Course directory 2020.2021

school of biology (FBM-BIO)
master

* your selection

> Biology > Master of Science (MSc) in Behaviour, Evolution and Conservation, Specialisation Geosciences, Ecology and Environment
NOTICE

This course catalogue was produced using data from the *SylviaAcad* information system of the University of Lausanne. Its database contains all information about courses proposed by the different faculties and their times. This data can also be consulted online at the address: https://applicationspub.unil.ch/interpub/noauth/php/Ud/index.php.

Web site of the faculty: http://www.unil.ch/ecoledebiologie/

Generated on: 09.11.2021
### LEGEND

#### NAME OF THE COURSE

<table>
<thead>
<tr>
<th>Type of course</th>
<th>Status</th>
<th>Hours per week</th>
<th>Teaching language</th>
<th>Hours per year</th>
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<tbody>
<tr>
<td>Semester</td>
<td>Credits</td>
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**N:** Levels  
**P:** Programme requirements  
**O:** Objective  
**C:** Content  
**B:** Bibliography  
**I:** Additional information

### ABBREVIATIONS

#### TYPE OF COURSE

<table>
<thead>
<tr>
<th>Abbreviation</th>
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<td>Lg</td>
<td>Guided lecture</td>
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<td>T</td>
<td>Fieldwork</td>
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<td>TP</td>
<td>Practical work</td>
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#### STATUS

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<tr>
<td>Opt</td>
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<td>Facultative, compulsory or optional (according to the study programme)</td>
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#### SEMESTER

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<td>Autumn</td>
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The Master program has a normal duration of 3 semesters and comprises 90 ECTS:
- 15 ECTS: Compulsory (5.5 ECTS) and Optional courses (9.5 ECTS) (Module 1)
- 15 ECTS: First Step Project (Module 2)
- 30 ECTS: Compulsory (5 ECTS) and Optional courses (25 ECTS) (Module 3)
- 30 ECTS: Personal Research Project (Master Thesis) (Module 4)

For specialisation Geosciences, Ecology and Environment (GEE) (30 ECTS), the student must obtain:
- 5.5 ECTS with Compulsory courses (marked in green) and at least one Cross-disciplinary course (marked in blue) in Module 1
- 5 ECTS with Inter-disciplinary compulsory courses in Module 3
- 15.5 ECTS with at least 15 ECTS with Disciplinary and Cross-disciplinary Optional courses in the Module 3
- Modules 2 and 4 have to be in geosciences, ecology or environment fields, validated by the head of GEE specialisation

Training objectives are available in its programme regulations.

Specific training objectives:
At the end of the course the students will be able to:
- Solve complex ecological problems through quantitative and modelling approaches, using complementary knowledge acquired in geosciences and environmental sciences
- Have an integrated view of natural systems and conduct interdisciplinary research projects in ecology/environment
- Transfer scientific knowledge and skills acquired to applied problems in the field of ecology, environment and conservation

Autumn Semester (semester 1)

<table>
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<tr>
<th>Courses / Enseignement</th>
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<th>ECTS Credits</th>
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<td>Data Analysis</td>
<td>C/E/S: 6/6</td>
<td>Salamin N., Bergmann S., Ciriolo G., Trejo Banios D.</td>
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<td>Spatial Analysis and GIS in Ecology</td>
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<td>Kawecki T.</td>
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<td><strong>Optional / Optionnel</strong></td>
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<td>Environmental Chemistry and Toxicology (GSE)</td>
<td>EC: 56 CPW</td>
<td>Chèvre N., Asta M.</td>
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<td>Molecular Methods in Ecology and Evolution</td>
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<td><strong>Total (Module 2)</strong></td>
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**Practical Project / Travail pratique**
- First Step Project | C/E/S: 224 | Kawecki T., Guisan A | 15 |

* Only students who choose a master project with animal experimentation are allowed to select this course

Disciplinary courses marked in green
Cross-disciplinary courses marked in blue

Abbreviations
C = Course
E/S = Exercise/Seminar
PW = Practical Work
CPW or CE = Course/Practical Work or Course/Exercise
BIOLOGICAL SECURITY

Patrick Michaux

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N: Master

P: A basic knowledge of microbiology and vegetal science

O: To familiarise future researchers with legislation concerning genetic engineering. In addition, possible biological risks associated to different applications of this technology will be discussed with the help of examples. This teaching is a mandatory prerequisite for First-Step.

C: * Legislation: article 24 of the Federal Constitution; law concerning environmental protection; law concerning epidemics; ordinance on protection against major accidents; Swiss commissions on biological security: notification and registration of projects.
   * Biological security in the laboratory: containment; security equipment; technical measures: laboratory construction; standard laboratory (microbiological) practice; classification of biological material: plasmids, microorganisms, cell lines, primary cells; security levels 1-4.
   * Release of genetically modified bacteria in the environment: monitoring, survival and dissemination, ecological impact, transfer of genes, containment systems.
   * Potential biological risks associated with the use of transgenic plants: dissemination, cross-pollination, gene transfer.
   * The problem of recombinant vaccines: vectors, DNA vaccines.
   * Somatic genetic therapy I: Illnesses accessible to treatment by somatic genetic therapy, gene transfer methods.
   * Somatic genetic therapy II: Evaluation of the biological risk for the patient and his environment.
DATA ANALYSIS

N: Master

P: We assume nothing more than the mathematics you would have obtained in your studies when you were 18.

O: In this course the goal is to be able to formulate hypotheses properly, design experiments, whether in the laboratory, in a clinic, or in the field, that have sufficient power to test these hypotheses, conduct appropriate statistical tests of the data generated, generate clear figures, and interpret the results obtained.

C: We will cover:
   1. Distributions and random variables
   2. Variance, covariance and measures of association
   3. Constructing statistical tests using distributions
   4. Regression
   5. Non-linear regression
# INTRODUCTION INTO SCIENTIFIC WRITING

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N: Master

P: Lecturing and paper writing are in English.

O: This short but intensive block course introduces students to the practice of scientific writing (and aspects related to publishing in peer-reviewed scientific journals). We will discuss questions/topics such as:
- Why is it important to publish?
- What is good/clear versus bad/unclear (scientific) writing?
- How to learn how to write well?
- How to structure and write a good scientific manuscript?
- The submission, editorial and reviewing process.
- How to review someone else’s paper?
- Plagiarism and publication ethics

Publishing is of key importance in scientific research: your job as a scientist is not finished until you have published your results - science is to a very large extent about effectively communicating your results and insights, i.e. what you have learned about how nature works. The ultimate aim of this intensive course is thus to equip students with a solid understanding of how to effectively communicate their research in writing.
C: Course Content
The course includes both lectures and practical exercises in class, distributed over four half-days. The lectures will give a broad and brief overview of different aspects of scientific writing and publishing as well as on plagiarism and publication ethics; however, the major emphasis of the course is on practical work on the part of the students. During the practical parts the students will learn, from scratch, the fundamental structure and essential components of scientific writing, how to write effective outlines/drafts and - most importantly - how to write complete, clear, well-structured papers. These practical exercises will thus require students to do reading and writing assignments, often under a bit of time pressure.
At the beginning the exercises will be worked on by teams of 2-4; towards the end, each student will work individually. Finally, to get a grade for this class, students will have to complete a written report (homework assignment). For each exercise as well as for the written report we will give detailed and individualized feedback. Note that all lecturing and assignment writing are in English.

Detailed Programme
Module 1: Lecture 1: Writing papers: overview of why and how.
We will discuss the following: Overview of class and organizational things (incl. homework assignments). Why is it important to publish? What is good/clear versus bad/unclear (scientific) writing? How to learn how to write well? [We will also briefly touch upon issues of good scientific practice and conduct, and various ethical issues connected to publishing.] Approx. 2 hours.
In groups of 2-3. Read the assigned (stripped down and short) manuscript and come up with a title and with keywords. Then write a short abstract (< 200 words). Approx. 1.5 hours. We will then discuss the solutions you have come up with, and their potential pros and cons, together in class. Approx. 30 mins.
Module 2: Lecture 2: Writing papers: details on structure, drafting, revising.
We will discuss the basics and essentials of writing a scientific paper (and also what not to do!). Specifically, I will explain how a paper should be structured and sub-structured, how to draft a paper (i.e., how to get started), how to build and complete a full manuscript, and then how to improve it by continuous and aggressive revising and re-revising. I will also give you hints and tips for effective writing. Approx. 1.5 hours.
Module 2: Practical 2. Write a paper: your own nano-paper from results.
I will give you some data/results (e.g., data figures/tables/legends/statistical outcomes) to choose from. Form teams of 3-4 people. Ask yourself: What do the results/figures/analyses show and mean? Then prepare a very short nano-paper (2 pages max), including: Title, Abstract, Introduction, Materials and Methods, Results, Discussion and Conclusion (there are some other components in a paper that we will skip for the sake of this exercise). Each component should be between 1 and 3-4 sentences maximum. Approx. 2 hours. We will then discuss your solutions and their potential pros and cons together in class; Approx. 30 mins. We will then give you detailed feedback on your papers by e-mail after the course.
Module 3: Lecture 3: Publishing papers: understanding the whole process.
We will briefly recapitulate what we have discussed and learned so far, and then focus on the ‘final’ stages of writing a paper and submitting it to a journal. Approx. 1 hour.
Module 3: Practical 3: Review a paper: critically assess a manuscript.
What distinguishes a good from a bad manuscript? Now you are the reviewer! Being a critical reviewer will help you to learn to distinguish between good and bad writing and thus help you to improve your own scientific writing. You will be given a short, stripped-down manuscript. Team up in groups of 2-3. Read both manuscripts critically, then make pro and contra lists for both manuscripts. Briefly explain why you would accept/reject (or reach some other decision) the manuscript for publication (
# SPATIAL ANALYSIS AND GIS IN ECOLOGY

Antoine Guisan

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N: Master

P: Basics in statistics and ecology

O: Teaching students the basics of GIS and remote sensing, as well as the main spatial methods available in spatial ecology.

C:
1. Introduction to GIS
2. Introduction to remote sensing
3. Raster analyses
4. Neighbourhood analyses
5. Spatial interpolation
6. Detection of spatial structures and patterns

B:

I: http://www.unil.ch/ecospat
This 5 credit course (56 hrs C&TP) is required for students completing the Masters in Environmental Geosciences. This course is divided into two modules focused on (i) application of empirical, thermodynamics and kinetic models that describe the distributions and concentrations of chemical species in environmental systems (ii) learning the methods and limits of environmental risk assessment, with a focus on chemicals, alone or in mixture. A personal assessment of one case study linked with the course topics is also required.

- Partitioning of organic and inorganic contaminants
- Structure-activity relationships
- Aqueous and surface speciation
- Rates of contaminant degradation
- Dose-response curves
- Environmental risk assessment

All the books are available in the Geosciences library:
- Principles and Applications of Aquatic Chemistry (1993) Morel and Hering
- Geochemistry, Groundwater and Pollution (2009) Appelo and Postman
- Environmental Modeling (1996) Schooner
This course provides an introduction to time series analysis and signal processing for the environmental sciences. Topics to be covered, in the context of relevant environmental examples, include linear system and signal analysis, convolution, the Fourier transform, auto- and cross-correlation, data filtering, filter design, sampling and signal reconstruction theory, spectral estimation, and time-frequency analysis. Concepts learned in lectures will be reinforced through weekly computer exercises.
NATURE CONSERVATION
Tim Badman, Laine Chanteloup, Emmanuel Reynard, Gretchen Walters

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N: Master

O: In November 2019, the University of Lausanne and the IUCN signed a partnership agreement aimed at intensifying their exchanges around research work and its applications on the planet’s environmental concerns. This course is a concrete application of this partnership involving both various researchers from Unil and IUCN professionals. A convention is also being set up between the University of Lausanne and the Lavaux World Heritage Association to strengthen the scientific knowledge carried out in this protected area. This course aims to get better acquainted with this site and the conservation challenges it faces.

The objective of this course is to bring elements of reflection and analysis to students concerning contemporary debates around the conservation and protection of nature. This course reviews the definitions as well as the historical and cultural aspects of nature conservation and the implementation of different protected areas around the world. It also addresses through various examples and case studies the current management issues in nature conservation. This course-seminar includes two field trips with meetings of IUCN professionals.

C:
- Introduction to Nature Conservation
- Protected areas and landscape governance
- Conservation and management issues
- Management effectiveness, World Heritage, geoparks, biosphere reserves and Ramsar.
- Fieldtrip to Lavaux Unesco site
- Hunting, protected areas and conservation
- Fieldtrip to IUCN center
- Conservation by indigenous peoples and local communities
- Conservation and Education

B:
REMOTE SENSING OF EARTH SYSTEMS
Pascal Egli, Stuart Lane, Grégoire Mariéthoz, Fabio Oriani

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N: Master

P: Bases in remote sensing, use of Matlab and/or other scripting languages

O: The aim of this course is to provide advanced knowledge of some specific methods used in remote sensing. This will include retrieval and processing of satellite data, data acquisition techniques such as photogrammetry, Structure-From-Motion and methods used as well as computer-aided processing and visualization of remote sensing data.

C: At the end of this course, students will: - Be able to locate and download satellite imagery, and apply treatment to such images in order to extract information; - Be familiar with platforms such as USGS GLOVIS and Google Earth Engine; - Be able to use advanced software tools such as the Matlab Image Processing Toolbox for the processing of remote sensing data; - Be able to apply standard methodologies such as classification, pansharpening, interpolation, edge detection or filters, among others; - Have the ability to apply and understand the principles of photogrammetry.

ADVANCED DATA ANALYSIS

Nicolas Salamin

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N: Master

P: You must have attended the first data analysis course, or convince me that you are competent at basic statistical analyses.

O: The aim of this course is to build upon the data analysis course, to prepare you to handle a range of different data and more complex analysis problems.

C: In this course we will cover:
   1. Repeated measures models and mixed effects models.
   2. Survival analyses
   3. Bayesian statistical inference
**ANIMAL COMMUNICATION AND PARASITISM**

Philippe Christe

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- **N:** Master
- **P:** None
- **O:** Across the animal kingdom, individuals of the same species differ in their propensity to take risks, and explore new environments, and to be active, aggressive or sociable. Individual differences in behaviour that are consistent through time and across contexts are coined ‘personalities’, ‘behavioural syndromes’ or ‘temperaments’. The terminology of personality is not a mere fashionable label of something usually studied by behavioural ecologists, but useful to conceptualise the common phenomenon that individuals differ markedly and consistently in their behavioural phenotypes across ecological and social contexts. The notion of personality implies that suites of behaviours are correlated within individuals and hence individuals are less flexible than would be expected under optimality models. In this course, I propose to study personality from an evolutionary point of view and also the evolution of language.

- **C:** This lecture is interactive and illustrated by recent research articles. 7h will be given by A. Roulin and 7h by P. Christe


- **I:** Aucune
MAJOR TRANSITIONS IN EVOLUTION

Laurent Keller

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English 14

N: Master

P: none

O: The aim of this course is to discuss some of the major transitions that occurred over the course of evolution. The general idea is that students will be able to work on a topic they selected themselves.

C: Students (in groups of 2 or 3) will have to identify a specific topic of interest and make a short presentation. There will then be a discussion between all participants of the course. The discussion will be lead by the students presenting and myself. Examples of topics that have previously been chosen by students include: Evolutionary explanation to the evolution of cooperation, speciation, the resolution of genomic conflict, evolution of sex chromosomes, the moulding of senescence, and the evolution of sexes.

B: La bibliographie sera déterminée lors du cours.
MOLECULAR METHODS IN ECOLOGY AND EVOLUTION
Luca Fumagalli, Ian Sanders

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N: Master

O: The objective of this course is to learn the relevant molecular tools that are currently used in ecology, evolutionary and conservation biology research and understand why and when to apply them.

C: This course covers the reasons why molecular genetics is a necessary tool in many ecology, evolution and conservation biology projects. We study its uses and then look at a selection of techniques, particularly for looking at polymorphism, that are not traditionally taught in molecular cell biology courses. Many of the techniques can only be learnt in the classroom as there is not enough time in a week to practically learn all useful techniques. Therefore, the associated laboratory class cover some of the fast techniques that are useful for studying polymorphisms in populations.

B: The course is mostly based on publications in international journals rather than one specific book. The publications are made available in PDF format at the beginning of the course.
**PHYLOGEOGRAPHY**

Luca Fumagalli

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N: Master

O: 1) Course
   Study of the historical processes (population expansions, bottlenecks, vicariance and migration) responsible for the current geographic distribution of genealogical lineages.
2) TPs
   Analysis and interpretation of phylogeographic data with the help of several softwares.

C: 1) Phylogeography: definition and historical backgrounds
   2) Animal and plant molecular markers
   3) Distribution area
   4) Gene tree/species tree
   5) Molecular clocks
   6) Coalescence
   7) Mismatch distribution
   8) Phylogenetic trees and networks
   9) Phylogeographic patterns
   10) Comparative phylogeography
   11) Phylogeography and conservation
   12) Phylogeography and genomics.

POPULATION GENETICS AND DYNAMICS

Jérôme Goudet

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N: Master

P: A good grasp of the principles of population genetics and population dynamics (i.e. at least an introductory course in both)

O: Gain an understanding of how genetics and genomics interact with demographic and selective processes.
website: http://www2.unil.ch/popgen/teaching/PGD20

C: In the first part of the course, selected papers from the recent literature are presented by students and discussed in a journal club format.
In the second part, in groups of 2-3 students you will use computer simulations and the quantiNemo program to investigate questions such as:
- efficacy of selection in the face of gene flow?
- effect of the number of loci encoding a trait on the speed of adaptation
- is neutral diversity a good proxy for adaptive diversity?

I: http://www2.unil.ch/popgen/teaching/PGD20/
## ANIMAL EXPERIMENTATION AND WILD ANIMALS

**Jean-François Rubin**

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FIRST STEP PROJECT
Richard Benton, Marie-Christine Broillet, Antoine Guisan, Tadeusz Kawecki, Laurent Lehmann, Marc Robinson-Rechavi

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N: Master
P: Practicals performed during the bachelor (molecular biology, genetics, biochemistry, bioinformatics)
O: - An initiation to the work of a scientist
   - Conduct experimental work in research lab (wet bench or in silico)
   - Interpretation of research results
   - Implement basic principles in experimental design (e.g. include the appropriate controls, statistical significance of the results etc...)
   - Present your experimental work in a written report which will be organized like a typical research article (introduction, results, discussion, materials and methods)
   - Present your work orally (seminar style)
C: Perform laboratory work for about 12 weeks during the time when the student does not follow theoretical classes. This research project will typically be performed under the guidance of a PhD student or a post-doc from the host laboratory.
Due to the sanitary evolution related to COVID-19, the study plans may be adapted during the semester as follows:

- possibility to switch from one mode of teaching to another (face-to-face => distance, synchronous => asynchronous, switch to co-modal teaching when it was not initially planned);
- adaptation of evaluation modalities, without inducing derogations from the Study Regulations (oral => written, exam => validation, individual work => group work, practical work => theoretical work, face-to-face evaluation => online evaluation, etc.);
- alternative or time-shifted modalities for teachings, internships, practical work, fieldworks and camps that could not take place or teachings that could no longer take place in the form initially planned.

Students are invited to consult this document regularly (Study Plan & Evaluation Procedure)
### INTEGRATED COURSE MOUNTAIN ECOSYSTEMS - ECOLOGY & EVOLUTION

**Antoine Guisan**

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# INTEGRATED COURSE MOUNTAIN ECOSYSTEMS - GEO-ENVIRONMENTAL SCIENCES

Antoine Guisan

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INTEGRATED PRACTICAL WORK MOUNTAIN ECOSYSTEMS IN THE ALPS

Antoine Guisan

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N: Master

P: Bachelor in environmental and/or biological sciences.

O: To offer an interdisciplinary vision of mountain environments and elevation gradients through the lens of different questions in ecology and evolution.

C: Two fields retreats of 2-days and 3-days, with courses and practical works and exercises, with 14C of lectures by different teachers in-between. Content of the lectures:
   1. Adaptations to marginal environments
   2. Reproductive systems along elevation
   3. Patterns of micro-organisms along elevation
   4. Biological invasions in mountains
   5. Impact of climate change on mountain species and communities - field observations and experiments
   6. Impact of climate change on mountain species and communities - spatial modelling
   7. Human-wild fauna conflicts in mountain regions

B: See English pages of the course

I: See English pages of the course
ENVIRONMENTAL DATA MINING

Mikhail Kanevski

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N: Master

P: Course in basic statistics, Geostatistics and GIS

O: - To present basics of data driven modelling and methodology of environmental data mining
- To understand and to use artificial neural networks of different architectures for environmental data analysis and modelling.
- To present fundamental ideas of statistical learning theory and application of kernel-based methods for the analysis and modelling of environmental data

C: Introduction to data driven modelling and data mining.
- Basic notions and concepts
- Learning from data: methodology
- Presentation of data and case studies
- Machine learning and data analysis
- Basics of machine learning
- Models selection and models evaluation
- Benchmark model: k-Nearest Neighbours
- Artificial neural networks:
  - Multilayer perceptron (MLP)
  - General Regression Neural Networks (GRNN) and Probabilistic Neural Networks (PNN)
  - Self-Organizing Kohonen (SOM) maps
- Statistical Learning Theory
  - Concepts and hypotheses
  - Support Vector Machines (SVM)
  - Support Vector Regression (SVR)
  - Classification and mapping of environmental data.
- Seminars, case studies, practices

GEOSTATISTICS AND GIS

Mikhail Kanevski

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N: Master

P: Course in basic statistics

O: The main objectives of the course are the following: to present fundamental hypotheses and theoretical ideas and applications of the analysis and modelling of spatial data; to use both deterministic and geostatistical models for spatial data treatment; to perform real data case studies based on topo-climatic and pollution data; to understand geostatistical models and interpretation of their results; to present and manipulate geospatial data using Geographical Information Systems (GIS).

C:
- Exploratory analysis of spatial data.
- Analysis of monitoring networks and de-clustering
- Global and local estimations
- Moving window statistics
- Deterministic interpolations and cross-validation
- Variography: exploratory variography and variogram modelling
- Geostatistics: family of kriging models
- Geostatistics and GIS.
- Geostatistical simulations. Modelling of spatial uncertainty and variability
- Sequential Gaussian simulations
- Post-processing of the simulations.
- Advanced simulation algorithms.
- Risk mapping.

B:
The objective of this course is to provide to the students a watershed-wide perspective on aquatic ecosystems and associated environmental issues, accounting for the ecological continuity of glaciers, rivers and lakes in the Alpine landscape. This course builds on preliminary knowledge in river hydrology and geomorphology to develop the ecological dimensions of river management. It also includes a full course in limnology blending the physical, biogeochemical and ecological aspects of lakes, emphasizing the necessity for such an integrative perspective to deal with current environmental challenges on Swiss lakes. The course is designed to favor hands-on in situ or in silico approaches of rivers and lakes. The course concludes with an introduction in how these principles are reflected in the Swiss Water Law as well as international comparisons.

The courses is divided into 2:
(1) Lakes and limnology, including lake ecology
(2) Rivers and ecology
The course finishes with a consideration of the relationship between this scientific understanding and policy, looking at the Swiss Water Law and also international comparisons.
The course comprises lectures and practical classes, as well as a small amount of fieldwork to support understanding. Specific training is also provided in certain key methods used by industry and regulators for biological water quality assessment.

B: Limnology, 3rd Edition
Lakes and River Ecosystems, R. Wetzel, 2001, Elsevier
ENVIRONMENTAL BIOGEOCHEMISTRY

Xavier Dupla

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N: Master

P: General Geochemistry, Aquatic Chemistry, Introductory Chemistry & Physics

O: Reactions occurring at mineral and microbial surfaces govern the attenuation, release and cycling of the elements in aquatic and soil environments. This course draws on the fields of surface chemistry, mineralogy and environmental microbiology to develop an understanding of key (bio)geochemical reactions in natural environments, particularly those impacted by anthropogenic activities.

LEARNING OBJECTIVES
- To understand interfacial processes and the application of empirical and thermodynamic-based models to describe sorption processes
- To gain a molecular-scale perspective of chemical reactions occurring at water-mineral, water-microbe, and microbe-mineral interfaces
- To become familiar with microscopic and spectroscopic techniques used to characterize natural particles and detect surface species
- To gain experience with the critical reading of the scientific literature

C: Part 1: Structure drives reactivity
- Soil components from a chemical perspective
- Arrangement of atoms in minerals and organic matter
- Properties of soil components and implications for interactions with ions/molecules in the soil solution

Part 2: Critical chemical processes in soils
- Dissolution and precipitation
- Ion sorption
- Electron transfer (reduction-oxidation reactions)
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FIELD AND LABORATORY METHODS (II): ALPINE CATCHMENTS

Marie-Elodie Perga

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N: Master

P: Aquatic ecosystems: glaciers, rivers, and lakes

O: This field camp aims at training students to the application of classical and up-to-date technologies to the study of the hydrological, geomorphological, physical and ecological aspects of an alpine catchment.

C: During a 5-day field camp, students will be trained to the use of typical hydrological tools, to the completion of ecological samplings and analyses for bioindications, to the good use and practices of automated sensors and probes for the study of alpine waters. Building a sampling plan and collecting their own data, students will have to conduct their own research question along these 5 days, in relative autonomy.
APPLIED ECOLOGY

C  Opt  English  14

S  3.00

TP  Opt  English  28

S

N: Master

P: BSc level in biology, including ecology

O: Applied ecology is a young crisis discipline undergoing a major effectiveness revolution. In most situations, urgent action is necessary, even in the absence of reliable information. How do we gather sound ecological information? How do we use it to plan natural communities conservation? In the process of answering these questions, wildlife ecologists often realize that research and practice are just two sides of the same coin.

C: The goal of the course is to teach students some of the skills they will need as evidence-based conservationists. Practical examples will be drawn from various ecosystems, communities and species. The course will revolve around the stages of adaptive management:
- monitoring ecological resources, monitoring occupancy and abundance
- research syntheses (systematic reviews and meta-analyses)
- ecological triage (systematic conservation planning and red lists)
- natural communities conservation planning and legislative context.

Field-based case studies will provide students an opportunity to apply and discuss some of the principles illustrated in the course. Practical work will include meeting with practitioners, discussing and analyzing their approach and methods through the prism of adaptive management.

« There is no such thing as a special category of science called applied science; there is science and its applications, which are related to one another as the fruit is related to the tree that has borne it. » Louis Pasteur
BIOLOGICAL INVASIONS

Cleo Bertelsmeier

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O: 1. Explain core theory and concepts underlying the spread and impacts of invasive species
   2. Critically assess the current debate about invasive organisms (semantic, social, economic, biological...)
   3. Understand how globalization leads to the accelerating dynamics of species ranging from viruses to mammals
   4. Understand the characteristics of invasive species and vulnerable ecosystems
   5. Discuss the interactions between biological invasions and other drivers of global change such as climate change

C: Biological invasions are considered one of the most important global threats to biodiversity. Understanding the processes shaping the success of species outside of their native ranges is therefore a major goal of conservation research. In this course, we elucidate the main hypotheses explaining the success and spread of invasive species, while insisting on current controversies and future research questions. Specifically, we will address:
   - The different stages of the invasion process (transport, establishment, spread, impacts)
   - Impacts and case studies of some of the worst invasive species
   - Mechanisms of invasions
   - Socio-economic aspects
   - The role of rapid adaptation in the invasion process
   - Species interactions, enemy release, community structure
   - Large scale patterns and dynamics
   - Interactions with other drivers of global change

B: See English pages of the course
**CO-EVOLUTION, MUTUALISM AND PARASITISM**

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N: Master

P: Must understand English and be prepared to give presentations

O: To understand the evolutionary consequences of organisms living together in mutualism or parasitism and how to investigate it experimentally

C: The course comprises some introductory talks given by me about concepts in co-evolution and theoretical frameworks for studying co-evolution. Afterwards, students give presentations on chosen key publications in this field and the group discusses these subjects after the presentations.

B: All bibliography is made available in pdf format before the course begins. For an example of the publications discussed you can find last year's publications in my document public folder.
CURRENT PROBLEMS IN CONSERVATION BIOLOGY

Claus Wedekind

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N: Master

P: Lectures, discussions, and proposal writing in English.

O: Introduction into
- some important problems of conservation biology
- funding opportunities for conservation projects
- the planning, writing, and reviewing of grant proposals in the context of the course
Own ideas shall be developed, presented and discussed in class.

C: Some current research topics within the field of conservation biology will be further introduced in lectures, potentially also guest lectures, and discussions in class. Each student then develops an own idea of a research project within these topics. After an introduction into funding agencies and the planning and writing of grant proposals, each student (or groups of two) write(s) up an own proposal and present(s) it to the class. The proposals of colleagues will then be peer-reviewed after an introduction into peer-reviewing of grant proposals.
Class size restricted to 10 students.
ECOLOGY OF THE FISHES OF SWITZERLAND

Jean-François Rubin

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P: none

O: Recognize the different habitats and species
   Know the biology of the principal species
   Identify the problems linked to the management of these habitats and species

C: Generalities on water
   Lakes
   Watercourses
   Plankton and plants
   Systematic of fish
   Anatomy of fish
   The fish of Switzerland
HONEYBEE ECOLOGY, EVOLUTION AND CONSERVATION

Vincent Dietemann

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**N:** Master

**O:** This series of lectures will show the complexity of insect societies, taking the honey bee as an example. It will give the opportunity to see how concepts learned elsewhere by the students can be placed within the context of a single species.

**C:** Since honeybees are economically important insects, they have been studied early in history and the knowledge we possess about them is greater than for any other social insect species. Our understanding of the honeybee reveals the complex organisation reached by insects when they form societies. This series of lectures will present some aspects of this complexity that will be replaced within its evolutionary context. Various aspects of honeybee ecology and evolution, including geophylogeny, biology, reproduction at individual and colony level, division of labour, communication, economical value, pathogens will be presented.

After a general introduction of this model species describing the diversity and biogeography of the taxon, we will dissect the communication abilities of European honeybees and compare it with related Asian species. We will see how this communication is used to organise foraging tasks sustaining colony growth. Honeybee health is a current concern and we will review the pathogens affecting them and comment the role of humans in their spread and control in an evolutionary context. Since honeybees are globally threatened, we will see what economical losses their decline could have and some conservation projects to invert the trend will be put in context.

Moritz RFA, Southwick EE, 1992. Bees are superorganisms. Spriinger Verlag
PHYLOGENY AND COMPARATIVE METHODS

Nicolas Salamin

C  Opt  English  7
S  1.50

E  Opt  English  14
S

N:  Master
P:  none
O:  Phylogenetic reconstruction methods and their application in evolutionary biology. To know and understand phylogenetic reconstruction methods in order to test the processes leading to genes and organisms evolution.

C:  The subjects will be presented during lectures as well as practicals.
   I. Reconstruction methods
      - What is a phylogenetic tree and how to interpret it?
      - Tree reconstruction:
         a) optimisation criteria and models of evolution
         b) search for the optimum tree
         c) Bayesian methods
      - Can we trust the inferred tree?
   II. Uses for phylogenetic trees
      - Detecting positive selection in a coding gene
      - Testing coevolution and cospeciation
      - Macroevolution:
         a) dating evolutionary events
         b) tempo and mode of evolution
         c) testing for key innovations
      - Phylogeny and conservation


I:  http://www.unil.ch/phylo/teaching/pmc.html

School of Biology (FBM-BIO)
# PLANT POPULATION GENETICS AND CONSERVATION

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SPATIAL MODELLING OF SPECIES AND BIODIVERSITY

Antoine Guisan

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N: Master

P: If possible, course ‘Spatial Analyses & GIS’ (ANSPAT) in 1st semester of the Master (not strictly required).

O: Species distribution models (SDMs) are increasingly important in ecology and conservation biology. This course proposes an introduction to these models and related concepts and methods. Overview of the main steps of model building. Advantages and limitations. Applications to various domains (climate change, invasions, rare species, ...).

C:
- Chap. 1. Introduction to species’ niche & distributions, and related models. Theory and principles behind these models. Competition and dispersal limitations. Types of response variables, main predictive modelling approaches, field sampling design, from predicting species distributions to predicting communities.
- Chap. 4. Assumptions behind these models. Pseudo-equilibrium, niche conservatism, niche completeness, realized niche, and other postulates.

B:

I: http://www.unil.ch/ecospat
## COMPARATIVE GENOMICS: FROM THOUSANDS OF GENOMES TO SINGLE CELLS

**Roman Arguello**

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**EVOLUTIONARY CONSEQUENCES OF HYBRIDIZATION AND WHOLE GENOME DUPLICATION**

Nils Arrigo

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The first goal of this course is to give a general introduction into primate behaviour, with a special focus on primate cognition and culture. The topic will be developed in a comparative framework, with references to behaviours found in other animals as well as well highlighting behaviours shared between human and non-human primates and the ones unique to humans. This first part will give the general background to understand the articles that will be discussed in the seminar sessions. During the seminar, students will select articles to read and discuss together. This part aims at developing the critical thinking of students and the exchange between the students using concrete examples of research with conflicting findings. The course will train students to summarize, explain and discuss a paper during the final presentation in front of the class, as well as to develop ideas about potential future directions of the research on a specific topic.

This course will be composed of three main parts followed by seminar sessions.
1) Primate Behaviour. Here we will study briefly the bases of animal behaviour followed by a presentation of the diversity in the taxa Primates. Then we will study the specificities of Primate behaviour. We will investigate the topics of social structure, reproduction and life history. Later we will focus more on social relationships with lectures on competition and conflict management, communication and cooperation. All these topics will be discussed with a comparative approach to other animals and humans.
2) Primate Cognition. Here we will study the cognitive abilities of primates. We will investigate briefly the specificities of primate physical cognition and we will develop more on their social cognition. On this topic, we will study the abilities of primates to understand others’ minds (theory of mind) and to exhibit strategic social behaviours like deception.
3) Primate Culture: Here we will study social learning mechanisms and strategies. We will investigate cases of conformity, traditions and culture in primates. This subject will highlight the specificities of human cultural behaviour as well as the shared roots with primates and other animals.

Additionally, a guest lecture will introduce students to principles of self-organised collective behaviour across taxa, from insects to fish and Humans.
During the seminar, students will choose a scientific article to read (alone or in groups depending on the number of students following the course). The papers will be discuss in the class. At the end of the seminar, all the students will present the main finding of their paper and potential future directions of research on the topic.

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N: Master
SCIENTIFIC MEDIATION AND COMMUNICATION - MUSEUM MODULE

Michel Sartori

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N: Master

P: None

O: This is a theoretical and practical course which will teach you how to write a text for an exhibition (scientific popularization). From original articles and textbooks to the exhibition content, several steps are required to make the exhibition attractive and accessible to a large audience. During this course, you will learn the basics of exhibition building, from content development to the elaboration of a mediation concept and a communication strategy.

C: After a 6 period's theoretical introduction, you will develop a personal project. This year, an due to the pandemia, we will propose general subjects linked to biology. We will propose individual subjects to be developed during the first lecture hours. We are also expecting from you to create a press release on your subject, as well as a mediation project.
## THE ENVIRONMENT, ADDRESSED IN AN INTERDISCIPLINARY WAY.

Antoine Guisan, Pierre-Louis Rey

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N: Master

P: None

O: To give students a deep understanding of an environmental issue, animated for the most part through contributions from external visitors to UNIL.

C: Conferences are in french. See french section for the 2019 programme.

B: Précisé par les intervenants de semaine en semaine
THE EVOLUTION OF COOPERATION: FROM GENES TO LEARNING AND CULTURE

Laurent Lehmann

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N: Master

O: What makes us such a unique species, able to cooperate in large-scale societies, organize social interactions, and dominate ecologically the Earth? The main goal of this course is to provide the foundations of social evolution, which consists of two main ingredients in humans: cooperation and cumulative cultural evolution. On one side, the course will thus focus on studying the main forces favoring and maintaining cooperation (mutually beneficial interactions, altruism) and conflict (cheating, malevolence, warfare) in group-structured populations. On the other side, we will study the forces behind cultural evolution, where behavior in interactions depends on genetic determinants, social learning, and individual learning ("gene-culture coevolution"). This will allow discussing the major steps in human social organization evolution, from primate autarky to division of labor in large-scale societies.

C: The course will be composed of five main parts and more focused on human behavior than the "Ecology and Evolution" class on which it builds:

1. Cooperation and conflict in well-mixed populations. Here, we will study the evolution of cooperation (and cheating) in well-mixed population (no division into groups). We will study the standard one-shot social dilemmas illustrating the tension between self-interest and group-interest, like the prisoner’s dilemma and the stag-hunt game. We will then investigate various settings of repeated interactions, where reputation dynamics between individuals are crucial to sustain long-term relationships.

2. Cooperation and conflict in group-structured population. Here, we will study the forces shaping cooperation when interactions occur in group-structured populations (the rule in humans), and where the localization of the social interactions generates in the same time novel incentives to cooperate and novel incentives for spiteful behavior. We will also consider conflicts between groups and study warfare in small-scale hunter-gather societies.

3. Social learning and gene-culture coevolutionary theory. Here, we will study the main modes of social learning ("cultural transmission"), which underlies cumulative cultural evolution that is the main determinant of the human lineage ecological success. We will also study gene-culture coevolution and how social learning impacts the dynamics of cooperation within groups.

4. Individual learning and preferences. Here, we will discuss the main modes of individual learning that allow individuals to learn information about the relevant behavior to express on their own (e.g., trial-and error learning and related decision heuristics, maximizing behavior). We will investigate the conditions under which evolution may and may not lead individuals to become equipped with goal functions ("utility maximization behavior").

5. Major transition from small to large-scale societies. Here, we will discuss the main evolutionary steps that took the human lineage in a 6 million year long co-evolutionary gene-culture ride from self reliant primate social organizations ("autarky") to large scale societies with extreme division of labor ("catallaxy"). This transition involved a zigzag path from dominance, to egalitarianism, to inequality again.
# SOCIAL GENETICS

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**N:** Master

**P:** none

**O:** This course provides the opportunity to read about, synthesise and then discuss the state-of-the-art in two social genetics topics: How did eusociality evolve? And what determines caste-fate in social insects?

**C:** Students will be set a question and given recent scientific papers to read and write about and they will then participate in discussions on the topic with the other students. They will additionally have the opportunity to discuss with researchers working directly on the topics.
DRIVERS OF INVERTEBRATE BIODIVERSITY ALONG ECOLOGICAL GRADIENTS
Tanja Schwander

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N: Master

P: Program requirement: Financial participation required by the student (approximately 700.-)

O: During this field course, we study different invertebrate taxa (mainly insects and gastropods) to understand the factors driving biodiversity and community composition, as well as the evolution of different life cycles under diverse ecological conditions in the Swiss Alps/Prealps.

C: Course content:
- Introductory lectures
- Excursions and group field work: analysis of community composition and biodiversity in various habitats
- Personal experiments (experimental design, data collection & analysis, presentation of results)
- Discussion of scientific papers
## ECOLOGY AND FAUNISTICS OF THE SEA SHORE, ROSCOFF

**Tanja Schwander**

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**N:** Master

**P:** Financial participation required by the student.

!!! Please, contact the person in charge before your inscription !!!

**O:** To allow a first, integrated approach of the intertidal biotope, and to understand the role played by the tides, the substrate and other conditions on the faunistic composition of littoral communities and on the physical and behavioural adaptations of the species.

**C:** Lecture (6 h): Introduction to intertidal ecology.

Excursions and group field work: analysis of zonation and biodiversity in various habitats (sand beach, rock, estuaries and so on). Additionally, each student shall be responsible for the study of one taxonomic group.

Lab experimentations: experimental design and realisation of an experiment in etho-ecology illustrating adaptive behaviour of an intertidal species.
## EVOLUTION AND BIOGEOGRAPHY OF SEMI-ARID AND ISLAND FLORAS

John Pannell

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**N:** Master

**P:** Financial participation required by the student.