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Course directory 2021.2022

school of Biology (FBM-BIO) Master

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

UNIL | Université de Lausanne

SUMMARY

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 : 03.06.2022

LEGEND

NAME OF THE COURSE

Teacher

Type of course	Status	Hours per week	Teaching language	Hours per year
Semester	Credits			

N: Levels

P: Programme requirements

O: Objective

C: Content

B: Bibliography

I: Additional information

ABBREVIATIONS

TYPE OF COURSE

Attest.	Attestation
C	Course
C/S	Course - seminar
Cp	Camp
E	Exercises
Exc	Excursion
Lg	Guided lecture
S	Seminar
T	Fieldwork
TP	Practical work

STATUS

Fac	Facultative
Obl	Compulsory
Opt	Optional
Fac/Comp/Opt	Facultative, compulsory or optional (according to the study programme)

SEMESTER

Sp	Spring
A	Autumn

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UNIL | Université de Lausanne
Ecole de biologie

Master of Science in Behaviour, Evolution and Conservation
Specialisation Geosciences, Ecology and Environment
2021-2022

The Master program has a normal duration of 3 semesters and comprises 90 ECTS :

Module 1 : 15 ECTS : Compulsory courses (5.5 ECTS) and Optional courses (9.5 ECTS)
Module 2 : 15 ECTS : First Step Project
Module 3 : 30 ECTS : Compulsory courses (6 ECTS) and Optional courses (24 ECTS)
Module 4 : 30 ECTS : Personal Research Project (Master Thesis)

For specialisation Geosciences, Ecology and Environment (GEE) (30 ECTS), the student must obtain :
Module 1 : 5.5 ECTS with Compulsory courses and at least one Interdisciplinary optional course (marked in blue)
Module 3 : 6.0 ECTS with Compulsory courses and
18.5 ECTS with Optional courses at least 15 ECTS with Disciplinary (marked in orange) and Interdisciplinary (marked in blue) optional courses
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)

Module	Courses / Enseignements	Hours per semester C	E/S	PW	Teaching Staff	ECTS Credits	Limited nb of students
MODULE 1	**Compulsory Courses / Enseignements obligatoires**						
	Data Analysis *Analyses de données*	6	-	6	**Bergmann S.**	2	
	Introduction into Scientific Writing *Introduction à la rédaction scientifique*	7	9	-	**Waterhouse R.**	2	
	Spatial Analysis and GIS in Ecology *Analyses spatiales et SIG en écologie*	7	10	-	**Guisan A.**	1.5	
	Master BEC Retreat *Retraite Master BEC*	-	-	-	**Kawecki T.**	-	
	Subtotal	20	19	6		5.5	
	Optional Courses / Enseignements optionnels						
	Environmental chemistry and toxicology (GSE, MSc in Environm. Sci.) *Chimie environnementale et toxicologie*	56 CPW			**Chèvre N., Asta M.**	5	
	Environmental time-series analysis (GSE, MSc in Environm. Sci.) *Traitement du signal et analyse de séries temporelles*	56 CPW			**Irving J.**	5	
	Nature Conservation (in French) (GSE, Master in Geography) *Conservation de la nature*	28 CSE + 16F			**Chanteloup L., Reynard E., Badman T., Walters G.**	4	
	Remote sensing of Earth Systems (GSE, MSc in Environm. Sci.) *Télédétection des systèmes terrestres*	56 CPW			**Mariethoz G., Lane S.**	5	
	Advanced Data Analysis *Analyses de données : niveau avancé*	6	-	6	**Ciriello G.**, Delaneau O.	2.5	
	Animal Communication and Parasitism *Communication animale et parasitisme*	14	-	-	**Christe P.**, Roulin A.	1.5	
	Major Transitions in Evolution *Les grandes étapes de l'évolution*	14	-	-	**Keller L.**	1.5	12
	Molecular Methods in Ecology and Evolution *Méthodes moléculaires en écologie et évolution*	18	-	42	**Sanders I.**, Fumagalli L., Salamin N.	5	
	Phylogeography *Phylogéographie*	7	10	-	**Fumagalli L.**	1.5	
	Population Genetics and Dynamics *Génétique et dynamique des populations*	7	10	-	**Goudet J.**	1.5	
	Animal Experimentation and Wild Animals * *Expérimentation animale et animaux sauvages*	20	-	20	**Rubin J.-F.**	-	
	Introduction to R (optional support) *Introduction à R (mise à niveau optionnelle)*				**Schütz F.**	-	
	Total					**15**	
MODULE 2	**Practical Project / *Travail pratique***						
	First Step Project *Travail d'initiation à la recherche*	-	-	224	**Kawecki T., Guisan A.**	**15**	

Interdisciplinary courses marked in blue

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

Abbreviations
C = Course
E/S = Exercise/Seminar
PW = Practical Work
CPW or CSE or F = Course/Practical Work or Course/Seminar/Exercise or Field

BIOLOGICAL SECURITY

Patrick Michaux

C	Obl	English	2
A			

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; ordnance 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

Sven Bergmann

C	Obl/Opt	English	6
A	2.0		

TP	Obl/Opt	English	6
A			

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 filed, 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

Robert Waterhouse

C	Obl	English	7
A	2.0		

E	Obl	English	9
A			

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.

Module 1: Practical 1. Summarise a paper: title, keywords, abstract.

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/tables/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

E	Obl/Opt	English	10
A			

C	Obl/Opt	English	7
A	1.5		

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: Wadsworth, R. & Treweek, J. 1999. Geographical Information Systems for Ecology
Caloz, R. & Collet, C. 2002. Précis de télédetection, vol. 3. Presses Univ. du Québec
Turner, Gardner, O'Neill 2001. Landscape Ecology in Theory and Practice: Patterns and Process. Springer
Dale, Birks, Wiens 2000. Spatial Pattern Analysis in Plant Ecology. Cambridge University Press.
Klopatek, J.M. & Gardner, R.H. 1999. Landscape Ecological Analysis: isuues and applications. Springer.
Hunsaker, C.T., Goodchild, M.F., Friedl, M.A. and Case, T.J. (Eds). 2001. Spatial uncertainty in ecology. Springer.
Hansson, L., Fahrig, L. and Merriam, G. 1995. Mosaic Landscapes and Ecological Processes. Chapman & Hall.

I: http://www.unil.ch/ecospat

ENVIRONMENTAL CHEMISTRY AND TOXICOLOGY

Maria Pilar Asta Andres, Nathalie Chèvre

C/TP	Opt	4	English	56
A	5.0			

N: Master

P: - Hydrochimie et pollution des eaux
- Ecotoxicologie

O: 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 assessement of one case study linked with the course topics is also required.

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

B: 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
Encyclopedia of aquatic ecotoxicology 2 volumes A-G et H-Z. (2013). Frérard JF., Blaise C., 2013 :
Fundamentals of ecotoxicology. 3rd ed (2010) Newman M. C.
Risk assessment of chemicals: an introduction (2007). Van Leeuwen C. J., Vermeire T. G., 2007 (ed).

ENVIRONMENTAL TIME-SERIES ANALYSIS

James Irving

C/TP	Opt	4	English	48
A	5.0			

N: Master

O: 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

C/TP	Opt	2	French
A	4.0		

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:
- Adams WM (2004) Against extinction: the story of conservation. Earthscan, London#; Sterling, VA
- Bory Stéphanie et Gábor Baranyai (dir), 2016, Les espaces naturels protégés sont-ils nécessaires?, Pessac Gironde, Presses univ de Bordeaux, Dynamiques environnementales 35, 235 p.
- Depraz Samuel, 2008, Géographie des espaces naturels protégés genèse, principes et enjeux territoriaux, Paris, A. Colin, Collection U. Géographie, 1 p.
- Héritier, Stéphane et Lionel Laslaz (dir), 2008, Les parcs nationaux dans le monde: protection, gestion et développement durable, Paris, Ellipses, Carrefours. Les dossiers, 312 p.
- Larrère, Raphaël. « Le conflit entre les chasseurs et les protecteurs de la nature ». La Ricerca Folklorica, no 48 (2003): 45 51.https://doi.org/10.2307/1480073.
- Laslaz, Lionel (dir.), 2012, Atlas mondial des espaces protégés: les sociétés face à la nature, Paris, EdAutrement, Autrement. Collection Atlas/Monde, 96 p.
- Laslaz Lionel, C. Gauchon, M. Duval, S. Héritier (dir.),, 2014, Les espaces protégés: entre conflits et acceptation, Paris, Belin, Mappemonde, 431 p.
- Mollett, Sharlene, and Thembela Kepe, eds. 2018. Land Rights, Biodiversity Conservation and Justice: Rethinking Parks and People. Routledge Studies in Sustainable Development. Abingdon, Oxon#; New York, NY: Routledge, Taylor & Francis Group.

REMOTE SENSING OF EARTH SYSTEMS

Pascal Egli, Stuart Lane, Grégoire Mariéthoz, Fabio Oriani

C/TP	Opt	4	English	48
A	5.0			

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.

B: - T. Lillesand, R. Kiefer, J. Chipman, 2015, Remote Sensing and Image Interpretation, Wiley. - J. Campbell & R. Whyne, 2011, Introduction to Remote Sensing, Guilford Press.- M-C Girard et C-M Girard, 2010, Traitement des données de télédétection, Dunod.- G. Vosselman and H.-G. Maas, 2010, Airborne and Terrestrial Laser Scanning, CRC Press.

ADVANCED DATA ANALYSIS

Giovanni Ciriello

C	Obl/Opt	English	6
A	2.5		

TP	Obl/Opt	English	6
A			

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

C	Opt	English	14
A	1.5		

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 conceptualize 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

B: Réale, D., Reader, S.M., Sol, D., McDougall, P.T. & Dingemanse, N.J. (2007). Integrating animal temperament within ecology and evolution. Biol. Rev., 82, 291-318.
Sih, A., Bell, A.M., Johnson, J.C. & Ziemba, R.E. (2004). Behavioral syndromes: an integrative overview. Q. Rev. Biol., 79, 241-277.
Journaux scientifiques figurant à la bibliothèque du Biophore ou sur internet (http://perunil.unil.ch/perunil/periodiques/).

I: Aucune

MAJOR TRANSITIONS IN EVOLUTION

Laurent Keller

C	Opt	English	14
A	1.5		

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

C	Obl/Opt	English	18
A	3.5/5.0		

TP	Obl/Opt	English	42
A			

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 at selection of techniques, particularly for looking at polymorphism, that are not traditionally taught in molecular cell biology courses. Man 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

C	Opt	English	7
A	1.5		

E	Opt	English	10
A			

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.

B: Avise JC. 2000. Phylogeography. Harvard University Press.

POPULATION GENETICS AND DYNAMICS

Jérôme Goudet

C	Obl/Opt	English	7
A	1.5		

E	Obl/Opt	English	10
A			

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, with a particular emphasis on inbreeding depression and genetic rescue
website:
http://www2.unil.ch/popgen/teaching/PGD21

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:
-When and how can a small population purge deleterious alleles?
-How can we quantify Inbreeding Depression?
-is neutral diversity a good proxy for the health status of a population?

I: http://www2.unil.ch/popgen/teaching/PGD21/

ANIMAL EXPERIMENTATION AND WILD ANIMALS

Jean-François Rubin

C	Opt	English	20
A S			

TP	Opt	English	20
A S			

N: Master

FIRST STEP PROJECT

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

TP	Obl	English	224
A	15.0		

TP	Obl	English	280
A	15.0		

TP	Obl	English	250
A	14.0		

TP	Obl	English	224
A	15.0		

TP	Obl	English	224
A	15.0		

TP	Obl	English	224
A	15.0		

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 (intruduction, 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.

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Ecole de biologie

Master of Science in Behaviour, Evolution and Conservation
Specialisation Geosciences, Ecology and Environment
2021-2022

Spring Semester (semester 2)

MODULE 3

Courses / Enseignements	Hours per semester C	E/S	PW	Teaching Staff	ECTS Credits	Limited nb of students
Compulsory Courses / Enseignements obligatoires						
Integrated course Mountain Ecosystems - Ecology & Evolution *Cours intégré écosystèmes de montagne - écologie et évolution*	14	-	-	**Guisan A.**	1.5	
Integrated course Mountain Ecosystems - Geo-Environmental Sciences *Cours intégré écosystèmes de montagne - sciences géo-environnementales*	14	-	-	**Guisan A.**	1.5	
Integrated Practical Work Mountain Ecosystems in the Alps *Travaux pratiques intégrés écosystèmes de montagne dans les Alpes*	-	-	52	**Guisan A.**	3	
Subtotal	28	0	52		**6**	
Optional Courses / Enseignements optionnels *						
Aquatic Ecosystems : Glaciers, Rivers and Lakes (GSE) *Ecosystèmes aquatiques : glaciers, rivières et lacs*	56 CPW			**Perga M.-E., Lane S.**	5	
Field and laboratory methods (I) : The UNIL campus as a microcosm (GSE) *Méthodes de terrain et de laboratoire : le campus UNIL comme microcosme*	56 PW			**Chèvre N., Vennemann T., Berg J.**	5	
Field and laboratory methods (II) : Alpine catchments (GSE- out of semester) *Méthodes de terrain et de laboratoire (II) : bassin versant alpin (GSE - hors semestre)*	40 PW			**Perga M.-E.**	5	
Machine Learning for Environmental Science and Engineering (GSE) *Apprentissage automatique pour les sciences et l'ingénierie de l'environnement*	56 CPW			**Beucler T.**	5	
Mountain streams: ecological processes and management (GSE) *Rivières de montagne : écosystèmes aquatiques de la haute montagne*	24 CPW			**Lane S.**	3	
Watershed and river network modelling (GSE) *Modélisation des bassins versants et des réseaux fluviaux*	56 CPW			**Peleg N., Ruiz-Villanueva V.**	5	
Mountain streams: sediment management (field class) (GSE - **autumn**) *Rivières de montagne : gestion des sédiments (cours de terrain en automne)*	40 PW			**Lane S.**	3	
Applied Ecology *Ecologie appliquée*	14	-	28	**Pellet J.**	3	
Biological Invasions *Invasions biologiques*	14	-	-	**Bertelsmeier C.**	1.5	
Co-evolution, Mutualism, Parasitism *Co-évolution, mutualisme, parasitisme*	14	-	-	**Sanders I.**	1.5	
Current Problems in Conservation Biology *Problèmes actuels en biologie de la conservation*	14	14	-	**Wedekind C.**	3	10
Ecology of the Fishes of Switzerland *Ecologie des poissons de Suisse*	7	-	10	**Rubin J.-F.**	1.5	
Honeybee Ecology, Evolution and Conservation *Ecologie des abeilles, évolution et conservation*	14	-	-	**Dietemann V.**	1.5	
Phylogeny and Comparative Methods *Phylogénie et méthodes comparatives*	14	14	-	**Salamin N.**	3	
Plant Population Genetics and Conservation *Génétique des populations végétales et biologie de la conservation*	7	-	10	**Felber F.**	1.5	
Spatial Modelling of Species and Biodiversity *Modélisation spatiale des espèces et de la biodiversité*	14	14	-	**Guisan A.**	3	
Comparative Genomics : from Thousands of Genomes to Single Cells *Génomique comparative : des milliers de génomes aux cellules individuelles*	7	7	-	**Arguello R.**	1,5	
Introduction to Primate Behaviour, Cognition and Culture *Introduction au comportement, à la cognition et à la culture des primates*	10	8	-	**Van de Waal E.**	1.5	
Sex, Ageing and Foraging Theory *Théories et modèles de l'évolution de la reproduction sexuée, la sénescence et la consommation de ressources*	9	-	9	**Mullon C.**	1.5	
Scientific Communication - Scientific Hands-on Workshop Module (in French only) *Médiation scientifique - module atelier scientifique*	14	14	-	**Kaufmann A., Reymond P.,** Ducoulombier D.,Trouilloud S., Ythier M.	3	8
Scientific Mediation and Communication - Museum Module *Communication et médiation scientifique - module musée*	6	-	22	**Sartori M.,** Glaizot O.	3	6
The Environment, addressed in an interdisciplinary way (most in French) (GSE) *Séminaire interfacultaire en environnement*	-	10	-	**Guisan A.**	2	
The Evolution of Cooperation : from Genes to Learning and Culture *L'évolution de la coopération : des gènes à l'apprentissage et la culture*	28	-	-	**Lehmann L.**	3	
Social Genetics *Génétique sociale*	2	12	-	**Keller L.,** Kay T.	1,5	
Optional Field Courses (Financial participation required by the student) ***Etudes de terrain optionnelles***						
Drivers of Invertebrate Biodiversity along Ecological Gradients *Facteurs déterminant la biodiversité des invertébrés le long de gradients écologiques*	7	-	49	**Schwander T.**	3	20
Evolution and Biogeography of Semi-arid and Island Floras *Evolution et biogéographie des flores insulaires en zone semi-aride*	-	-	40	**Pannell J.**	2	14
Total					**30**	

Interdisciplinary courses marked in blue
Disciplinary courses marked in orange

* - Before choosing an optional course, please check the "programme requirement" (prerequisites for the course) in the course description
- To complete the acquisition of the credits, it is possible to take optional courses from the module 1 during the third semester depending on their availability and only with the approval of the head of the Master

Spring semester (semester 2) and Autumn Semester (semester 3)

MODULE 4

Course / Enseignement		ECTS Credits
Master Thesis GEE *Travail de Master GEE*	Thesis Director *Directeur du travail de Master*	30

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 where 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

C	Obl/Opt	English	14
S	1.5		

N: Master

P: none

O: To obtain a multidisciplinary knowledge basis on aspects of ecology & evolution of mountain ecosystems

C: General introduction to mountain environments
Adaptations to marginal environments
Reproductive systems along elevation
Patterns of micro-organisms along elevation
Biological invasions in mountains
Impact of climate change on mountain biota - field observations and experiments
Impact of climate change on mountain biota - spatial modelling
Human-wild fauna conflicts in mountain regions

B: Donnée séparément pour chaque leçon.

I: Planning détaillé donné sur moodle aux étudiant.e.s inscrit.

INTEGRATED COURSE MOUNTAIN ECOSYSTEMS - GEO-ENVIRONMENTAL SCIENCES

Antoine Guisan

C	Obl/Opt	English	14
S	1.5		

N: Master

P: None

O: To obtain a multidisciplinary knowledge basis on aspects of geosciences & environment of mountain ecosystems

C: Mountain Topoclimatology - the case of the Alps
Geology of the Alps
Glaciers in the Alps, recession, and climate change
The hydrology of mountain basins
Mountain lakes
Sediment flux in mountain basins
Geomorphology of Alpine areas
Pollutant release by glaciers, lake contamination, impact on biodiversity
Evaluating risks of natural hazards
Mountain soils
Remote Sensing of Mountain Ecosystems
Separate bibliography for each sub-topic

B: Donnée séparément pour chaque leçon.

I: Voir moodle pour étudiant.e.s inscrit.e.s

INTEGRATED PRACTICAL WORK MOUNTAIN ECOSYSTEMS IN THE ALPS

Antoine Guisan

T	Obl/Opt	English	52
S	2.0/3.0		

N: Master

P: Having followed at least one of the two associated lecture series (GE or EE).

O: The objectives are four-fold:
- be able to carry out a small research project from beginning to end.
- Learn to work in interdisciplinary team: groups of 5 students from the FBM and FGSE (if possible at least one FGSE student per group).
- be able to efficiently and elegantly communicate your scientific findings (oral and written).
- learn how to carry ecological field work.

C: Two field retreats in Arolla (VS) - usually in May (2 days) and July (4.5 days)
First retreat to design a project and write a proposal
Second retreat to conduct the project in the field, and write a final report ("paper style")
Instructions on the two retreats' programs and the expected proposal and final report on moodle.
Bibliography:
Differents species identification field guides.
Bowman, W. D., and T. R. Seastedt, editors. 2001. Structure and Function of an Alpine Ecosystem : Niwot Ridge, Colorado. Oxford University Press Inc New York.
Nagy, l., and G. g. 2009. The biology of alpine habitats. Oxford University Press, Oxford.
Körner, C. 2003. Alpine plant life: Functional plant ecology of high mountain ecosystem. 2nd Edition edition. Springer, New York.
Ozenda, P. 1985. La végétation de la chaîne alpine dans l'espace montagnard européen. Masson, Paris.

B: Différents guides d'identification d'espèce sur le terrain.
Bowman, W. D., and T. R. Seastedt, editors. 2001. Structure and Function of an Alpine Ecosystem : Niwot Ridge, Colorado. Oxford University Press Inc New York.
Nagy, l., and G. g. 2009. The biology of alpine habitats. Oxford University Press, Oxford.
Körner, C. 2003. Alpine plant life: Functional plant ecology of high mountain ecosystem. 2nd Edition edition. Springer, New York.
Ozenda, P. 1985. La végétation de la chaîne alpine dans l'espace montagnard européen. Masson, Paris.

I: Info détaillées sur moodle pour étudiant.e.s inscrit.e.s

AQUATIC ECOSYSTEMS: GLACIERS, RIVERS, AND LAKES

Stuart Lane, Marie-Elodie Perga

C/TP	Opt	English	56
S	5.0		

N: Master

P: Basic fluvial hydraulics (or equivalent) General ecology Statistical analysis of environmental Data

O: 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.

C: 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
Lakes: a very short introduction, W Vincent, 2018, Oxford University Press

FIELD AND LABORATORY METHODS (I): THE UNIL CAMPUS AS A MICROCOSM

Jasmine Berg, Nathalie Chèvre, Torsten Vennemann

TP	Opt	English	60
S	5.0		

N: Master

FIELD AND LABORATORY METHODS (II): ALPINE CATCHMENTS

Marie-Elodie Perga

CP	Opt	English	50
S	5.0		

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.
Due to the large number of students, students are split in between a field camp on alpine streams (Arolla) and another on lakes from the Lexplore platform.

C: For the Lexplore Camp.
The camp alternates field work on the Lexplore platform, to analyses in the labs and hand-on work in classes.
The main objective of the camp is to train students for good practices in environmental data collection, from planning of the sampling design, to the basics principles of chemical or sensors-based measurements, the operations on-site, quality charts and sensors calibration and maintenance, mooring design, data curation and modelling.
Course structure
- Preparation of the field camp (in classroom). Specifications on the given missions, planning of required actions and measurements to be undertaken, budget and material. Protocols for chemical measurements in the lab, and technical specifications on sensors technologies.
- On the field and in the labs: use of sensors (temperatures, pressure, DO, CO2, YSI multiparameter probe; calibration, installation, data retrieval), field measurements (river flows, use of mutiparameter probes, water sampling, sediment sampling, dGPS, chemical and biological samples_chl a, DO by winkler's titration, alkalinity, pH, phosphorous concentrations by molybdate blue, microscopic analyses for zooplankton).
- Data curation and modelling (LakeMetabolizer) in classrooms
- Report: data analyses, literature, completion of the missions.
For the Arolla camp
Students will receive in high level training in two methods chosen from the following albeit with different emphases given your prior experience:
1. Continuous monitoring of river discharge.
2. Continuous monitoring of suspended load.
3. Use of biological sampling to determine mountain stream health.
4. Drone-based river corridor survey for land cover mapping.
5. Drone-based river corridor survey for measurement of erosion and deposition.
6. Grain-size characterization of the stream bed.
This training includes
a. Monitoring design (where, when, how often), protocols and standards
b. Choice of equipment, options, costs
c. Installation
d. Calibration data collection
e. Processing of acquired data including calibration relations, error quantification and propagation of error
Students will undertake (a) through (d) during the field camp; and work on (e) during the evenings at the field camp.

MACHINE LEARNING FOR ENVIRONMENTAL SCIENCE AND ENGINEERING

Tom Beucler

C/TP	Opt	English	56
S	5.0		

N: Master

P: - Basic knowledge of Python
- Interest in environmental science and engineering

O: Full English syllabus (with links) at [https://wp.unil.ch/dawn/files/2021/09/Syllabus_ML_Env_Sc_Eng_Spring_2022.pdf]
In this 10-week hands-on course, we will introduce common ML algorithms in the context of their application in environmental science and engineering. By the end of this course, you should be able to:
1. Name common ML algorithms (listed in Section 2 of the syllabus) and summarize their advantages and limitations, especially in the context of environmental science,
2. Implement them in Python (mostly using the Numpy, Scikit-Learn, Keras, and Tensorflow libraries in Google Collab notebooks),
3. Know from experience which algorithms are most appropriate for environmental applications you are passionate about (e.g., your Masters thesis).

C: Full English syllabus (with links) at [https://wp.unil.ch/dawn/files/2021/09/Syllabus_ML_Env_Sc_Eng_Spring_2022.pdf]
Tentative Schedule (written in Sep 2021 and subject to changes: Please check the course's Moodle and Google Calendar for the latest updates)
Week 1: Basics of Python/Git & Introduction to the Course
(Lecture Feb 24 at 2PM, Lab Feb 25 at 9AM) +Basics of Google Collab Notebooks, Possible final projects. No reading assigned for the first week.
Week 2: Linear/Logistic Regression for Classification/Regression & Bias-Correcting Forecasts
(Lecture Mar 3 at 2PM, Lab Mar 4 at 9AM) +Training/Validation/Test split, Best practices for training and benchmarking. Reading1 = Ch 3+4 of GéronReading2 = Statistical Methods in the Atmospheric Sciences (Ch7: Statistical Forecasting 7.1-7.4+7.9)
Week 3: Decision Trees/Random Forests/SVMs & Environmental Risk Analysis
(Lecture Mar 17 at 1PM, Lab Mar 17 at 3PM) +Ensemble Learning, RVM.Reading1 = Ch 5+6+7 of Géron, Reading2 = A ML-Based Approach for Wildfire Susceptibility Mapping. The Case Study of the Liguria Region in Italy
Week 4: Unsupervised Learning for Clustering/Dimensionality Reduction & Environmental Complexity
(Lecture Mar 10 at 2PM, Lab Mar 11 at 9AM) +K-Means, DBSCAN, Hierarchical clustering, t-SNE, Gaussian Mixtures.Reading1 = Ch 8+9 of GéronReading2 = Revealing the Impact of Global Heating on North Atlantic Circulation Using Transparent Machine Learning
Week 5: Artificial Neural Networks & Surrogate Modeling
(Lecture Mar 24 at 2PM, Lab Mar 25 at 9AM)Reading1 = Ch 10+11 of GéronReading2 = Deep learning to represent subgrid processes in climate models
Week 6: Convolutional Neural Networks & Remote Sensing
(Lecture Mar 31 at 2PM, Lab Apr 1 at 9AM) +Fully Convolutional Networks, ResNets, U-Nets, Graph neural nets.Reading1 = Ch 14 of GéronReading2 = Remote sensing image classification with the SEN12MS dataset
Week 7: Explainable Artificial Intelligence & Understanding/Communicating Predictions
(Lecture Apr 7 at 1PM, Lab Apr 7 at 3PM) +Permutation tests, Partial-dependence plots, Saliency maps, Feature visualization.Reading1 = Extracts from "Interpretable ML" by Christoph MolnarReading2 = Interpretable Deep Learning for Spatial Analysis of Severe Hailstorms
Week 8: Recurrent Neural Networks & Hydrological Modeling
(Lecture Apr 14 at 1PM, Lab Apr 14 at 3PM) +Attention, Transformers.Reading1 = Ch 15+16 of GéronReading2 = Towards learning universal, regional, and local hydrological behaviors via ML [...]
Week 9: Generative Modeling & Statistical Downscaling
(Lecture Apr 25 at 1PM, Lab Apr 25 at 3PM) +Auto-encoders, Generative adversarial networks.Reading 1 = Ch 17 of GéronReading2 = Adversarial super-resolution of climatological wind and solar data
Week 10: Office Hours for Final Projects
(Lecture May 5 at 1PM, Lab May 6 at 4PM)1) Possible overview of student-chosen related topics not covered in class that may be relevant to projects: Bayesian inference, Causal discovery/inference, Data ethics, Gaussian Processes, Knowledge-guided ML, Reinforcement Learning.2) In-class peer review: Each class member submits the draft of their final project for review and reviews 3 drafts from peers.

B: Main textbooks of the course (the full bibliography can be found on the course's website/Moodle): 1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition" by Aurélien Géron (https://www.oreilly.com/library/view/hands-on-machine-learning/9781492032632/) 2. "Deep Learning with Python" by Francois Chollet (https://www.manning.com/books/deep-learning-with-python) 3. "Data-Driven Science and Engineering" by Steven Brunton (https://www.cambridge.org/core/books/datadriven-science-and-engineering/77D52B171B60A496EAFE4DB662ADC36E)

I: https://www.unil.ch/dawn/teaching/

MOUNTAIN STREAMS: ECOLOGICAL PROCESSES AND MANAGEMENT

Stuart Lane

C/TP	Opt	English	25
S	3.0		

N: Master

P: A background in fluvial hydraulics is a help.

O: The aim of this course is to introduce students to the relationship between the physical environment of glaciers and mountain streams and the ecosystems that form there; and the implication for the management of mountain freshwater systems.

C: The course covers

1. The conceptualization of glaciers and rivers within the continuum of ecosystems that form from source to sink in river systems and the specificities that result.
2. Glacial ecosystems and the kinds of glacial life, on ice and under ice
3. The downstream influences of snow-melt and glacier-melt in terms of hydrology, sediment transport, stream temperature and nutrients
4. The types of mountain streams that result and the autogenic processes that shape the availability of stream habitat in space and its perturbation through time
5. The physical and chemical environment of mountain streams in terms of hydraulics, sediment, light, temperature, oxygen, nutrients
6. Primary production and food webs in mountain streams
7. Biogeochemical cycles and fluxes of matter
8. Connections between rivers and lakes in the continuity of mountain streams from sources to sinks
9. Proglacial ecosystems
10. The management of mountain streams (flow regime, sediment regime, organic matter regime); kinds of interventions; application in CH (the Swiss Water Law) in comparison with other countries ("nationalized" approaches like the EU Water Framework Directive; "commodified" approaches like the US stream mitigation banks); restoring mountain streams

WATERSHED AND RIVER NETWORK MODELLING

Nadav Peleg, Virginia Ruiz-Villanueva

C/TP	Opt	English	56
S	5.0		

N: Master

O: This course aims to:
1. introduce the spatially distributed description of river networks and their watersheds using geographical information systems (GIS).
2. familiarize with several hydrological and morphological model types, from conceptual to physically based, and to advanced modeling framework (including parameter calibration, model validation, sensitivity tests, and uncertainty analysis).
3. provide theoretical and practical capabilities of model development for hydro-morphological systems and a range of catchment- and river-scale processes.

C: The course combines theory (lectures) with a series of practical tasks (exercises) using mainly ArcGIS and Matlab software.
The course covers the following topics:
- Spatial Analysis, Watershed Hydrology and Morphometry in GIS: Advanced topographic and morphometric analyses on digital elevation models (DEMs) in Hydrology. Existing software, hydrological-related GIS toolboxes, and river-related packages.
o Watershed as a landscape unit. Geomorphometry, flow characteristics and land surface parameters (e.g., flow direction, flow accumulation, Topographic wetness index. Terrain roughness. Stream power index).
o River network analysis: Network organization, topological and hierarchical analysis. Riverscape attributes (thalweg, center line, channel width, valley bottom). Stream gradient, stream power.
- Geospatial and climate data for hydrology. Land use, soil types, geology. Hydrological Response Units (HRU) definition. Measurement of climate data (rainfall, temperature) in time and space. Weather radar. Satellite data. Climate reanalysis data. Spatial interpolation.
- Introduction to hydrological modeling: Conceptual hydrological models. Physically-based hydrological models. Model calibration, validation, sensitivity, and uncertainty.
- Modelling climate change impacts on watersheds: Climate models. Climate scenarios. Land-use changes. Hydro-morphological impact studies. Hydro-climatic uncertainties.
- Connectivity: Longitudinal, lateral, and vertical dimensions. Hydrological connectivity. Hillslope-channel connectivity. Sediment cascades. Quantifying connectivity (indices).
- Watershed scale erosion and sediment transport processes: Soil production and erosion. Sheet-rill-gully erosion.
- Introduction to landscape hydro-geomorphic system modeling: Cellular Automata Models. Gridded landscape evolution models.

MOUNTAIN STREAMS: SEDIMENT MANAGEMENT

Stuart Lane

T	Opt	French	40
A	3.0		

N: Master

P: River hydraulics, forms and processes

O: Train students in the basics of sediment management in Alpine streams and rivers; give students an opportunity to realize this training thorough additional experience of project management, data acquisition through fieldwork, data analysis and working in groups. This cours is given in French and a fuller description is provided above.

C: Students receive a request to prepare
1. A proposition for work to be done to resolve an active river management problem; and when this is expected;
2. Students have to undertake field data collection and data analysis around a specific area which in turn contributes to a group analysis of the problem.
A fuller description is provided in French above.

B: Suite à une colloque sur ce sujet, à Bramois, Sion en janvier 2018, il y a trois vidéos disponibles à http://wp.unil.ch/alpenv/presentations/
Vous devez impérativement regarder ces vidéos avant le camp car ça va être impossible de faire le camp sans la connaissances là-dedans. Les trois vidéos sont
Bakker M et al., 2018. Morphodynamiques de la Borgne d'Arolla depuis les années 1950. (Bakker_CollArolla_Jan2018).
Gabbud, C et al., 2018. Ecologie d'une rivière de haute montagne, la Borgne d'Arolla, soumise au réchauffement climatique et à l'exploitation hydroélectrique.
(Gabbud_CollArolla_Jan2018).
Lane SN et al., 2018. Le Val d'Arolla comme lieu de recherche scientifique et Le paysage Alpin face aux changements climatiques : l'exemple du Val d'Arolla (Lane_CollArolla_Jan2018).
Lectures clés
Bakker, M., Costa, A., Silva, T. A.,Stutenbecker, L., Girardclos, S., Loizeau,J.-L., Molnar, P., Schlunegger, F. and Lane, S. N. (2018). Combined flow abstraction and climate change impacts on an aggrading Alpine river. Water Resources Research, 54, 223-242.
Gabbud, C. and Lane, S.N., 2016. Ecosystem impacts of Alpine water intakes for hydropower: the challenge of sediment management. WIRES Water, 3, 41-61
Une version en français et synthétisée est aussi disponible (mais ce n'est qu'un synthèse et donc il faut aussi lire l'original):
Gabbud, C. and Lane, S.N., 2017. Impacts des prises d'eau alpines sur les écosystèmes - le rôle-clé de la gestion sédimentaire. Eau, Energie, Air, 108, 285-90. Disponible à : http://www.unil.ch/idyst/files/live/sites/idyst/files/shared/Liens_PDF/ASAE_4_2016_Gabbud_ImpactsPrisesEau_GestionSedimentaire.pdf

APPLIED ECOLOGY

Jérôme Pellet

C	Opt	English	14
S	3.0		

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.
After this lecture, students are able to understand the underlying concept of evidence-based conservation and adaptive management. They have applied the concepts in several different conservation settings.

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

C	Opt	English	14
S	1.5		

N: Master

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

Ian Sanders

C	Opt	English	14
S	1.5		

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 availble in pdf format before the course begins. For an example of the publications discussed you can find last years publications in my docunil public folder.

CURRENT PROBLEMS IN CONSERVATION BIOLOGY

Claus Wedekind

C	Opt	English	14
S	3.0		

E	Opt	English	14
S			

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

C	Opt	English	7
S	1.5		

TP	Opt	English	10
S			

N: Master

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

C	Opt	English	14
S	1.5		

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.

B: Seeley T, 1985. Honeybee Ecology. Princeton University Press.
Seeley T, 1995. The wisdom of the hive. Harvard University Press.
Moritz RFA, Southwick EE, 1992. Bees are superorganisms. Spiringer Verlag
Oldroyd B, Wongsiri S, 2006. Asian Honey Bees. Harvard University Press.
Koeniger N, Koeniger G, Tingek S, 2010.Honey Bees of Borneo. Natural History Publications
Winston ML, 1987. The Biology of the honey bee. Harvard University press.

PHYLOGENY AND COMPARATIVE METHODS

Nicolas Salamin

C	Opt	English	14
S	3.0		

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

B: Felsenstein, J. 2003. Inferring phylogenies. Sinauer Associates.
Page, R. 2003. Tangled trees: Phylogeny, cospeciation, and coevolution. University of Chicago Press.
Purvis, A., Gittleman, J.L. and Brooks, T. 2005. Phylogeny and conservation. Cambridge University Press.
Swofford, D.L., Olsen, G.K., Waddell, P.J. and Hillis, D.M. 1996. Phylogeny reconstruction. Pages 407-514 In Molecular Systematics (D.M. Hillis, C. Moritz, B.K. Mable, eds.). Sinauer Associates.
Yang, Z.H. 2006. Computational Molecular Evolution. Oxford University Press.

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

PLANT POPULATION GENETICS AND CONSERVATION

François Felber

C	Opt	English	7
S	1.5		

TP	Opt	English	10
S			

N: Master

SPATIAL MODELLING OF SPECIES AND BIODIVERSITY

Antoine Guisan

C	Opt	English	14
S	3.0		

E	Opt	English	14
S			

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 disperal limitations. Types of response variables, main predictive modelling approaches, field sampling design, from predicting species distributions to predicting communities.
Chap. 2. Model calibration. Presence-only versus presence-absence data, statistical theory and methods for presence-only data, regressions and classifications for presence-absence, ensemble modelling and forecasting.
Chap. 3. Model evaluation. Internal versus external evaluation. Data and metrics for evaluation. Crossvalidation, jackknife, bootstrap, uncertainties.
Chap. 4. Assumptions behind these models. Pseudo-equilibrium, niche conservatism, niche completeness, realized niche, and other postulates.

B: Guisan, A. & Zimmermann, N.E. (2000). Predictive habitat distribution models in ecology. Ecological Modelling 135(2-3): 147-186.
Guisan A, Thuiller W (2005) Predicting species distribution: offering more than simple habitat models. Ecology Letters, 8, 993-1009.
Guisan et al. (2013) Predicting species distributions for conservation decisions. Ecology Letters 16: 1424-1435.

I: http://www.unil.ch/ecospat

COMPARATIVE GENOMICS: FROM THOUSANDS OF GENOMES TO SINGLE CELLS

Roman Arguello

C	Opt	English	7
S	1.5		

E	Opt	English	7
S			

N: Master

O: An introduction to central topics and questions in comparative genomics and molecular evolution

C: 1. Intro
A. what is a genome and the concept of heredity?
B. broad differences in the tree of life
C. principle factors influencing genome architecture
D. are genomes optimized? (early thoughts on selection)
2. Population Variation vs. Divergence: how do genetic changes arise?
3. Evolution of Genome Architecture
4. Origin of New Genes
5. Evolution of Gene Families
6. Evolution of Transcriptomes
7. Single Cell Transcriptomics
8. (depending on time) Ancient DNA and Evolution

INTRODUCTION TO PRIMATE BEHAVIOUR, COGNITION AND CULTURE

Erica Van de Waal

C	Opt	English	10
S	1.5		

S	Opt	English	8
S			

N: Master

O: 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.

C: 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 investigates 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.
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.

B: van Schaik, C. P. (2016). The primate origins of human nature (Vol. 2). John Wiley & Sons.
Clutton-Brock, T. (2016). Mammal societies. John Wiley & Sons.
Boyd, R., & Silk, J. B. (2014). How humans evolved. WW Norton & Company.

SEX, AGEING AND FORAGING THEORY

Charles Mullon

C	Opt	English	9
S	1.5		

TP	Opt	English	9
S			

N: Master

O: The goal is to be introduced to the theoretical principles and some modelling approaches to fundamental problems in evolutionary ecology and life history. We explore the evolution of sexual reproduction, senescence and resource consumption through mathematical and computational modelling. In addition to core concepts of evolutionary ecology and life history, students learn how to formalise a theoretical model in mathematical form, implement it in a computer program (e.g. R, C or Python) and analyse its output.

SCIENTIFIC COMMUNICATION - SCIENTIFIC HANDS-ON WORKSHOP MODULE

Alain Kaufmann, Philippe Reymond

C	Opt	French	14
S	3.0		

E	Opt	French	14
S			

N: Master

SCIENTIFIC MEDIATION AND COMMUNICATION - MUSEUM MODULE

Michel Sartori

C	Opt	English	6
S	3.0		

TP	Opt	English	22
S			

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, 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

S	Opt	French	18
S	2.0		

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.

B: Précisé par les intervenants de semaine en semaine

I: https://moodle.unil.ch/course/view.php?id=23492

THE EVOLUTION OF COOPERATION : FROM GENES TO LEARNING AND CULTURE

Laurent Lehmann

C	Obl/Opt	English	28
S	3.0		

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 zizag path from dominance, to egalitarianism, to inequality again.

SOCIAL GENETICS

Laurent Keller

C	Opt	English	2
S	1.5		

E	Opt	English	12
S			

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

C	Opt	English	7
S	3.0		

T	Opt	English	49
S			

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

EVOLUTION AND BIOGEOGRAPHY OF SEMI-ARID AND ISLAND FLORAS

John Pannell

T	Opt	French	40
S	2.0		

N: Master

P: Financial participation required by the student.