE, Kerstin, LIU, Laibao, PADRÓN, Ryan S., MARTÍNEZ-SANCHO, Elisabet, BABST, Flurin, FRANK, David C., GESSLER, Arthur, KAHMEN, Ansgar, POULTER, Benjamin, SENEVIRATNE, Sonia I., HAFNER, Polona, **LEVANIČ, Tom**, et al. Recent human-induced atmospheric drying across Europe unprecedented in the last 400 years. *Nature geoscience*. 2024, vol. 17, iss. 1, str. 58–65. ISSN 1752-0908. [COBISS.SI-ID [179713283](#)],
 7. JEVŠENAK, Jernej, KLISZ, Marcin Mirosław, MAŠEK, Jiří, ČADA, Vojtěch, JANDA, Pavel, SVOBODA, Mirosław, VOSTAREK, Ondřej, TREML, V., VAN DER MAATEN-THEUNISEEN, Ernst, POPA, Andrei, ARNIČ, Domen, PRISLAN, Peter, **LEVANIČ, Tom**, ČUFAR, Katarina, NOVAK, Klemen, ŠKRK DOLAR, Nina, HAFNER, Polona, KRAJNC, Luka, BRUS, Robert, GRIČAR, Jožica, MERELA, Maks, SKUDNIK, Mitja, OŠTIR, Krištof, et al. Incorporating high-resolution climate, remote sensing and topographic data to map annual forest growth in central and eastern Europe. *Science of the total environment*. [Online ed.]. 2024, vol. 913, e. 169692, str. 1-14. ISSN 1879-1026. [COBISS.SI-ID [179238147](#)]
 8. MRAK, Tanja, GRIČAR, Jožica, UNUK NAHBERGER, Tina, BOŽIČ, Gregor, KRAJNC, Luka, PRISLAN, Peter, ARNIČ, Domen, **LEVANIČ, Tom**, KRAIGHER, Hojka. How beech provenance affects the structure of secondary xylem, leaf traits, and the ectomycorrhizal community under optimal growth conditions. *Trees*. 2024, vol. 38, str. 637–653. ISSN 1432-2285. [COBISS.SI-ID [193140483](#)],
 9. KERMAVNAR, Janez, **LEVANIČ, Tom**, KUTNAR, Lado. Stable isotope composition in tree rings of *Fagus sylvatica* L. saplings reflects environmental variation induced by silviculture and microsite factors. *Forest ecology and management*. 2023, vol. 537, article no. 120949, 14 str. ISSN 1872-7042 [COBISS.SI-ID 147879171]
 10. LIPUŽIČ, Pia Caroline, **LEVANIČ, Tom**, HANZU, Mihail, ČATER, Matjaž. Growth response of European beech (*Fagus sylvatica* L.) and Silver Fir (*Abies alba* Mill.) to climate factors along the Carpathian massive. *Forests*. [Online ed.]. 2023, vol. 14, iss. 7 [article no. 1318], 13 str. ISSN 1999-4907, [COBISS.SI-ID 157075203]
 11. **LEVANIČ, Tom**, CIGIČ, Blaž, GERM, Mateja, POLIŠENSKÁ, Ivana, VACULOVÁ, Kateřina, PRAVST, Igor, KOČJAN AČKO, Darja, KREFT, Ivan. Differences in ratio of carbon stable isotopes among barley grain milling fractions with various concentrations of beta-glucans. *Molecules*. 2023, vol. 28, article no. 5738, str. 1-8. ISSN 1420-3049. [COBISS.SI-ID [160452867](#)], [
 12. **LEVANIČ, Tom**, UGARKOVIĆ, Damir, SELETKOVIĆ, Ivan, OGNJENOVIĆ, Mladen, MARUŠIĆ, Mia, BOGDANIĆ, Robert, POTOČIĆ, Nenad. Radial increment of beech (*Fagus sylvatica* L.) is under a strong impact of climate in the continental biogeographical region of Croatia. *Plants*. 2023, vol. 12, iss. 13 [article no. 2427], str. 1-22. ISSN 2223-7747 [COBISS.SI-ID [157081859](#)],
 13. MÉSZÁROS, Ilona, ADORJÁN, Balázs, NYITRAI, Balázs, KANALAS, Péter, OLÁH, Viktor, **LEVANIČ, Tom**. Long-term radial growth and climate-growth relationships of *Quercus petraea* (Matt.) Liebl. and *Quercus cerris* L. in a xeric low elevation site from Hungary. *Dendrochronologia*. 2022, vol. 76, art. 126014, 13 str. ISSN 1612-0051 [COBISS.SI-ID [127065859](#)]

14. KOSTIĆ, Saša, **LEVANIČ, Tom**, ORLOVIĆ, Saša, MATOVIĆ, Bratislav, STOJANOVIĆ, Dejan. Turkey oak (*Quercus cerris* L.) is more drought tolerant and better reflects climate variations compared to pedunculate oak (*Quercus robur* L.) in lowland mixed forests in northwestern Serbia : a stable carbon isotope ratio ($\delta^{13}C$) and radial growth approach. *Ecological indicators : integrating monitoring, assessment and management*. 2022, vol. 142, art.109242, str. 1-11, ilustr. ISSN 1470-160X. [COBISS.SI-ID [117186307](#)],