LRES 507. Environmental Risk Assessment. 3 Credits. (3 Lec) F alternate years to be offered odd years 3 cr. LEC 3 PREREQUISITE: BIOB 170, BIOE 370, STAT 401. Principles of risk analysis, including risk assessment, perception, communication, and management. Emphasis on human toxicology, ecotoxicology, dose-response relationships, exposure analysis, environmental fate, and deterministic and probabilistic risk assessment. Case studies will include examples from pesticides, biotechnology, and invasive species.

LRES 510. Biodiversity Survey and Monitoring Methods. 3 Credits. (2 Lec, 1 Lab) F. Biodiversity survey and monitoring designs, sampling methods, and data evaluation techniques are introduced. Emphasis is on plants but other taxa are addressed for agricultural, rehabilitation and wildland systems. One week of fieldwork required prior to semester; course completion 3rd week of October. Co-convened with ENSC 410.

LRES 511. Environmental Data Mgmt. 2 Credits. (2 Lec) S alternate years to be offered even years PREREQUISITE: Graduate standing. Introduces graduate students in the natural sciences to concepts of designing data models and creation of associated databases. Database development project during the course is intended to facilitate proper management of data for each student's graduate research project.

LRES 515. Microbial Ecology. 3 Credits. (3 Lec) S alternate years, to be offered odd years. PREREQUISITE: BIOM 415. Critical review of literature on the distribution and activity of microorganisms in natural microbial communities based on microbial adaption and physical, chemical and biological features of the microenvironment. A critical discussion of literature and approaches.

LRES 521. Holistic Thought & Management. 3 Credits. (3 Rct) S PREREQUISITE: Graduate Standing Students will be able to use holistic, systems thinking approaches and Holistic Management process, for problem solving and decision making for complex issues in natural resource management, policy, ethics, research. Students will apply holistic and reductionist thought to their lives.

LRES 525. Applied Remote Sensing. 3 Credits. (2 Lec, 1 Lab) S 3 cr. LEC 2 LAB 1 PREREQUISITE: GPHY 426 or consent of instructor. Applications of remote sensing for graduate students, including advanced studies of multispectral and hyperspectral sensors and image processing algorithms. Emphasis is on using remote sensing technologies for solving applied land resource issues. Co-convened with GPHY 429R.

LRES 528. Sust Crop Systems. 1 Credit. (1 Rct) F alternate years to be offered odd years 1 cr. REC 1 PREREQUISITE: Any graduate student or undergraduate student with approval from the instructor. The course goal is to elevate agricultural students' awareness of peer-reviewed literature that demonstrates application of principles to address issues of sustainability in agriculture. The course will use a student-lead discussion format to highlight issues and principles in a series of papers that the class will read. The course will emphasize the practical interaction among agronomy, ecology, economics, and sociology to create an awareness of the interdisciplinary issues associated with sustainability in agriculture.

LRES 529. Sustainable Cropping Systems. 3 Credits. (3 Lec) S PREREQUISITE: ENSC 245 and either AGSC 341 or AGSC 342; graduate standing or consent of instructor. The course goal is to elevate agricultural students' awareness of peer-reviewed literature that demonstrates application of principles to address issues of sustainability in agriculture. The course will use a student-lead discussion format to highlight issues and principles in review of a series of papers that the class will read. The course will focus on the interaction among agronomy, ecology, economics, and sociology to create an awareness of the interdisciplinary issues associated with sustainability in agriculture. Topical issues associated with climate change impacts, system resilience and thresholds and ways to understand complex interactions will be considered for discussion. Co-convened with AGSC 428.

LRES 530. Natural Resource Law. 3 Credits. (3 Lec) S 3 cr. LEC 3 The course examines major natural resource laws, emphasizing the federal model. A modified case study approach is used to review legislation and related court cases governing natural resources, including water, minerals, timber, range, wildlife, recreation, and wilderness. Co-convened with NRSRM 430.

LRES 531. Applied Watershed Hydrology. 3 Credits. (3 Lec) F PREREQUISITES: ENSC 245 or GEO 325 Patterns of streamflow, their measurement, quantitative characterization, underlying physical processes including precipitation, evapotranspiration, soil water dynamics, snowmelt, overland and subsurface hillslope runoff, and channel flow are examined. Applications to aquatic and riparian resources, environmental problems, and human safety are emphasized.

LRES 532. Soil Ecosystems and Processes. 3 Credits. (3 Lec) F PREREQUISITES: BIOM 160 This course focuses on biological and non-biological processes in soil ecosystems. Topics covered are soil's function and role within our environment, nutrient and carbon cycling in soil, and effects of human activities and disturbance on soil and ecosystem function.

LRES 533. Wetland Ecology & Management. 3 Credits. (3 Lec) S PREREQUISITES: General Biology, General Ecology This class will examine wetland ecology and the management of resources. Students will study hydrological and geomorphic processes at watershed and site scales, how processes drive wetland hydrology and hydric soil development and maintenance, and the interaction with biological systems.

LRES 534. Environmental Data Analysis. 3 Credits. (3 Lec) S PREREQUISITE: M 121Q or equivalent. Modern sciences are data-driven and this course focuses on making sense of data, both quantitatively and conceptually. Topics include a review of relevant algebra skills, methods to describe data, inferential statistical methods, sampling, experimental design, & regression focusing on interpretation.

LRES 535. Tech of Spatial Analysis. 3 Credits. (2 Lec, 1 Lab) F alternate years to be offered even years 3 cr. LEC 2 LAB 1 PREREQUISITE: STAT 410 or consent of instructor. Exploration and understanding of analytical techniques needed to deal with spatially correlated data. Emphasis is placed on practical applications within geographic information systems and image processing.

LRES 536. Ecology of Invasive Plants II. 1 Credit. (1 Lec) S PREREQUISITE: LRES 569. Through this course, students will learn to organize plant population data and analyze it to determine population temporal and spatial dynamics. In addition they will learn how to apply the conclusions drawn from the analysis to invasive species management decisions.

LRES 540. Ecology Plants & Community. 3 Credits. (3 Rct) F PREREQUISITE: General biology (BIOM 160), and general ecology (BIOM 258) and general statistics (STAT 216Q) and college mathematics. This course will explore plant ecology at the individual, population and community levels. Topics include plant response to stress, population biology, and community assembly, and possibly non-native species and restoration. Quantitative measures for assessing populations and communities will be addressed.

LRES 543. Agroecology/Appl Plant Ecology. 3 Credits. (2 Lec, 1 Lab) S alternate years to be offered even years 3 cr. LEC 2 LAB 1 PREREQUISITE: BIOE 370, M 171, ENSC 443, STAT 216 Focus on the principles and theories of population and community ecology as they relate to invasive plant species in natural and agroecosystems. Measuring plant interference and assessing population interactions and dynamics through empirical and theoretical models. Review theory and methodology concerning plant population demographics, dispersal, and natural trait selection. Examine the role of biodiversity and evolution in determining sustainable management of ecosystems.

LRES 544. Water Quality. 3 Credits. (3 Lec) F PREREQUISITES: ENSC 110 or equivalent This course covers water quality fundamentals (physical, biological, and chemical) and integrates science-policy management and research. This course uses examples from county Extension, watershed groups, conservation districts, and agencies across Montana interfaced with MSU hydrology and water quality research.

LRES 545. Watershed Analysis. 3 Credits. (3 Lec) S 3 cr. LEC 2 LAB 1 PREREQUISITE: ENSC 444 and STAT 216 or BIO 318 Conceptual and quantitative analysis of watershed processes with an emphasis on modeling surface water hydrology and water resources management. Watershed modeling concepts including analysis of time series, spatially variable data, model calibration, and uncertainty analysis will be studied and demonstrated. The course will emphasize critical analysis of current hydrologic computational methods and hands-on use of watershed models.
LRES 546. Quant Methods Environmental, 3 Credits. (3 Lec) S alternate years to be offered odd years 3 cr. LEC 3 PREREQUISITE: STAT 410 and ENSC 444. Introduction and application of numerical skills desirable for watershed and environmental modelers, including applied time series analysis, applied spatial statistics, probabilistic approaches to data analysis, uncertainty analysis and introductory programming skills. The course will focus on the use of real life and relevant environmental/watershed case studies and examples to illustrate theory.

LRES 552. Adv Soil/Environ Microbiology, 3 Credits. (3 Lab) S alternate years to be offered even years 3 cr. LAB 3 PREREQUISITE: Graduate standing or consent of instructor. Advanced laboratory course wherein students define a project de novo, design and execute the appropriate experiments, interpret data appropriately, and then assemble the results into a written format that thoroughly discusses the project and outcomes. Projects may include the isolation and characterization of specific microorganisms or the study and in-depth characterization of select biogeochemical cycles catalyzed by microorganisms. Classic, novel, and ecologically relevant incubation approaches are used with the pertinent environmental samples that typically include soil, lake, river or groundwater samples.

LRES 554. Soil Landscape Modeling, 3 Credits. (2 Lec, 1 Lab) S alternate years to be offered odd years LEC 2 LAB 1 PREREQUISITE: ENSC 454 and STAT 410. Quantitative soil-landscape modeling with an emphasis on multi-variante spatial statistics, digital terrain modeling, and underlying landscape processes. The course is built around “hands-on” projects and discussions of peer-reviewed literature.

LRES 555. Aquatic Geochemistry, 3 Credits. (2 Lec) S alternate years to be offered odd years 3 cr. LEC 2 REC 1 PREREQUISITE: CHMY 211, CHMY 228, ENSC 245 or equivalent. Advanced coverage of aqueous geochemistry in terrestrial and aquatic systems including chemical processes such as complexation, precipitation-dissolution, sorption-desorption, partitioning, oxidation-reduction and gas-water equilibria. Applications of these principles will be demonstrated in subject areas including biogeochemical cycling, bioremediation, contaminant fate and transport, salt-affected soils and wetland processes. Reactivity will focus on current literature, applied problems, and case studies.

LRES 557. Thermal Biology in YNP, 2 Credits. (1 Lec. 1 Lab) Su 2 cr. LEC 1 RCT/DIS 1 PREREQUISITE: B.S. Science/Science Education; Enrollment limited to M.S. Science Education Graduate Program A survey of the ecology of important organisms common in thermal habitats of Yellowstone National Park, including a review of different life forms (prokaryotes and eukaryotes) and their modes of metabolism, and the physical and chemical habitats that define their environment. Course includes lecture, laboratory, and field components. Students will be asked to design curricula for K-12 audiences.

LRES 558. Isotope Biogeochemistry, 2 Credits. (1 Lec) S alternate years to be offered even years PREREQUISITE: Consent of instructor. Fundamentals and applications of isotope systems useful in the environmental sciences, including light elements such as carbon, mid-mass elements such as iron, and heavy elements such as uranium. Measurement techniques will be discussed, and application to student inspired questions explored.

LRES 561. Belowground Plant Ecology, 3 Credits. (3 Lec) S alternate years, to be offered odd years. PREREQUISITE: STAT 401 or equivalent; BIOE 370 or equivalent; BIOO 433 or equivalent. Application of basic ecological principles to belowground interactions of plant communities. Topics include plant competition, belowground herbivory, plant-microbe interactions including mycorrhizae, and diversity/productivity links in soil systems. Case studies will include invasive species, restoration scenarios, sustainable agriculture, and wildland communities.

LRES 562. Land Rehab Field Problem, 2 Credits. (2 Lab) S alternate years, to be offered odd years. PREREQUISITE: ENSC 460, ENSC 461. Extended field trip to numerous drastically disturbed sites across the Northern Plains. On-site review of land rehabilitation problems, solutions, and methodologies. Participation by industry, regulatory agency staff, and rehabilitation professionals will occur at most sites.

LRES 563. Restoration Ecology, 3 Credits. (3 Lec) F PREREQUISITE: BIOE 370 or equivalent ecology course. Review of ecosystem structure and function, and community and population processes in intact systems, along with the effects of major disturbances on natural systems. Restoration amendments will be discussed in terms of their effects on ecosystem structure and function. The course includes case studies, and focuses on plant and soil systems.

LRES 564. Fundamentals of Environmental Monitoring, 2 Credits. (1 Lec. 1 Lab) F. Provides a graduate level perspective on field measurement methodology in environmental science. Foci are electronic transducers, data loggers, and programmatic approaches to measurement and uncertainty analysis. Incoming students are expected to have a quantitative undergraduate degree related to environmental science.

LRES 565. Environmental Biophysics, 3 Credits. (2 Lec. 1 Lab) S 3 cr. LEC 2 LAB 1 PREREQUISITE: BIOB 170 or equivalent and PHSX 205. The study of physical relations Earth-systems perspective. The course will consist mostly of readings from primary literature and student-lead discussion. We will choose a problem/question, work together to survey relevant literature through a meta-analysis, and strive to produce a manuscript for publication.

LRES 566. Ecosystem Biology, 3 Credits. (3 Lec) S PREREQUISITE: CHMY 143, GPHY 111, ENSC 110 and ENSC 245 (or equivalent understanding). Introduction to the study of biogeochemical cycles and ecosystem dynamics from an Earth-systems perspective. The course will focus on understanding the “grand elemental cycles” of carbon, nitrogen, and phosphorous of Earth's major ecosystems and how modern human activities are affecting these cycles. Co-convened with ENSC 468.

LRES 569. Ecol of Invasive Plants in GYE, 2 Credits. (1 Lec, 1 Lab) Su 2 cr. LEC 1 LAB 1 Current theories on what makes species invasive and what ecosystem conditions invite or resist non-indigenous plant species will be considered. Direct involvement in field research associated with testing methodology for monitoring the invasive potential of several exotic species in the otherwise pristine mountain environments.

LRES 571. Landscape & Ecosys Ecology, 3 Credits. (3 Rct) F PREREQUISITE: General Biology, General Ecology. General Statistics Focuses on principles and applications of landscape and ecosystem ecology. Students will explore factors that shape landscape patterns in space and time and consequences for ecosystem processes. The course explores the methods and tools of landscape and ecosystem analysis.

LRES 572. Frontiers in Remote Sensing, 1 Credit. (1 Sem) S PREREQUISITES: GPHY 429 or GPHY 426 or LRES 525 or equivalent. This course focuses on the emerging trends, technologies, and applications in remote sensing. Each time the course is taught, it will focus on a novel aspect of remote sensing science. Potential topics include UAS, lidar, radar, newly deployed satellites, sensors, and emerging scientific applications in remote sensing. Students who have a background and/or interest in remote sensing applications will be exposed to cutting-edge science, technologies and applications which will broaden their exposure to this rapidly developing field.

LRES 573. Remote Sensing Env Sci, 3 Credits. (3 Rct) S PREREQUISITE: General Ecology (BIOE 370) and general statistics (STAT 216Q). This course focuses on understanding the basics of remote sensing science geared towards critical interpretation of the applications of remote sensing in environmental science. In addition, students will be exposed to hands-on exercises in basic digital image processing and analysis.

LRES 575. Prof Paper & Project, 1-4 Credits. (1-4 Lec) On Demand 1-4 IND Maximum 6 cr. PREREQUISITE: Graduate standing. A research or professional paper or project dealing with a topic in the field. The topic must have been mutually agreed upon by the student, the major advisor, and graduate committee.
LRES 588. Professional Development. 1-3 Credits. (1-3 Lec) On Demand
1 - 3 cr. May be repeated; maximum 3 cr. PREREQUISITE: Graduate standing, teaching experience and/or current employment in a school organization, consent of instructor and Dean of Graduate Studies. Courses offered on a one-time basis to fulfill professional development needs of in service educators. A specific focus is given to each course which is appropriately subtitled.

LRES 589. Graduate Consultation. 3 Credits. (3 Ind) F.S.Su
3 cr. TUT PREREQUISITE: Master's standing, consent of instructor and approval of the Dean of Graduate Studies. This course may be used only by students who have completed all of their coursework (and thesis, if on a thesis plan), but who need additional faculty or staff time or help.

LRES 590. Master’s Thesis. 1-10 Credits. (1 Ind; max unlimited) F.S.Su
1 - 10 cr. IND Maximum credits unlimited. PREREQUISITE: Master's standing.

LRES 591. Special Topics. 1-4 Credits. (1 Rct; 12 cr max) On Demand
1 - 4 cr. Maximum 12 cr. PREREQUISITE: Upper division courses and others as determined for each offering. Courses not required in any curriculum for which there is a particular one-time need or given on a trial basis to determine acceptability and demand before requesting a regular course number.

LRES 592. Independent Study. 1-3 Credits. (1 Ind; 6 cr max) On Demand
1 - 3 cr. Maximum 6 cr. PREREQUISITE: Graduate standing, consent of instructor, approval of department head, and Dean of Graduate Studies. Directed research and study on an individual basis.

LRES 594. Seminar. 1 Credit. (1 Sem; 6 cr max) F.S.Su
1 cr. SEM Maximum 6 cr. PREREQUISITE: Graduate standing or seniors by petition. Course prerequisites as determined for each offering. Students prepare, present, and critique scientific presentations.

LRES 596. Doctoral Thesis. 1-10 Credits. (1 Ind; max unlimited) F.S.Su
1 - 10 cr. IND Maximum credits unlimited. PREREQUISITE: Doctoral standing.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Adobe Garamond Pro.

The editor may contact Leepfrog for a draft with the correct fonts in place.