Course directory 2018.2019

school of Biology (FBM-BIO) Master

* your selection

> Biology > 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/**

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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

UNIL | Université de Lausanne
Ecole de biologie

Master of Science in Behaviour, Evolution and Conservation
Specialisation Geosciences, Ecology and Environment
2018-2019

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
- 19.5 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)

	Courses / Enseignement	Hours per semester C	E/S	PW	Teaching Staff	ECTS Credits	Limited nb of students
MODULE 1	**Compulsory / *Obligatoires***						
	Advanced Data Analysis in Biology I *Analyse de données en biologie I : niveau avancé*	6	-	6	**Robinson M.** Malaspinas A.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	
	Subtotal	20	19	6		5,5	
	Optional / Optionnel						
	Environmental chemistry and toxicology (GSE) *Chimie environnementale et toxicologie*	56 CTP			**Peña J., Chèvre N.**	5	
	Remote sensing of Earth Systems (GSE) *Télédétection des systèmes terrestres*	56 CTP			**Mariethoz G., Derron, M.-H., Lane S., Mettra F.**	5	
	Planning and protection of the Alps 1 (in French) (GSE) *Aménagement et protection des Alpes 1*	17	5	8	**Reynard E.**	3	
	Management of protected areas at the international level (in French) (GSE) *Gestion des aires protégées au niveau international*	8	-	20	**Badman T., Reynard E.**	2	
	Environmental time-series analysis (GSE) *Traitement du signal et analyse de séries temporelles*	56 CTP			**Irving J.**	5	
	Advanced Data Analysis in Biology II *Analyse de données en biologie II : niveau avancé*	6	-	6	**Robinson M.** Malaspinas A.S.	2,5	
	Animal Communication and Parasitism *Communication animale et parasitisme*	14	-	-	**Christe P.**, Roulin A.	1,5	
	Molecular Methods in Ecology and Evolution *Méthodes moléculaires en écologie et évolution*	18	-	42	**Sanders I.**, Fumagalli L., N. Salamin	5	
	Phylogeography *Phylogéographie*	7	10	-	**Fumagalli L.**	1,5	
	Population Genetics and Dynamics *Génétique et dynamique des populations*	7	10	-	**Goudet J.**	1,5	
	Problem-based Learning in Biological Models *Apprentissage par problème : modèles biologiques*	7	35	-	**Franken P.**	3,5	
	Scientific Research in all its Forms (for Biology) (in French only) *La recherche dans tous ses états (pour biologie)*	14	-	-	**Preissmann D.**	1,5	
	The Major Transitions in Evolution *Les grandes étapes de l'évolution*	14	-	-	**Keller L.**	1,5	12
	Introduction to R (optional support) *Introduction à R (mise à niveau optionnelle)*				**Schütz F.**	-	
	Animal Experimentation and Wild Animals * *Expérimentation animale et animaux sauvages*	20	-	20	**Rubin J.-F.**	1.5	
	Total					**15**	
MODULE 2	**Practical Project / *Travail pratique***						
	First Step Project *Travail d'initiation à la recherche*	-	-	224	**Goudet J., 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 optional courses marked in blue

Abbreviations
C = Course
E/S = Exercise/Seminar
PW = Practical Work
CTP = Course/Practical Work

ADVANCED DATA ANALYSIS IN BIOLOGY I

Anna Sapfo Malaspinas, Matthew Robinson

C	Obl/Opt	English	6
A	2.00		

TP	Obl/Opt	English	6
A			

N: Master

INTRODUCTION INTO SCIENTIFIC WRITING

Robert Waterhouse

C	Obl	English	7
A	2.00		

E	Obl	English	9
A			

N: Master

P: Lecturing and paper writing are in English.

O: Synposis of the major course aims in English:
This short but intensive block course introduces students to the practice of scientific writing (and aspects related to getting published in peer-reviewed scientific journals).
We will discuss questions 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 elses paper?
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: 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; however, the major emphasis of the course is on practical work on 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 1 written report (homework assignment). For each exercise as well as for the written reports we will give detailed and individualized feedback.
Detailed Program
Day 1: Lecture 1: Writing papers: the basics 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. 1 hour.
Day 1: Practical work 1. How to think of an effective title and how to write a succinct 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). We will then discuss the solutions you have come up with, and their potential pros and cons, together in class. Approx. 3 hours.
Day 2: Lecture 2: How to write a scientific paper. 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 agressive revising and re-revising. I will also give you hints and tips for effective writing. Approx. 1 hour.
Day 2: Practical work 2. Writing your own paper in a nutshell. I will give you some data/results (e.g., data figures/ tables/legends/statistical outcomes) to choose from. Form a team of 2-3. Ask yourself: What do the results/tables/ figures/analyses show and mean? Then prepare a very short mini-paper (1 page 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. We will then discuss your solutions and their potential pros and cons together in class; I will then give you detailed feedback on your papers by e-mail within 1 week of the exercise. Approx. 3 hours.
Day 3: Lecture 3: How to write a scientific paper: recap. We will briefly recapitulate what we have discussed and learned so far. Approx. 30 min - 1 hour
Day 3: Practical work 3: Review a paper. 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 2 short, stripped-down manuscripts. 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	1.50		

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

CHIMIE ENVIRONNEMENTALE ET TOXICOLOGIE

Nathalie Chèvre, Jasquelin Pena, Torsten Vennemann

C/TP	Opt		4	English	56
A	5.00				

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).

TÉLÉDÉTECTION DES SYSTÈMES TERRESTRES

Marc-Henri Derron, Stuart Lane, Grégoire Mariéthoz, François Mettra

C/TP	Opt		4	English	56
A	5.00				

N: Master

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

O: L'objectif de ce cours est de fournir des connaissances avancées sur certaines méthodes spécifiques utilisées en télédétection. Cela comprendra la récupération et le traitement des données satellitaires, des techniques d'acquisition de données telles que la photogrammétrie, Structure-From-Motion et les méthodes utilisées, ainsi que le traitement et la visualisation assistés par ordinateur des données de télédétection.

C: A la fin de ce cours, les étudiants pourront:
- être capable de localiser et de télécharger des images satellites et d'appliquer un traitement à ces images afin d'extraire des informations;
- se familiariser avec des plateformes telles que USGS GLOVIS et Google Earth Engine;
- être capable d'utiliser des outils logiciels avancés tels que la boîte à outils Matlab Image Processing Toolbox pour le traitement des données de télédétection;
- être capable d'appliquer des méthodologies standard telles que la classification, le pansharpening, l'interpolation, la détection des contours ou les filtres, entre autres;
- être capable d'appliquer et de comprendre les principes de la photogrammétrie.

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.

PLANNING AND PROTECTION OF THE ALPS 1

Marianne Milano, Emmanuel Reynard

C	Opt	French	24
A	3.00		

N: Master

P: None

O: Study of planning and protection policies in the Alps at different scales.

C: Public: master students in Geography and Tourism Studies. The objectives are to study current challenges concerning the sustainable development in the Alps. The course proposes an analysis of spatial trends in the Alps since the 19th century, as well as the development of management instruments at the national and international scales. The course is designed as a project-based approach, with a large part of it devoted to carrying out a "study mandate" in collaboration with an Alpine municipality.

B: Voir page moodle.

MANAGEMENT OF PROTECTED AREAS AT THE INTERNATIONAL LEVEL

Tim Badman, Emmanuel Reynard

C/TP	Opt	French
A	2.00	

N: Master

P: The course is open to all Master's students.

O: The course module on management of protected areas at the international level has the objective of familarisation with, and analysis of international systems for protected areas including: - the IUCN protected area categories, - the IUCN-World Commission on Protected Areas system of protected area management effectiveness, and - the international systems for protection included in the UNESCO World Heritage Convention, the Ramsar Convention, the UNESCO Man and Biosphere Programme, and the Global Geoparks Network.

C: The course is organised in three parts: a) A seminar and an assessed group exercise b) A field visit to the headquarters of IUCN (Gland) c) A field visit to Lavaux

ANALYSE DE SÉRIES TEMPORELLES ENVIRONNEMENTALES

James Irving

C/TP	Opt		3	English	42
A	5.00				

N: Master

O: Ce cours fournit une introduction à l'analyse des séries temporelles et au traitement du signal pour les sciences de l'environnement. Les sujets à couvrir, dans le contexte des exemples environnementaux pertinents, comprennent l'analyse linéaire des systèmes et des signaux, la convolution, la transformée de Fourier, l'auto-corrélation et la corrélation croisée, le filtrage, la conception des filtres, l'échantillonnage et la reconstruction du signal, l'estimation spectrale, et l'analyse temps-fréquence. Les concepts appris lors des cours seront renforcés par des exercices informatiques.

ADVANCED DATA ANALYSIS IN BIOLOGY II

Anna Sapfo Malaspinas, Matthew Robinson

C	Obl/Opt	English	6
A	2.50		

TP	Obl/Opt	English	6
A			

N: Master

ANIMAL COMMUNICATION AND PARASITISM

Philippe Christe

C	Opt	English	14
A	1.50		

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

MOLECULAR METHODS IN ECOLOGY AND EVOLUTION

Luca Fumagalli, Ian Sanders

C	Obl/Opt	English	18
A	3.50/5.00		

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	1.50		

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	1.50		

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.
website:
http://www2.unil.ch/popgen/teaching/PGD18

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/PGD18/

PROBLEM-BASED LEARNING IN BIOLOGICAL MODELS

Paul Franken

C	Opt	English	7
A	3.50		

E	Opt	English	35
A			

N: Master

SCIENTIFIC RESEARCH IN ALL ITS FORMS

Delphine Preissmann

C	Opt	2	French	14
A	1.50			

N: Master

P: * Bachelor degree
* Passive knowledge of French

O: - Integrate technics & scientific methods from different academic fields
- Synthesize information from different disciplines
- Transpose knowledge & results from one academic field to another

C: This course offers a multidisciplinary perspective on decision making. While addressing this topic, speakers from different faculties will shed light on their own way of practicing research.

I: http://www.unil.ch/sciencesaucarre/page86487.html

THE MAJOR TRANSITIONS IN EVOLUTION

Laurent Keller

C	Opt	English	14
A	1.50		

N: Master

P: none

O: Understand how life has become increasingly more complex during the course of evolution on earth

C: We will addres the major transitions of life, including the evolution of multicelularity, evolution of sex and emergence of animal societies and language in humans

B: La bibliographie sera déterminée lors du cours

ANIMAL EXPERIMENTATION AND WILD ANIMALS

Jean-François Rubin

C	Opt	English	20
A	1.50		

TP	Opt	English	20
A			

N: Master

FIRST STEP PROJECT

Richard Benton, Marie-Christine Broillet, Jérôme Goudet, Antoine Guisan, Laurent Lehmann, Marc Robinson-Rechavi

TP	Obl	English	224
A	15.00		

TP	Obl	English	282
A	15.00		

TP	Obl	English	250
A	14.00		

TP	Obl	English	224
A	15.00		

TP	Obl	English	224
A	15.00		

TP	Obl	English	224
A	15.00		

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
2018-2019

Spring Semester (semester 2)

MODULE 3

Courses / Enseignement	Hours per semester C	E/S	PW	Teaching Staff	ECTS Credits	Limited nb of students
Interdisciplinary Compulsory Courses ***Enseignements interdisciplinaires 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*	-	-	44	**Guisan A.**	2	
Subtotal	28	0	44		**5**	
Optional / Optionnel *						
Environmental data mining (GSE) *Fouille de données environnementales*	56 CTP			**Kanevski M.**	5	
Geostatistics and GIS (GSE) *Géostatistique et SIG (Syst. d'Inform. Geogra.)*	56 CTP			**Kanevski M.**	5	
Aquatic Ecosystems : Glaciers, Rivers and Lakes (GSE) *Ecosystèmes aquatiques : glaciers, rivières et lacs*	56 CTP			**Perga M.-E., Lane S.**	5	
Environmental biogeochemistry : molecular-scale : perspectives on water-microbe-mineral interactions (GSE) *Biochimie environnementale*	30 CTP			**Peña J.**	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 CTP			**Peña J.**, Chèvre N., Vennemann T.	5	
Applied Ecology *Ecologie appliquée*	14	-	28	**Pellet J.**	3	
Biological Invasions *Invasions biologiques*	14	-	-	**Alexander J., Guisan A.**	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*	7	14	-	**Salamin N.**	1,5	
Plant Population Genetics and Conservation *Génétique des populations végétales et biologie de la conservation*	7	-	10	**Felber F.**	1,5	
Plant Range Dynamics and Global Change *Dynamique des distributions géographiques de plantes et changements globaux*	7	-	10	**Randin C.**	1,5	
Predictive Models of Species' Distribution *Modèles de distribution d'espèces et de la biodiversité*	14	14	-	**Guisan A.**	3	
Advanced Quantitative Genetics *Génétique quantitative avancée*	10	7	-	**Robinson M.**	1,5	
Evolution of Genome Architecture *Evolution de l'architecture du génome*	7	7	-	**Arguello R.**	1,5	
Evolutionary Consequences of Hybridization and whole Genome Duplication *Conséquences évolutives de l'hybridation et de la duplication de génome*	14	-	-	**Arrigo N.**	1,5	
The Environment, addressed in an interdisciplinary way (most in French) (GSE) *Séminaire interfacultaire en environnement*	-	10	-	**Guisan A.**	2	
Introduction to Primate Behaviour, Cognition and Culture *Introduction au comportement, à la cognition et à la culture des primates*	10	6	-	**Van de Waal E.**	1,5	
Scientific Mediation and Communication - Scientific Hands-on Workshop Module (in French only) *Communication et médiation scientifique - module atelier scientifique*	8	-	20	**Kaufmann A., Reymond P.,** Ducoulombier D.,Trouilloud S.	3	8
Scientific Mediation and Communication - Museum Module *Communication et médiation scientifique - module musée*	6	-	22	**Sartori M.,** Glaizot O.	3	6
Social Evolution : from Genes to Culture *Evolution sociale : des gènes à 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 optionnel***						
Biological Conservation of the Mediterranean Region *Biologie de la conservation dans les régions méditerranéennes*	-	-	40	**Roulin A., Christe P., Fumagalli L.**	2	
Ecology and Faunistics of the Sea Shore, Roscoff *Ecologie et faunistique du bord de mer, Roscoff*	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	
Total					**30**	

* Possibility of taking Cross-disciplinary optional courses from the module 1 during semester 3 according to their availability

Disciplinary courses marked in green

Cross-disciplinary optional courses marked in blue

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

INTEGRATED COURSE MOUNTAIN ECOSYSTEMS - ECOLOGY & EVOLUTION

Antoine Guisan

C	Obl/Opt		English	14
S	1.50			

N: Master

INTEGRATED COURSE MOUNTAIN ECOSYSTEMS - GEO-ENVIRONMENTAL SCIENCES

Antoine Guisan

C	Obl/Opt	English	14
S	1.50		

N: Master

INTEGRATED PRACTICAL WORK MOUNTAIN ECOSYSTEMS IN THE ALPS

Antoine Guisan

T	Obl/Opt		English	44
S	2.00			

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

FOUILLE DE DONNÉES ENVIRONNEMENTALES

Mikhail Kanevski

C/TP	Opt	English	56
S	5.00		

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

B: - Kanevski M., Pozdnoukhov A., Timonin V. Machine Learning for Spatial Environmental Data. EPFL Press, 2009.
- Kanevski M. (Editor). Advanced Mapping of Environmental Data. Geostatistics, Machine Learning, and Bayesian Maximum Entropy. iSTE/Wiley, 2008.
- Bishop C. Pattern recognition and machine learning. Springer, 2006.
- Hastie T., Tibshirani R., Friedman J. The Elements of Statistical Learning. 2d edition. Springer, 2009.

GÉOSTATISTIQUE ET SIG

Mikhail Kanevski

C/TP	Opt		English	56
S	5.00			

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: 1. Kanevski M. and M. Maignan. Analysis and Modelling of Spatial Environmental Data. EPFL Press, 2004.
2. Kanevski M. (Editor). Advanced Mapping of Environmental Data. Geostatistics, Machine Learning, and Bayesian Maximum Entropy. iSTE/Wiley, 2008.
3. Wackernagel H. Multivariate Geostatistics. 3d edition. Springer, 2003.
4. Chiles J-P., Delfiner P. Geostatistics. Modelling Spatial Uncertainty. John Wiley and Sons, 2012.

ECOSYSTÈMES AQUATIQUES : GLACIERS, RIVIÈRES ET LACS

François Mettra, Marie-Elodie Perga

C/TP	Opt	English	56
S	5.00		

N: Master

B: Limnology, 3rd Edition, Lakes and River Ecosystems, R. Wetzel, 2001, Elsevier
Lakes: a very short introduction, W Vincent, 2018, Oxford University Press

ENVIRONMENTAL BIOGEOCHEMISTRY

Jasquelin Pena

C/E	Opt		French	30
S	5.00			

C/TP			French	32
A				

N: Master

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

C: 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

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

Nathalie Chèvre, Jasquelin Pena, Torsten Vennemann

TP	Opt		English	56
S	5.00			

N: Master

APPLIED ECOLOGY

Jérôme Pellet

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

Jake Alexander, Antoine Guisan

C	Opt	English	14
S	1.50		

N: Master

O: 1. Explain core theory and concepts underlying the spread and impacts of non-native species.
2. Give key insights emerging from invasions as natural experiments in ecology and evolution.
3. Design an empirical study using non-native species as a model system.

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. However, the spread of invasive species can also be seen as natural experiments on a grand scale, giving important insights into the regulation and functioning of populations, communities and ecosystems. In this course, we elucidate the main hypotheses explaining the success and spread of invasive species, whilst emphasising the insights that biological invasions have given us into basic ecological and evolutionary processes.

B: See English pages of the course

CO-EVOLUTION, MUTUALISM AND PARASITISM

Ian Sanders

C	Opt	English	14
S	1.50		

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	3.00		

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, guest lectures, and discussion 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.

ECOLOGY OF THE FISHES OF SWITZERLAND

Jean-François Rubin

C	Opt	English	7
S	1.50		

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	1.50		

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	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

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	1.50		

TP	Opt	English	10
S			

N: Master

PLANT RANGE DYNAMICS AND GLOBAL CHANGE

Christophe Randin

C	Opt	English	7
S	1.50		

TP	Opt	English	10
S			

N: Master

PREDICTIVE MODELS OF SPECIES' DISTRIBUTION

Antoine Guisan

C	Opt	English	14
S	3.00		

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

ADVANCED QUANTITATIVE GENETICS

Matthew Robinson

C	Opt	English	10
S	1.50		

E	Opt	English	7
S			

N: Master

EVOLUTION OF GENOME ARCHITECTURE

Roman Arguello

C	Opt	English	7
S	1.50		

E	Opt	English	7
S			

N: Master

P: Evolutionary biology, some statistics that involve probabilistic reasoning, basic molecular biology

O: - To investigate several of the outstanding topics in genome/molecular evolution
- To develop familiarity with several of the current debates within the field
- To develop familiarity with quantitative/computation approaches to addressing questions within the field

C: Primary literature (reviews and reports), simulation software, computational approaches

EVOLUTIONARY CONSEQUENCES OF HYBRIDIZATION AND WHOLE GENOME DUPLICATION

Nils Arrigo

C	Opt		English	14
S	1.50			

N: Master

THE ENVIRONMENT, ADDRESSED IN AN INTERDISCIPLINARY WAY.

Antoine Guisan, Pierre-Louis Rey

S	Opt	French	18
S	2.00		

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

INTRODUCTION TO PRIMATE BEHAVIOUR, COGNITION AND CULTURE

Erica Van de Waal

C	Opt	English	10
S	1.50		

S	Opt	English	6
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.

SCIENTIFIC MEDIATION AND COMMUNICATION - SCIENTIFIC HANDS-ON WORKSHOP MODULE

Alain Kaufmann, Philippe Reymond

C	Opt	French	8
S	3.00		

TP	Opt	French	20
S			

N: Master

SCIENTIFIC MEDIATION AND COMMUNICATION - MUSEUM MODULE

Michel Sartori

C	Opt	English	6
S	3.00		

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. No specific themes this year ; we will propose some ideas to be developed during the first lecture hours. You may also have the opportunity to propose your own subject of peculiar interest for you.

SOCIAL EVOLUTION : FROM GENES TO CULTURE

Laurent Lehmann

C	Obl/Opt	English	28
S	3.00		

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	1.50		

E	Opt	English	12
S			

N: Master

BIOLOGICAL CONSERVATION OF THE MEDITERRANEAN REGION

Alexandre Roulin

T	Opt	English, French	40
A S	2.00		

N: Master

P: Financial participation required by the student.

O: Faunistic knowledge on birds, insects, crustaceans, mammals and reptiles with an emphasis on conservation issues. We will visit several places (Extermadura, Andalucia around the Doñana national parc, Tarifa and Brazo del Este) where the fauna is fundamentally different and habitats have suffered from human activities to different degrees.

C: Excursions and group field work. Discussion of scientific articles about conservation issues of Spanish endangered species. Additionnally, each student shall be responsible for the study of one endangered species. Discussion of projects that could be carried out in Spain to answer questions on evolutionary biology, behavioural ecology and conservation.

B: Polycopié distributé aux participants

ECOLOGY AND FAUNISTICS OF THE SEA SHORE, ROSCOFF

Tanja Schwander

T	Opt	English, French	49
S	3.00		

C	Opt	English, French	7
S	3.00		

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 itertidal 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). Additionnally, 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 adaptative behaviour of an intertidal species.

EVOLUTION AND BIOGEOGRAPHY OF SEMI-ARID AND ISLAND FLORAS

John Pannell

T	Opt	French	40
S	2.00		

N: Master

P: Financial participation required by the student.