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<td>Forest Tree Improvement and Regeneration</td>
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**Prerequisites:**
- Variation and use of diagnostic keys to identify important species of micromorphological variations of spikelets; interpretation of spikelet classification and identification of grasses based on macro- and micromorphological variations of spikelets; interpretation of spikelet variation and use of diagnostic keys to identify important species of North America; a grass collection required.
- Interpretation of plant morphology for keying and identification of important flowering rangeland plants; vegetative and floral characters for important plant families including toxic compounds affecting domestic livestock. Plant collection required.
- Ecosystem science and management; development of a professional portfolio and résumé; exploration of career options through team approach; conduct one service project.
- Ecosystem science and management; fundamental principles and methods for understanding biosocial interdependencies in complex environmental issues; use of computer-aided group decision-making techniques to develop cooperative strategies for resolving local or global environmental issues.
ESSM 311 Biogeochemistry and Global Change
Credits 3. 3 Lecture Hours.
Framework for understanding biogeochemical cycles, their significance at both global and ecosystem levels of organization, and their contemporary relevance to ecosystem science and management.
Prerequisites: RENR 205, RENR 215, any BIOL and/or CHEM course, junior or senior classification or approval of instructor.

ESSM 313 Vegetation Sampling Methods and Designs in Ecosystems
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Basis for vegetation sampling in ecosystems; methods for conducting sampling; selection of sampling unit appropriate for vegetation type; sampling statistics; mean comparisons; regression analysis; sampling design principles; development of sampling plan; presentation and interpretation of sampling data.
Prerequisites: Any MATH course satisfying university core curriculum, junior or senior classification or approval of instructor.

ESSM 314 Principles of Rangeland Management Around the World
Credits 3. 3 Lecture Hours.
Basic knowledge of world rangeland ecosystems, how these systems are managed in diverse cultural settings; principles of underlying ecological processes influenced by various land management practices; foster understanding of the values that people in different countries place on rangeland resources; use of these values to enhance geologically sustainable and socially acceptable rangeland management practices.
Prerequisite: Junior or senior classification or approval of instructor.

ESSM 315 Rangeland Inventory and Monitoring
Credit 1. 2 Lab Hours.
Theory and methods to inventory rangeland vegetation; sampling design; analysis of inventory data; interpretation of sampling data; preparation of a technical report; presentation of inventory data in text, tables, and graphs using the style of the Rangeland Ecology and Management discipline.
Prerequisites: ESSM 313, junior or senior classification or approval of instructor.

ESSM 316 Range Ecology
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Organization and distribution of rangeland ecosystems of the world, with emphasis on North America; community dynamics and functions stressed including biotic history, succession, disturbance regimes, competitive interactions, herbivory, energy flow and nutrient cycling; conservation of rangeland resources.
Prerequisites: RENR 205, RENR 215, ESSM 302, ESSM 314, ESSM 315, junior or senior classification or approval of instructor.

ESSM 317 Vegetation Management
Credits 3. 3 Lecture Hours.
Familiarization with practices that cause changes in rangeland vegetation composition for multiple uses; understanding of criteria for range improvement practices; comparison of expected responses of livestock forage production, watershed parameters and wildlife to vegetation changes following range improvements; systems concept for planning, analysis and implementation of range improvement practices.
Prerequisites: ESSM 314, junior or senior classification or approval of instructor.

ESSM 318 Coupled Social and Ecological Systems
Credits 3. 3 Lecture Hours.
Resilience-based stewardship of social-ecological systems; ecological concepts of resilience, sustainability, ecosystem services, and vulnerability; investigation of linkages among social and ecological system components; contribution to sustainability and provisioning of ecosystem services; evaluation of multiple knowledge sources as the basis for adaptive ecosystem management.
Prerequisites: RENR 205, AGEC 105 or equivalent, junior or senior classification or approval of instructor.

ESSM 319 Principles of Forestry
Credits 4. 3 Lecture Hours. 3 Lab Hours.
Theory and practice of forestry in controlling forest establishment, composition, structure and growth; principles of natural and artificial regeneration; intermediate cultural operations; silvicultural systems; use and control of fire in forests; principles of sustainable stand management.
Prerequisite: Junior or senior classification or approval of instructor.

ESSM 320 Ecosystem Restoration and Management
Credits 3. 3 Lecture Hours.
A basic conceptual framework for restoration ecology and ecological restoration; major principles of ecology related to practical problems confronting humankind, such as, environmental pollution and degradation, exotic species invasions, land use and management trade-offs and consequences; importance of biological diversity.
Prerequisite: RENR 205, RENR 215 or equivalent, junior or senior classification or approval of instructor.

ESSM 324 Forest Measurements
Credits 2. 4 Lab Hours.
Measures and measurement of the dimensions and attributes of forested areas including the diameters, heights, volume and biomass of trees within a well-defined area; tools used for forest measurement; the conduct of forest inventories; summary measures and reports of inventory results; remote sensing and related technologies that assist forest measurements.
Prerequisites: ESSM 313 and ESSM 319 or concurrent enrollment; junior or senior classification.

ESSM 351/RENR 405 Geographic Information Systems for Resource Management
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Geographic Information Systems (GIS) approach to solving spatial problems and managing natural resources, including the acquisition, management, manipulation, analysis, and mapping of spatial and non-spatial databases; identification of natural and relevant features from various data sources; integration of relevant technologies and data; extensive use of GIS software to solve real-world problems. Only one of the following will satisfy the requirements for a degree: ESSM 351/RENR 405, RENR 405/ESSM 351, ESSM 651, BAEN 651/ESSM 651 and RENR 651.
Prerequisite: Junior or senior classification or approval of instructor.
Cross Listing: RENR 405/ESSM 351.

ESSM 398 Interpretation of Aerial Photographs
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Identification and evaluation of natural and cultural features on aerial photographs; methods for extracting information concerning land use, vegetative cover, surface and structural features, urban/industrial patterns and archaeological sites.
Prerequisite: Junior or senior classification or approval of instructor.
ESSM 404 Changing Natural Resource Policy
Credits 3. 3 Lecture Hours.
Process through which environmental policies are changed; study theories of social and political change; teams use theories with their original research on environmental policy problems to create and implement plans for changing environmental policies in their own communities.
Prerequisite: Junior or senior classification or approval of instructor.

ESSM 405 Forest Resource Assessment and Management
Credits 3. 1 Lecture Hour. 4 Lab Hours.
Integration of biophysical, economic and social factors in forest resource analysis, management planning and decision making; applications of interdisciplinary knowledge and multiple-use principles to practical forest management problems.
Prerequisite: Senior classification or approval of instructor.

ESSM 406 Natural Resources Policy
Credits 3. 3 Lecture Hours.
Natural resources and forest policy development in the United States and review of current issues in forest and related natural resource policy.
Prerequisite: Junior or senior classification or approval of instructor.

ESSM 415 Range Analysis and Management Planning
Credits 4. 3 Lecture Hours. 2 Lab Hours.
Basic concepts and theories of range management systems. Resource inventory, analysis and management planning.
Prerequisites: AGEC 105 or ECON 202, ESSM 314, ESSM 317; junior or senior classification or approval of instructor.

ESSM 416 Fire Ecology and Natural Resource Management
Credits 3. 3 Lecture Hours.
Behavior and use of fire in the management of natural resources; principles underlying the role of weather, fuel characteristics and physical features of the environment related to the development and implementation of fire management plans.
Prerequisite: RENR 205 or equivalent, junior or senior classification or approval of instructor.

ESSM 420 Ecological Restoration of Wetland and Riparian Systems
Credits 3. 2 Lecture Hours. 2 Lab Hours.
How wetland and riparian areas link terrestrial and aquatic systems and function hydrologically and ecologically within watersheds; integrated approaches for restoration of degraded wetland and riparian systems; improving water resources through vegetation management with a special interest in rangelands.
Prerequisites: RENR 205, junior or senior classification or approval of instructor.

ESSM 430 Advanced Restoration Ecology
Credits 3. 3 Lecture Hours.
A dynamic discipline relying heavily on the fundamentals of ecology; practice translating and communicating key ecological concepts to advanced case studies in ecological restoration; enhance skills for professional applications.
Prerequisites: RENR 205, ESSM 320, ESSM 420; junior or senior classification.

ESSM 440 Wetland Delineation
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Covers the application of the 1987 Wetland Delineation Manual in use by the Army Corps of Engineers (CORPS); field indicators of hydrophic vegetation; hydric soils, wetland hydrology, methods for making jurisdictional determinations in non-disturbed and disturbed areas, recognition of problem wetlands and technical guidelines for wetlands.
Prerequisite: Junior or senior classification.

ESSM 444 Remote Sensing of the Environment
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Principles and techniques necessary for applying remote sensing to diverse issues in studying and mapping land uses and land covers of the terrestrial environment; emphasizes a hands-on learning approach with theoretical foundations and applications in both aerial and satellite remote sensing, using optical and lidar datasets.
Prerequisite: Junior or senior classification or approval of instructor.

ESSM 459 Programming for Spatial Data Applications
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Programming for spatial data applications in general and for natural resources application in particular; basic programming concepts and constructs for the creation and manipulation of spatial data; automating of processes; programming behind spreadsheet and GIS applications.
Prerequisites: ESSM 351/RENR 405 or equivalent, junior or senior classification or approval of instructor.

ESSM 461 Spatial Databases for Data Storage, Manipulation and Analysis
Credits 3. 1 Lecture Hour. 4 Lab Hours.
Relational databases and advanced geodatabase capabilities; types of geodatabases; Structured Query Language including join-types and subqueries; ArcGIS Desktop Advanced.
Prerequisites: ESSM 459; junior or senior classification or approval of instructor.

ESSM 462/GEOG 462 Advanced GIS Analysis for Natural Resource Management
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Advanced topics in Geographic Information Systems (GIS) to solve natural resource problems; manipulation of raster data types; three-dimensional modeling; emphasis on geoprocessing as it relates to applied projects, particularly with habitat suitability models; field and lab use of Global Positioning Systems (GPS); internet-based GIS modeling.
Prerequisites: ESSM 351/RENR 405 or AGSM 461/SPSC 461 or equivalent or approval of instructor; junior or senior classification.
Cross Listing: GEOG 462/ESSM 462.

ESSM 464 Spatial Project Management
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Integration of key components of spatial project management to ensure a successful project implementation using life-cycle methodology and spatial project management; strategy and planning, requirements analysis, design, development, deployment, and operations and maintenance; term project working with real world data to develop and manage a spatial project for practical applications.
Prerequisites: ESSM 351/RENR 405 and ESSM 444, junior or senior classification or approval of instructor.

ESSM 480 Plant Identification and Undergraduate Range Management Exam Team Competitions
Credits 0 to 3. 0 to 3 Other Hours.
Knowledge of plants morphology, identification and distribution for the profession of range management; knowledge of range management across the world; weekly tests to train on plant and range management knowledge. May be repeated for credit.
Prerequisites: Junior or senior classification or approval of instructor.

ESSM 481 Senior Seminar
Credit 1. 1 Lecture Hour.
Completion of professional e-portfolio, résumé and job application; exploration of job search, application, and interview; discipline competency exams; program evaluation.
Prerequisite: Senior classification in ESSM degree program.
ESSM 484 Internship
Credits 0 to 4. 0 to 4 Other Hours.
Supervised experience program conducted in the student's area of specialization.
Prerequisite: Approval of student's advisor.

ESSM 485 Directed Studies
Credits 0 to 3. 0 to 3 Other Hours.
Individual study and research upon a selected range problem.
Prerequisite: Approval of student's advisor.

ESSM 489 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 4 Lab Hours.
Selected topics in an identified area of rangeland ecology and management. May be repeated for credit.
Prerequisite: Approval of instructor.

ESSM 491 Research
Credits 0 to 4. 0 to 4 Other Hours.
Research conducted under the direction of faculty member in ecosystem science and management. May be repeated for credit.
Prerequisites: Junior or senior classification and approval of instructor.