

MONTANA STATE UNIVERSITY-BOZEMAN  
COLLEGE OF AGRICULTURE  
DEPARTMENT OF ANIMAL AND RANGE SCIENCES

PROPOSAL FOR THE INITIATION OF A  
DOCTOR OF PHILOSOPHY IN ANIMAL AND RANGE SCIENCES

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**I. GENERAL INFORMATION**

Nature of Proposal:	A new on-campus graduate program
Title of Proposed Program:	Doctor of Philosophy in Animal and Range Sciences
Proposed Implementation Date:	Summer 2002
Academic Unit Responsible for Degree Program:	Department of Animal and Range Sciences, College of Agriculture

**II. DESCRIPTION AND OBJECTIVES OF PROGRAM**

**II.A. Overview of Proposed Program**

The Department of Animal and Range Sciences at Montana State University seeks permission to offer an academic program leading to a Ph.D. in Animal and Range Sciences. Faculty, staff and resources position the department to deliver a unique program that: 1) exploits a multi-disciplinary scientific approach to the dynamic interactions between livestock production/marketing systems and natural resource management, and 2) prepares leaders to address some of the most critical issues facing livestock production and natural resource management in Montana and the Northwest. Two options will emphasize scientific discovery, synthesis and application, with research projects ranging from fundamental to applied, molecular to landscapes. The Animal Science Option revolves around range livestock production, value-added animal products, and value-based marketing. The Range Science Option focuses on rangeland plant, soil, water, livestock and wildlife ecology.

Nineteen professors holding Ph.D. degrees will deliver the program. Currently, 4 Ph.D. students are being trained in collaboration with other units, 3 new students are ready to start programs, and current grants could support 5 Ph.D. students. A variety of domestic and international employment opportunities exist for graduates.

No additional faculty or staff is needed to deliver the program. Added operating expenses will be covered by: 1) reallocation of some resources from our M.S. program, and 2) grants and contracts. Livestock and range resources of the Montana Agricultural Experiment Station are excellent; while library, laboratory and office resources are adequate to launch the program. A new Animal Biosciences Building currently being planned will further enhance our laboratories and complement the Ph.D. program as the department strives for regional prominence.

A Ph.D. program will greatly improve the department's ability to: 1) fill open faculty positions with the best scientists available, 2) recruit more students into academic programs, and 3) secure more extra-mural funding.

**II.B. Needs Assessment**

In spring 2000, an in-depth external review of the Department of Animal and Range Sciences was conducted. The review team concluded: "Fundamental to enhancing programs and attracting new faculty is the establishment of a Ph.D. program." Our faculty has advised 4 Ph.D. students in collaboration with other universities, and is currently training 4 Ph.D. students in other departments and institutions -- students that would be enrolled in Animal and Range Sciences if a Ph.D. program were available. Current grants could support 5 Ph.D. students, and 3 qualified students have expressed interest in beginning Ph.D. programs in our department if a program were available. The department receives many unsolicited requests from students wishing to pursue a Ph.D., 6 to 8 per year from U.S. students, and 10 to 12 from international students.

**II.B.1. Employment Opportunities**

Domestic and international employment opportunities for Ph.D.s in Animal and Range Sciences include colleges and universities, state and federal natural resource management agencies, production/marketing alliances, and feed, pharmaceutical, seedstock, genomic, and meat packing/processing companies. According to recent federal surveys, the strongest employment opportunities in agriculture are anticipated for meat scientists, animal geneticists, water quality specialists,

and food and agricultural waste management specialists (see Appendix A).

## **II.C. Relationship to the Role and Scope of MSU-Bozeman**

We believe that our faculty, staff and resources position us to deliver a unique program that: 1) exploits a multi-disciplinary scientific approach to the dynamic interactions between livestock production/marketing systems and natural resource management, and 2) prepares leaders to address some of the most critical issues facing livestock production and natural resource management in Montana and the Northwest. We propose to offer two options, both of which emphasize scientific discovery, synthesis and application, with research projects ranging from fundamental to applied, molecular to landscapes. The Animal Science Option revolves around range livestock production, value-added animal products, and value-based marketing. The Range Science Option focuses on rangeland plant, soil, water, livestock and wildlife ecology. This program directly contributes to the missions of the College of Agriculture and our department by increasing Montana's competitiveness, adding value to agricultural products, and enhancing the management of Montana's livestock and rangeland resources in ways that are economically, socially and ecologically sustainable.

The faculty includes scientists with expertise in genetics, reproductive physiology, meats, nutrition, forages, grazing ecology, riparian ecology, shrub ecology, wildlife management, and systems analysis. The department currently includes 21 faculty positions, 17 of which are occupied by professors holding Ph.D. degrees, and scientists holding a Ph.D. are being recruited to fill two open positions. At least 10 faculty members are expected to advise graduate students pursuing Ph.D. degrees in the near future. Current grant-funded collaborative research and education programs with faculty in the departments of Agricultural Economics and Economics, Plant Sciences and Plant Pathology, Entomology, Veterinary Molecular Biology, and Land Resources and Environmental Sciences increase the breadth and quality of the proposed program.

We believe that a Ph.D. program will greatly improve the department's ability to: 1) fill open faculty positions with the best scientists available, 2) recruit more students into our academic programs, and 3) secure more extra-mural funding – funding that will make a positive economic contribution to the economy of Bozeman and Montana. A Ph.D. program will allow us to compete for funds such as USDA training grants that are only available to units offering a Ph.D. degree.

Livestock and range resources of the Montana Agricultural Experiment Station are excellent and our field facilities include the Livestock Teaching and Research Center (Bozeman), Fort Ellis Research Farm (Bozeman), Red Bluff Research Ranch (Norris), Bandy Experimental Ranch (Ovando), and the Northern Agricultural Research Center (Havre). Cooperative research agreements also exist with the Bair Ranch Research and Education Trust (Martinsdale) and with two USDA Agricultural Research Service locations, the Fort Keogh Range and Livestock Experiment Station (Miles City) and the U.S. Sheep Experiment Station (Dubois, ID). In addition, the department has laboratory facilities for advanced studies in meat science, nutrition, reproductive physiology, and wool quality. A new Animal Biosciences Building currently being planned will further enhance our laboratories and complement the Ph.D. program as the department strives for regional prominence.

The Department's teaching, research and extension programs in Animal and Range Sciences address the core of Montana's economy, culture, and natural environment. Rangelands comprise 70% of Montana's land area and help support Montana's \$1 billion per year livestock industry. Montana's rangelands also provide wildlife habitat, clean water and unparalleled aesthetic beauty. The location of the MSU campus within the Greater Yellowstone Ecosystem further immerses the Department in science and policy issues of regional, national and international importance. The addition of a Ph.D. program will better enable the Department to fulfill its mission of creating and extending knowledge that enhances Montana's economy, culture and natural environment.

## **II.D. Effect on Administrative Structure of the Institution and Potential Involvement of Other Departments or Colleges**

No additional faculty or staff is needed to deliver the program. Some administrative time will be redistributed to meet demands created by the Ph.D. program. Faculty advisors will shift some time spent in laboratory and fieldwork to mentoring students. Office space is currently available to support projected growth in the program for several years, possibly at the expense of some study space currently provided to undergraduate students. Laboratory space and equipment, livestock-handling facilities, and animal numbers are adequate to support the program. Additional office space and improved laboratories to support long-term growth will be available in the new Animal Biosciences Building.

The program is well supported by other academic programs at Montana State University. Students will complete much of their course work in courses offered by other departments. See Appendix B for a list of courses outside the department that students could apply to their doctoral program.

## **II.E. Programs Offered in Montana, the Pacific Northwest and States Bordering Montana**

Currently, North Dakota State University, South Dakota State University, and the University of Wyoming offer Ph.D. programs in Animal Science and Range Science. The University of Idaho offers a Ph.D. program in Range Science. Our department is one of four Animal and Range Sciences programs in the U.S. (i.e., programs where the two disciplines are combined in a single department). New Mexico State University, North Dakota State University, and South Dakota State University also have combined departments.

The natural resources and production systems available to similar departments or related departments in neighboring states are quite different from those important Montana and MSU. For example, New Mexico is largely characterized by desert landscapes and production systems, while Idaho emphasizes either desert shrub or forested landscapes. North and South Dakota focus on prairie landscapes and grain-livestock enterprises, with little emphasis on big game wildlife. Animal Science programs at the University of Wyoming show little integration with respect to natural resource or wildlife issues.

A Ph.D. program in neither Animal Science nor Range Science exists at the University of Montana. We believe that our faculty, resources and areas of excellence allow our proposed program to fill a unique and important academic niche.

## **II.F. Accreditation**

The professional societies that accredit university undergraduate curricula in Animal Science and Range Science do not review graduate degree programs.

In spring 2000, an in-depth external review of the Department of Animal and Range Sciences was conducted. The review team concluded: "Fundamental to enhancing programs and attracting new faculty is the establishment of a Ph.D. program." This conclusion was repeated in the final statement of the review team's report: "Establishment of a Ph.D. program is fundamentally important for success."

## **II.G. Proposed Curriculum**

### **II.G.1. General Policies**

The Ph.D. program is based upon an area of specialization in research and intensive course work that would normally require three years of full-time work beyond the MS degree. Candidates must fulfill the requirements of the College of Graduate Studies. See Appendix C for example programs of study. General Requirements:

1. A M.S. in Animal Science, Range Science, or closely related field.
2. A minimum of 50 credits of course work beyond the B.S. degree. Thesis credits may not be included in this count. Course work completed as part of a student's M.S. degree may be included. The 50 credits must include:
  - a. 3 credits of ARNR 507.
  - b. 9 credits in a supporting area. The supporting area must be outside the major in the sense of subject matter and content. A supporting area of study within the major department may be acceptable.
  - c. 1 graduate course in experimental design and 2 graduate statistical methods courses.
3. A minimum of 18 credits of ARNR 690 – Doctoral Thesis.
4. A minimum of 30 credits must be taken through the regular registration process, on the campus of MSU after admission to the Ph.D. program.
5. Students must attend a seminar each semester in residence.
6. The major professor and the student's graduate committee will determine additional specific course requirements for completion of the Ph.D. degree.
7. Students must be registered for a minimum of 3 credits through the regular registration process during the semester of an examination, a defense of dissertation, and the semester of graduation.
8. A maximum of 6 credits of Individual Problems (570) courses may be included.
9. A maximum of 9 credits on a pass/fail basis (excluding 690) may be included. Individual Problems (570) courses may not be taken as pass/fail.
10. Correspondence courses will not be accepted.
11. Age of courses at time of graduation may not exceed 10 years. The maximum time between the comprehensive examination and granting the degree is 5 years.
12. Upon completion of the Ph.D. students will have completed the following or equivalent (courses completed for the MS degree may be applied):
  - a. Animal Science Option. Students must complete 2 additional semesters of graduate level (400-500 level) Biological Sciences, plus 3 of the following 5 courses:  
ARNR 520 – Nutrient Metabolism of Domestic Animals

- ARNR 521 – Advanced Ruminant Nutrition
- ARNR 523 – Advanced Physiology of Reproduction
- ARNR 524 – Advanced Animal Breeding
- ARNR 525 – Muscle and Growth Biology
- b. Range Science Option. Students must complete 2 additional semesters of graduate level (400-500 level) Biological Sciences, plus 3 of the following 4 courses:
  - ARNR 541 – Range Ecophysiology
  - ARNR 543 – Riparian Processes and Function
  - ARNR 544 – Advanced Grazing Management and Ecology
  - ARNR 553 – Grazing Behavior of Livestock and Wildlife

## **II.G.2. Admission Requirements**

Students must have completed the equivalent of a M.S. degree in Animal Science, Range Science, or closely related field. In selecting applicants, the Animal and Range Sciences Graduate Committee will consider undergraduate and graduate achievement, GRE scores, and letters of recommendation (3 required). Applicants judged to have deficiencies in preparation would be admitted provisionally and required to enroll in additional courses to make up the deficiencies. Because a M.S. degree is required each student entering the program will have a graduate GPA  $\geq$  3.0. To avoid specific GPA and GRE thresholds the Animal and Range Sciences Graduate Committee will rely on a combination of measures and a thorough review of the student's file.

We anticipate many international students applying for admission to this program. Therefore, international students whose native language is not English must submit scores from the Test of English as a Foreign Language (TOEFL) before admission and/or award of an assistantship. These scores must meet the minimum standards required by the College of Graduate Studies at Montana State University.

## **II.G.3. Course Descriptions**

### **ARNR 500 SEMINAR. 1 cr.**

Topics offered at the graduate level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

### **ARNR 507 RESEARCH METHODS. 1 cr.**

Application of scientific method and research techniques, including design of experiments and use of appropriate statistical procedures.

### **ARNR 520 NUTRIENT METABOLISM OF DOMESTIC ANIMALS. 3 cr.**

Biochemistry of animal nutrition with emphasis on integration of biochemical principles to animal production systems. Nutrients emphasized are proteins, carbohydrates and lipids.

### **ARNR 521 ADVANCED RUMINANT NUTRITION. 3 cr.**

Physiological and microbial aspects of ruminant digestion and their influence on the metabolism of extraruminal tissues.

### **ARNR 523 ADVANCED PHYSIOLOGY OF REPRODUCTION. 3 cr.**

Study of the basic concepts of reproductive process of mammals with special emphasis on the application of recent techniques in solving reproductive problems associated with fertility and infertility.

### **ARNR 524 ADVANCED ANIMAL BREEDING. 3 cr.**

Quantitative genetics applied to the improvement of animals. Biometrical relationships among relatives, methods of estimating genetic parameters, application of crossbreeding systems and selection techniques.

### **ARNR 525 MUSCLE AND GROWTH BIOLOGY. 3 cr.**

Growth and development of muscle, muscle structure and how growth is controlled by hormones and DNA will be studied. The impact growth manipulation has on the final product, meat will also be evaluated.

### **ARNR 541 RANGE ECOPHYSIOLOGY. 3 cr.**

Lectures and selected readings on the response of range plants and animals to daily and seasonal changes in their environment, including physiology, animal behavior, and plant population biology.

### **ARNR 543 RIPARIAN PROCESSES AND FUNCTION. 3 cr.**

This course involves an in depth investigation of the physical and biological parameters unique to riparian areas of the Northern Rocky Mountains and Great Plains. Emphasis will be placed on how these

parameters interact to create the vegetation communities associated with riparian areas.

**ARNR 544 ADVANCED GRAZING MANAGEMENT AND ECOLOGY.** 3 cr.

Review of management principles for livestock grazing grasslands and shrublands and their ecological relationship to other areas. Study design and scientific results will be examined to critically review information.

**ARNR 553 GRAZING BEHAVIOR OF LIVESTOCK AND WILDLIFE.** 2 cr.

Behavioral processes of foraging by livestock and wild ungulates; application of theoretical concepts to range livestock production and natural resource management.

**ARNR 570 INDIVIDUAL PROBLEMS.** 1 - 3 cr.

Directed research and study on an individual basis.

**ARNR 575 RESEARCH OR PROFESSIONAL PAPER/PROJECT.** 1 - 4 cr.

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 and his or her major adviser and graduate committee.

**ARNR 580 SPECIAL TOPICS.** 1 - 4 cr.

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.

**ARNR 589 GRADUATE CONSULTATION.** 3 cr.

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.

**ARNR 690 DOCTORAL THESIS.** 1-10 cr.

**III. Fiscal Impact and Budget Information**

**III. A. Summary of Projected Enrollments, Expenditures, and Revenues for the First Year and Subsequent Biennium.**

	FY 2002-2003		FY 2003-2004		FY 2004-2005	
	FIRST YEAR		SECOND YEAR		THIRD YEAR	
I. Planned Student Enrollment	FTE	Headcount	FTE	Headcount	FTE	Headcount
A. New enrollment	1	2	1.5	3	2.5	5
B. Shifting enrollment	0.5	1	1	2	1	2
Total planned students enrollment		3		5		7
II. Expenditures						
A. Personnel Costs	FTE	Cost	FTE	Cost	FTE	Cost
1. GRA (@\$15,000 per .5 FTE)	1.5	\$45,000	2.5	\$75,000	3.5	\$105,000
2. Fringe Benefits		\$2,250		\$3,750		\$5,250
Total FTE personnel and costs		\$47,250		\$78,750		\$110,250
B. Operating expenditures						
1. Miscellaneous						
a. Printing (Promotion)		\$500		\$500		\$500
Total operating expenditures		\$500		\$500		\$500
Grand Total Expenditures		\$47,750		\$79,250		\$110,750
III. Revenues						
A. Sources of funds						
1. Appropriated funds						
reallocation		\$16,250		\$32,000		\$32,000
2. Federal funds		\$31,500		\$47,250		\$78,750
Grand Total Revenues		\$47,750		\$79,250		\$110,750

### III. B. Faculty and Staff Requirements

The proposed Ph.D. program can be implemented without additional faculty or staff. Doctoral students will improve the quality and sizes of graduate classes currently delivered by the Department. All professors (current = 19) will make contributions to the program. Seventeen professors can advise Ph.D. students. Our two vacant positions will be filled with professors holding a Ph.D.

#### III. B.1. Names and Qualifications of Current Faculty

Name	Degree	Rank	Specialty
Ansotegui, Ray	Ph.D.	Associate Professor	Range Nutrition
Berardinelli, Jim	Ph.D.	Professor	Reproductive Physiology
Boles, Jane Ann	Ph.D.	Assistant Professor	Meat Science
Bowman, Jan	Ph.D.	Associate Professor	Ruminant Nutrition
Cash, Dennis	Ph.D.	Associate Professor	Forage Management
Funston, Rick	Ph.D.	Assistant Professor	Reproductive Physiology
Gagnon, Sandy	M.S.	Associate Professor	Horse Management
Gipp, Wayne	Ph.D.	Professor	Swine Management
Hatfield, Pat	Ph.D.	Associate Professor	Ruminant Nutrition
Knight, Jim	Ph.D.	Professor	Wildlife Management
Kott, Rodney	Ph.D.	Professor	Sheep Management
Marlow, Clayton	Ph.D.	Associate Professor	Riparian Ecology
Mosley, Jeff	Ph.D.	Professor	Grazing Ecology
Olson, Bret	Ph.D.	Professor	Range Ecology
Paterson, John	Ph.D.	Professor	Ruminant Nutrition
Sowell, Bok	Ph.D.	Associate Professor	Grazing Systems
Surber, Gene	M.S.	Associate Professor	Water Quality
Tess, Mike	Ph.D.	Professor, Interim Head	Production Systems
Wambolt, Carl	Ph.D.	Professor	Shrub Ecology
Open	Ph.D.	Assistant Professor	Animal Genetics
Open	Ph.D.	Professor	Department Head

#### III. B. 2. Projected Need for New Faculty Over Five Years

It is anticipated that there will be up to 5 retirements within the next 5 years. New scientists will be recruited to meet the needs of the department and that can play an important role in the Ph.D. program. All new faculty hires will require a Ph.D.

### III.C. Operating Expenses, Library Costs and Facilities

#### III.C.1. Operating Expenses

Added operating expenses will be covered by: 1) reallocation of some resources from our M.S. program, and 2) grants and contracts.

1. Personnel Expenditures:
  - a. GRA – reallocation of 2 Montana Agricultural Experiment Station assistantships from the M.S. program to the Ph.D. Program. Remaining assistantships funded from grants.
  - b. Fringe benefits – reallocation of all fringe benefits from above expenditures.
2. Operating Expenditures:
  - a. Printing – costs of printing and distributing promotional materials.
3. Revenues:
  - a. Reallocation of Montana Agricultural Experiment Station funds as presented above.
  - b. Grant funds – new funds into the graduate program from grants and contracts.

#### III.C.2. Library Resources

Library resources, departmental references, and faculty collections of scientific literature are sufficient to launch the program. The transition to more online journals and thus the increased access to more scientific journals in the future will greatly enhance the success of this program. As the program grows grant support will be used to augment library holdings as needed.

#### III.C.3. Equipment Needs

No new equipment is needed to launch the program. Grants and contracts and the Montana Agricultural Experiment Station will fund future equipment needs.

### **III.C.4. Space Requirements**

Office space is currently available to support projected growth in the program for several years, possibly at the expense of some study space currently provided to undergraduate students. Laboratory space and equipment, livestock-handling facilities, and animal numbers are adequate to support the program. Additional office space and improved laboratories to support long-term growth will be available in the new Animal Biosciences Building. This facility will provide state-of-science laboratories and classrooms.

### **IV. Evaluation of Proposed Program**

1. MSU Animal and Range Sciences Faculty – Approved April 2001
  2. MSU Graduate Council – Approved October 2001
  3. MUS Board of Regents – Notice of Intent – Approved January 2002
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## **Appendix A**

### **Employment Opportunities for College Graduates in the Food and Agricultural Sciences Agriculture, Natural Resources, and Veterinary Sciences 2000-2005**

#### Scientists, Engineers, and Related Specialists

Average annual openings for scientists, engineers, and related specialists in the U.S. food, agricultural, and natural resources system are projected at 18,538 during 2000-2005. This compares to an expected 18,878 qualified graduates each year.

More scientists, engineers, technicians, and related specialists are being employed each year in the U.S. food, agricultural, and natural resources system. However, slightly more than enough qualified graduates are expected during the next five years. This is because numbers of newly qualified graduates are expected to grow more rapidly than expansion of employment openings.

The strongest employment opportunities are anticipated for food scientists, food process engineers, plant and animal geneticists, water quality specialists, turf scientists, horticultural scientists, plant and animal inspectors, and food and agricultural waste management specialists.

Plenty of qualified graduates are projected in molecular biology, animal nutrition, entomology, agricultural economics, wildlife science, veterinary medicine general practices, and weed science.

Individuals employed as scientists, engineers, and related specialists must have strong preparation in the basic sciences and their applications to food, agricultural, and natural resources problems. Doctoral degrees are required for individuals who will be managing engineering and scientific research. Supporting engineering, technologist, and technician positions usually require a baccalaureate or higher degree.

Source: "TECHNICAL ADDENDUM, EMPLOYMENT OPPORTUNITIES FOR COLLEGE GRADUATES IN THE FOOD AND AGRICULTURAL SCIENCES--Agriculture, Natural Resources and Veterinary Sciences, 2000-2005" Goecker, Gilmore, and Whatley. <http://faeis.tamu.edu/supplydemand/executive.htm>



## Appendix B

### Additional Courses Outside The Department Applicable To Doctoral Programs In Animal And Range Sciences<sup>1</sup>

AGED 507 – Program Planning and Evaluation	GEOG 410 – Remote Sensing
BCHM 441 – Biochemistry of Macromolecules	GEOG 501 – GIS & Environmental Modeling
BCHM 442 – Metabolic Regulation	LRES 517 – Environmental Issues in Agriculture
BCHM 444 – Biochem. Methods in Mol. Biol.	LRES 530 – Natural Resource Law
BCHM 541 – Lipids and Proteins	LRES 542 – Adv. Natural Resource Ecology
BCHM 543 -- Proteins	LRES 550 – Wetland & Riparian Ecosystems
BCHM 544 – Molecular Biology	LRES 551 – Soil Science and Plant Nutrition
BIOL 404 – Limnology	MB 501 – Prin. & Tech. of Animal Exper.
BIOL 405 – Advanced Animal Ecology	MEDS 510 – Anatomy (Micro)
BIOL 406 – Rocky Mountain Ecosystems	MEDS 512 – Mech. in Cellular Physiology
BIOL 421 – Yellowstone Wildlife Ecology	MEDS 514 – Molecular & Cellular Biology
BIOL 426 - Neuroethology	PS 450 – Plant Physiology
BIOL 430 – Plant Physiology	PS 457 – Plant Development
BIOL 432 – Plant Anatomy	PS 516 – Agric. Research Design & Analysis
BIOL 434 - Agrostology	PS 541 – Advanced Plant Genetics
BIOL 436 – Plant Systematics	PS 542 – Genetic Plant Improvement
BIOL 437 – Plant Development	STAT 420 - Probability
BIOL 438 – Developmental Mechanisms	STAT 424C – Mathematical Statistics
BIOL 439 – Stream Ecology	STAT 501 – Interm. Probability and Statistics
BIOL 504 – Quantitative Biology	STAT 502 – Interm. Mathematical Statistics
BIOL 506 – Population Dynamics	STAT 505 – Linear Models I
BIOL 515 – Landscape Ecology & Management	STAT 506 – Linear Models II
BIOL 532 – Physiological Plant Ecology	STAT 524 - Biostatistics
BIOL 533 – Physiological Plant Ecology Lab	STAT 526 – Experimental Design
BIOL 534 – Vegetation Ecology	STAT 530 – Nonparametrics
ECON 561 – Econometrics I	STAT 534 – Spatial Data Analysis
EDLD 528 – College Students	STAT 537 – Multivariate Analysis I
EDLD 530 – College Teaching	STAT 538 – Multivariate Analysis II
ENTO 514 – Behavioral Ecology	VTMB 412 – Advanced Immunology
ESCI 432 – Surface-Water Resources	VTMB 414 – Advanced Microscopy
ESCI 502 – Fluvial Geomorphology & Hydrol.	VTMB 421 – Genome Science
F&WL 502 – Anal. of Pop. & Habitat Data	VTMB 422 – Functional Gene Expression
F&WL 504 – Wildlife-Habitat Relationships	VTMB 452 – Protein Biochemistry
F&WL 511 – Advanced Stream Ecology	VTMB 505 – Eukaryotic Gene Regulation
F&WL 520 – Mammal Management	VTMB 512 – Ultrastructural Cytology

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<sup>1</sup> Very few 400-level courses would be included in a normal Ph.D. program; however, 1 or 2 might be required to sequence with higher-level courses in supporting areas.

## Appendix C

### Example Degree Programs

#### Example Ph.D. Program - Animal Science Option (57 total credits)

This example assumes that a student has a M.S. degree in Animal Science and has taken 20 credits of course work (not including thesis credits) for the M.S. degree and has completed the equivalent of ARNR 521 – Ruminant Nutrition, ARNR 523 – Advanced Physiology of Reproduction, ARNR 524 – Advanced Animal Breeding, STAT 401 – Applied Linear Statistical Models, and STAT 412 – Analysis of Variance and Design of Experiments.

<b>Fall 2002</b>	<b>credits</b>	<b>Spring 2003</b>	<b>credits</b>	<b>Summer 2003</b>	<b>credits</b>
ARNR 520	3	ARNR 507	1	ARNR 690	3
BCHM 444	3	ARNR 522	3		
STAT 526	3	ARNR 525	3		
<b>Fall – 2003</b>	<b>credits</b>	<b>Spring – 2004</b>	<b>credits</b>	<b>Summer 2004</b>	<b>credits</b>
MB 420	3	BCHM 543	3	ARNR 690	3
PS 541	4	LRES 551	3		
ARNR 690	3	STAT 537	3		
<b>Fall – 2004</b>	<b>credits</b>	<b>Spring – 2005</b>	<b>credits</b>	<b>Summer 2005</b>	<b>credits</b>
ARNR 507	1	ARNR 507	1	ARNR 690	3
ARNR 553	2	ARNR 690	6		
STAT 538	3				

#### Example Ph.D. Program - Range Science Option (60 total credits)

This example assumes that a student has a M.S. degree in Range Science and has taken 20 credits of course work (not including thesis credits) for the M.S. degree and has completed the equivalent of ARNR 453 – Rangeland Resource Measurements, ARNR 544 – Advanced Grazing Management and Ecology, BIOL 430 – Plant Physiology, BIOL 434 – Agrostology, and STAT 412 – Analysis of Variance and Design of Experiments.

<b>Fall 2002</b>	<b>credits</b>	<b>Spring 2003</b>	<b>credits</b>	<b>Summer 2003</b>	<b>credits</b>
ARNR 543	3	ARNR 507	1	ARNR 690	3
ARNR 541	3	ARNR 690	3		
STAT 526	3	F&WL 504	3		
<b>Fall – 2003</b>	<b>credits</b>	<b>Spring – 2004</b>	<b>credits</b>	<b>Summer 2004</b>	<b>credits</b>
BIOL 515	4	BIOL 534	3	ARNR 690	3
ARNR 553	2	BIOL 521	3		
LRES 542	3	STAT 537	3		
<b>Fall – 2004</b>	<b>credits</b>	<b>Spring – 2005</b>	<b>credits</b>	<b>Summer 2005</b>	<b>credits</b>
ARNR 507	1	ARNR 507	1	ARNR 690	3
ARNR 521	3	ARNR 690	6		
STAT 538	3				
LRES 530	3				