Asignatura	Genetic Resources Conservation and Molecular Markers (A11)		
Materia	Bloque I		
Módulo	Optative		
Titulación	Máster en Gestión Forestal basada en Ciencia de Datos - Forest Management based on Data Science & Master in Mediterranean Forestry and Natural Resources – MEDFOR		
Plan	572 / 506	**Código**	54277
Periodo de impartición	1º cuatrimestre	**Tipo/Carácter**	ELECTIVE
Nivel/Ciclo		**Curso**	2º
Créditos ECTS	6		
Lengua en que se imparte	Inglés-English		
Profesor/es responsable/s	Dr. José Climent Maldonado (2 ECTS) Dr. Ruth C. Martín Sanz (2 ECTS)		
Datos de contacto (E-mail, teléfono…)	Dr. José Climent Maldonado climent@inia.es 913476862 http://sostenible.palencia.uva.es/users/jcliment		
Horario de tutorías	See at www.uva.es > Masteres >Título correspondiente>Tutorías		
Departamento	1.-Producción Vegetal y Recursos Forestales; 2- CIFOR- INIA INSTITUTO UNIVERSITARIO DE INVESTIGACIÓN EN GESTIÓN FORESTAL SOSTENIBLE (iuFOR)		
Date of approval by the committee	20 June 2024		

1. Situación / Sentido de la Asignatura/ / Course framework

1.1 Contextualización / Context

Long-term stability of forest ecosystems is based on the preservation of the adaptability of forest trees to changing environmental conditions. A precondition, both for the sustainable management of forests and for the conservation of their genetic resources, is to understand the diversity of forest species at the specific, genetic and functional level. During last decades, a huge amount of information and data has been published, both from molecular traits –thanks to the fast progress of sequencing tools and bioinformatic analysis of the sequences– and from phenotypic traits. In forest species, there are still few studies combining molecular and quantitative approaches, but the need and reach of this synergy is widely recognized. Based in this knowledge, a set of strategies and tools for conservation of genetic resources has been developed.

1.2 Relación con otras materias / Relation with other courses

Genetic Resources Conservation and Molecular Markers is an optional course closely related to the compulsory courses **Fundamentos de investigación e innovación**, **Cambio Global y Bosque** and **Estadística avanzada**, as they work theoretical bases and tools of fundamental importance for the scope of work of the course. In addition, courses of the optional module are linked to the subject, being remarkable:

Métodos de Gestión Forestal, **Multifuncional silviculture**, **Learning by doing: adaptive Management**, **Forest Pest and Diseases**, **Conservación Flora y Fauna**, **Dinámica sistemas forestales**, **Geographical Information Systems** and **Geospatial analysis**.

The application module can be attached to Genetic Resources Conservation and Molecular Markers depending on the choice made by the student on their TFM and Internship.

1.3 Prerrequisitos / Requisites

The general prerequisites of the Master

2. Competencias / Competences

2.1 Generales / Basic

G1 Knowledge of the basic elements of professional work in a practical way, analyzing and synthesizing relevant data and organizing and planning teams and processes

G2 Ability to communicate orally and written, both in specialized forums and for non-experts

G4 Ability to work both as a team and independently in a local, regional, national or international context

G5 Ability to take initiatives and develop entrepreneurship

2.2 Específicas / Specific

In this course students will develop the following specific competences:

E7 Ability to apply different methods and techniques of analysis to address interdisciplinary problems in forest systems

E11 Ability to search, select, generate and manage appropriate databases to obtain information relevant to the problems of forest management

3. Objetivos / Objectives

The students will acquire a global vision of the main problems facing by the forest genetic resources, and will learn how to:

1. Evaluate the need of conservation and use of particular genetic resources
2. Decide the most appropriate conservation strategy.
3. Decide on the molecular tools suitable to identify genotypes and measure diversity in forest species
4. Understand the interplay between conservation and breeding in different contexts
5. Manage information on the main databases related with these topics

4. Contenidos y/o bloques temáticos/ Contents

Bloque 1: "Complex phenotypic traits and data associated"

Carga de trabajo en créditos ECTS: 2

a. Contextualización y justificación / Context and justification

Currently the main bottleneck in genetic association studies used in genetic conservation and breeding are the relevant phenotypic traits. Two main problems are frequent: first, the need of high-throughput phenotyping methods and, second, the need of assessing traits closely linked to fitness to gain insight in the adaptive meaning of morphological and physiological traits. Moreover, most traits depend on the environment to some extent, and they interact in a complex way within alternative strategies to cope with either stress, competition and perturbations. This knowledge of what is "adaptive" depending on the objective and the main environmental limitations is key in conservation and use of forest genetic resources, including breeding for commercial purposes.

b. Objetivos de aprendizaje / Learning objectives:

To know the wide number of relevant phenotypic traits in forest trees and which variables are used to describe those traits
To classify traits into groups of biological consistency
To know how to define (and work with) protocols and databases
To acquire skills in quantitative genetics, including plasticity and g x e
To understand how complex traits combine in meaningful life history strategies

c. Contenidos / Contents

1. Concepts and drivers of evolutionary change
2. Phenotyping: morphological and functional traits
3. Life history traits: Mediterranean pines as a case of study
4. Genetic trials: Experimental designs and networks
5. Quantitative genetics
6. Phenotypic plasticity, g x e interaction and trait correlation (integration)
7. Practical implications for conservation and deployment of forest genetic resources

d. Métodos docentes / Teaching Methods

See general description below

e. Plan de trabajo / Work Plan

See general description below

f. Evaluación / Evaluation

See general description below

g Material docente / Teaching materials

g.1 Bibliografía básica / Basic Bibliography

Falconer DS, Mackay FC (1996) Introduction to Quantitative Genetics (4th Edition). Pearson Education Limited. 480 pp.

Garnier E, Lavorel S, Poorter H, et al. (2013) New handbook for standardised measurement of plant functional traits worldwide. Australian Journal of Botany 61: 167–234.

Cornelissen JHC, Lavorel SB, Garnier EB, et al. (2003) A handbook of protocols for standardised and easy measurement of plant functional traits worldwide. Australian Journal of Botany 51: 335–380.

Schlichting CD, Pigliucci M (1998) Phenotypic evolution - A reaction norm perspective. Sunderland, MA.: Sinauer Associates. 387 pp.

g.2 Bibliografía Complementaria / Other Bibliography

Alberto FJ, Aitken SN, Alia R, González-Martínez SC, Hänninen H, Kremer A, Lefèvre F, Lenormand T, Yeaman S, Whetten R, Savolainen O (2013) Potential for evolutionary responses to climate change - evidence from tree populations. Global change biology 19: 1645–61.

Alpert P, Simms EL (2002) The relative advantages of plasticity and fixity in different environments: when is it good for a plant to adjust? Evolutionary Ecology 16: 285–297.

Chambel MR, Climent J, Alia R, Valladares F (2005) Phenotypic plasticity: a useful framework for understanding adaptation in forest species. Investigación Agraria: Sistemas y Recursos Forestales. 14: 334–344.

Grivet D, Climent J, Zabal-Aguirre M, Neale DB, Vendramin GG, González-Martínez SC (2013) Adaptive evolution of Mediterranean pines. Molecular Phylogenetics and Evolution 68: 555–66.

Kremer A, Potts BM, Delzon S (2014) Genetic divergence in forest trees: understanding the consequences of climate change (J Bailey, Ed.). Functional Ecology 28: 22–36.

Lortie CJ, Aarssen LW (1996) The specialization hypothesis for phenotypic plasticity in plants. International Journal of Plant Sciences 157: 484–487.

Matesanz S, Valladares F (2014) Ecological and evolutionary responses of Mediterranean plants to global change. Environmental and Experimental Botany 103: 53–67.

Matyas C (1996) Climatic adaptation of trees: rediscovering provenance tests. Euphytica 92: 45–54.

Pausas JG, Bradstock R, Keith D, Keeley JE (2004) Plant functional traits in relation to fire in crown-fire ecosystems. Ecology 85: 1085–1100.

Petit RJ, Hampe A (2006) Some evolutionary consequences of being a tree. Annual Review of Ecology, Evolution, and Systematics 37: 187–214.

Pigliucci M, Marlow ET (2001) Differentiation for flowering time and phenotypic integration in Arabidopsis thaliana in response to season length and vernalization. Oecologia 127: 501–508.

Torices R, Muñoz-Pajares AJ (2015) PHENIX: An R package to estimate a size-controlled phenotypic integration index. Applications in plant sciences 3.

Sampedro L, Moreira X, Zas R (2011) Costs of constitutive and herbivore-induced chemical defences in pine trees emerge only under low nutrient availability. Journal of Ecology 99: 818–827.

Santos-del-Blanco L, Alía R, González-Martínez SC, Sampedro L, Lario F, Climent JM (2015) Correlated genetic effects on reproduction define a domestication syndrome in a forest tree. Evolutionary Applications 8: 403–410.

Stearns SC (1980) A new view of life-history evolution. Oikos 35: 266–281.

Voltas J, Chambel MR, Prada MA, Ferrio JP (2008) Climate-related variability in carbon and oxygen stable isotopes among populations of Aleppo pine grown in common-garden tests. Trees - Structure and Function.

g.3 Otros recursos telemáticos (píldoras de conocimiento, blogs, videos, revistas digitales, cursos masivos (MOOC), …)

https://www.plantphenomics.org.au/

h. Recursos necesarios / Other Resources

Sample databases from GENFORED (www.genfored.es), available without cost, under request

Bloque 2: "Molecular tools to evaluate intraspecific diversity and support conservation decisions"

Carga de trabajo en créditos ECTS / Credits: 2

a. Contextualización y justificación / Context and justification:

This block focuses on the molecular basis for phenotypic traits and on the importance of maintaining this (often) hidden diversity. We will describe the main molecular tools available for intraspecific diversity assessment and will discuss on their uses in FGR genetic study and conservation.

b. Objetivos de aprendizaje /Learning objectives

To understand how diversity arises at molecular level;

To know the molecular tools available to assess intra and interspecific diversity

To understand the uses of molecular markers in breeding (MAS)

To explore molecular genetics Databases and to practice its use

c. Contenidos /Contents

1. Molecular basis of biodiversity and potential consequences of mutations
2. Molecular markers & sequencing tools in detecting intraspecific biodiversity
3. Uses of genetic maps and arrays in FGR breeding
4. Basis for Molecular Genetic & Genomic Databases uses

d. Métodos docentes / Teaching Methods:

See general description below.

e. Plan de trabajo / Work Plan :

See general description below.

f. Evaluación / Evaluation

See general description below.

g. Bibliografía básica / Basic Bibliography

Bozeman Science: http://www.bozemanscience.com/ap-biology

SSR Database Evoltree (INRA) http://ssrdatabase.pierroton.inra.fr/login/login

GenBank https://www.ncbi.nlm.nih.gov/genbank/

Specific updated resources for each section will be available weekly on UVA-Moodle platform

h. Bibliografía complementaria/ Other Bibliography

Specific updated resources for each section will be available weekly on UVA-Moodle platform

i. Recursos necesarios / Other Resources

Virtual campus.

Classroom with audiovisual media.

Bloque 3: "Main problems and strategies for conservation of the forest genetic resources"

Carga de trabajo en créditos ECTS Credits:	2

a. Contextualización y justificación / Context and justification:

In the current global context, several factors are causing an important genetic erosion in many ecosystems, including forest all over the world. This block analyses the different strategies and tools that can help in the conservation of forest genetic resources and the criteria to select the more suitable combination of them.

b. Objetivos de aprendizaje / Learning objectives

To know the concept of forest genetic resources (FGR), their importance and main concerns for their conservation.

To understand how to assess the need for conservation of a particular FGR.

To know the basis and main strategies for conservation of FGR.

To understand how to decide the more suitable strategy of conservation.

c. Contenidos / Contents

1.- FGR: concepts, state of the world's FGR, main threats.

2.- Insight of population genetics to support the conservation of FGR.

3.- Distribution of the genetic variability in forest populations. Management of the geographic variability.

4.- Strategies of conservation of FGR*: in situ, ex situ, circa situm*.

5.- Main databases related to conservation of FGR.

d. Métodos docentes /Teaching Methods

See general description below.

e. Plan de trabajo / Work Plan

See general description below.

f. Evaluación / Evaluation

See general description below.

g Material docente / Teaching materials

g.1 Bibliografía básica / Basic Bibliography

Eriksson G, Clapham ED 2006 An introduction to forest genetics. http://www.slu.se/Forest-Genetics-online

FAO, FLD & IPGRI. 2004. Forest genetic resources conservation and management. Vol 1: Overview, concepts and some systematic approaches. Rome.

FAO, D. IPGRI (2001) Forest genetic resources conservation and management, vol 2, In managed natural forests and protected areas (in situ). International Plant Genetic Resources Institute, Rome, Italy.

FAO, FLD, IPGRI. 2004. Forest genetic resources conservation and management. Vol. 3: In plantations and genebanks (ex situ). International Plant Genetic Resources Institute, Rome, Italy. http://www.fao.org/forestry/fgr/publications/en/

g.2 Bibliografía Complementaria / Other Bibliography

Bozzano M, Jalonen R, Thomas E, Boshier D, Gallo L, Cavers S, ... Loo J (2014). The state of the world's forest genetic resources–thematic study. Genetic considerations in ecosystem restoration using native tree species. FAO, Rome. The State of the World's Forest Genetic Resources

Rao NK, Hanson J, Dulloo ME, Ghosh K, Nowell D, Larinde M (2006). Manual of seed handling in genebanks. Handbooks for Genebanks No. 8. Bioversity International, Rome, Italy (p. 4). ISBN 978-92-9043-740-6 Bioversity International Via dei Tre Denari, 472/a 00057 Maccarese Rome, Italy Bioversity International.

Multilingual Glossary Forest Genetic Resources: http://iufro-archive.boku.ac.at/silvavoc/glossary/1_2en.html

g.3 Otros recursos telemáticos (píldoras de conocimiento, blogs, videos, revistas digitales, cursos masivos (MOOC), …)

http://www.fao.org/forestry/fgr/64623/es/

http://www.euforgen.org/links.html

http://www.diva-gis.org/documentation

http://www.bioversityinternational.org/e-library/

http://www.iucn.org/es/

https://www.genesys-pgr.org/es/welcome

http://www.gbif.org/

h. Recursos necesarios / Other Resources

Virtual campus of the course.

Classroom with audiovisual media.

i. Temporalización / General Schedule of the course

CARGA ECTS	PERIODO PREVISTO DE DESARROLLO
6 ECTS	1st semester

5. Métodos docentes / Teaching Methods

This course will rely on theoretical/practical lessons (with presentations), individual and group works based on case studies and extant databases, technical visits, hands-on seminars and lab practice.

Classes will take place according to published schedule. A combination of theoretical classes and study of cases will be followed, together with the necessary individual and group work that will allow the active participation of the students in the course.

Lab practice (~6h) will consist on DNA Extraction; PCR Amplification and derived markers; electrophoresis and other analytical tools; Amplicons and sequences analysis. In case of confinement, practical classes will be replaced by demonstration and videos.

Technical visits will consist in a field trip to a common garden experiment and a visit to an in vitro collection of germplasm.

6. Tabla de dedicación del estudiante a la asignatura/ Student workload

Interaction with Faculty members ACTIVIDADES PRESENCIALES o PRESENCIALES A DISTANCIA(1)	**HORAS / Hours**	**ACTIVIDADES NO PRESENCIALES Individual or group work**	**HORAS / Hours**
Clases teórico-prácticas (T/M) /Theory	30	Estudio y trabajo autónomo individual/Individual study	70
Clases prácticas de aula /Practical work (Problems,…)	10	Estudio y trabajo autónomo grupal /Group study	20
Laboratorios (L)/Labs	8		
Prácticas externas, clínicas o de campo/Field trips	4		
Seminarios (S)/Seminars	4		
Evaluación/Evaluation	4		
Total presencial (face to face)	60	**Total no presencial**	90
Total presencial		Total no presencial	
		TOTAL presencial + no presencial	

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7. Sistema y características de la evaluación / Grading system and criteria

INSTRUMENTO/PROCEDIMIENTO Tools	PESO EN LA NOTA FINAL Weight on final grade	OBSERVACIONES Observations
Personal and group works, projects and presentations	50%	
Final exam	50%	The exam includes both theoretical and practical aspects.
CRITERIOS DE CALIFICACIÓN/ Grading criteria		

- **Convocatoria ordinaria/ first call:**
  Each block accounts for 1/3 of the final grade
  A minimum score of 4 out of 10 in the exam is required to pass the course.
- **Convocatoria extraordinaria/ second call:**
  The same criteria and requirements as the first call if a minimum of 60% of the assignments have been presented with grades equal to or greater than 5. Otherwise, 100% of the score will be that of the written exam and a minimum grade of 5 out of 10 will be required.