



College of Arts and Sciences

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8 September 2016

MEMO

TO: Kate Miller
Provost/VPAA

FROM: Paula M. Lutz
Dean, Arts and Sciences

RE: Program Review for Botany M.S.—Dean's recommendation

The Botany Department has graduated 20 students in the past 5 years—5 per year in the past three years. Many of these students train in Rocky Mountain floristics—documenting and analyzing RM plant diversity—within the Rocky Mountain Herbarium here. UW has maintained the preeminent floristics program in North American over the past thirty years in terms of research and graduate education.

This is a top research department with over \$2M per year in research funding. Botany is a strong participant in the Science Initiative and is poised to benefit from new, cutting-edge facilities in the SI building. Botany faculty are also key players in the next (recently submitted) EPSCoR proposal which should enhance their graduate program.

U.S. News & World Report noted in 2014 the precipitous decline in botany degrees in the U.S. since the 1980's. This will be a growth area in the coming years, providing graduates not only for industry but also for federal and state agencies. This serves our land grant mission.

Taking into consideration the current strength of the department, future investment in the research enterprise there, the unique niche with the RM Herbarium, and state and national needs, **the dean's recommendation is to maintain the M.S. in Botany.** Increased recruiting efforts will help their graduate student numbers as well as an effort to better balance graduate education with post-doc education.

**Institutional Program Review
University of Wyoming**

1. Title of program/specialization

Botany MS

2. Undergraduate or graduate specialization

Graduate

3. Department and college

Department of Botany, College of Arts and Sciences

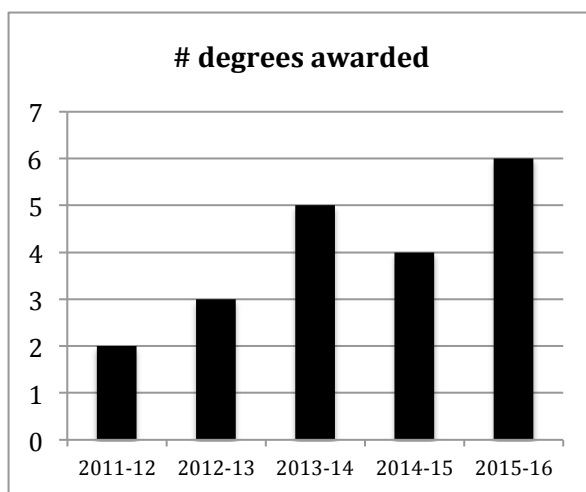
4. Department head name and contact information

David G. Williams, 307-766-4387, dgw@uwyo.edu

5. Program productivity

a. Number of graduates over 5-year period:

The department awarded 20 MS degrees in Botany from Summer term 2011 to Spring term 2016 (5 academic years; avg 4/year). The numbers of degrees awarded has increased over the last 5 years (inset figure).



b. Enrollment in major over 5-year period:

The Botany MS program enrollment has averaged 14 per year from Summer term 2011 to Spring term 2016 (last 5 academic years).

6. Program quality

a. Program accreditation

There is no professional accreditation for the program.

b. Credentials of faculty

i. and ii. Faculty list with highest degree, discipline and ethnicity

Faculty	Highest Degree	Discipline of Highest Degree	Gender	Ethnicity
Indy Burke	PhD	Botany	F	White
Gregory Brown	PhD	Botany	M	White
Alex Buerkle	PhD	Ecology and Evolutionary Biology	M	White
Ellen Currano	PhD	Geosciences	F	White
Kenneth Driese	PhD	Botany	M	White
Brent Ewers	PhD	Ecology	M	White
William Lauenroth	PhD	Ecosystem Ecology	M	White

Mark Lyford	PhD	Botany	M	White
Steven Miller	PhD	Botany	M	White
Burrell Nelson	MA	Botany	M	White
Christopher North	MS	Biological Sciences	M	White
Ramesh Sivanpillai	PhD	Forestry (Remote Sensing)	M	Asian
Daniel Tinker	PhD	Botany	M	White
Catherine Wagner	PhD	Ecology & Evolutionary Biology	F	White
Naomi Ward	PhD	Biological Sciences	F	White
Cynthia Weinig	PhD	Evolutionary Genetics	F	White
David Williams	PhD	Botany	M	White
Brianna Wright	MS	Botany	F	White

iii. Grants awarded 2011-2016

The faculty in the Department of Botany annually are awarded external grant funding averaging about \$2.3 million (*See Appendix*).

c. Program reputation

i. Program national ranking

Surveys reporting national rankings of Botany MS degree programs are not available. The complication for achieving comparative analyses is that graduate programs focused on botany are offered and embedded within a number of broader disciplinary areas, including integrative biology, agronomy, plant sciences, environmental sciences, and natural resources management. However, many of our Botany MS students are trained within our floristics program, which focuses on documenting and understanding the diversity of plants throughout the Rocky Mountain region. This program is the preeminent floristics program in North America over the past 30+ years, both in terms of research and graduate education.

ii. Other indicators of program reputation

Program faculty includes some of the top and most well respected scholars and professional leaders in the fields of plant systematics and taxonomy, ecology and evolution. The program builds on the top herbarium worldwide for Rocky Mountain flora and is the home of the American Society of Plant Taxonomy. Faculty teachers and scholars in the program include AAAS fellows and editors for 15 peer-reviewed international journals. Students in the Botany MS degree program have close mentor relationships internationally renowned botanists.

d. Curriculum of major

The Botany MS degree is designed to provide advanced knowledge and research capability in plant biology through graduate courses and experience in research. Research experience is achieved through the planning and execution of a thesis that can be reasonably accomplished in approximately a two-year period and the results of which could be a contribution to the science of plant biology through publication. The M.S. may be a culminating degree for direct entry to employment or may be a step toward the Ph.D.

No later than the beginning of the student's second semester, or second summer session, a program listing the curricular plan fulfilling the course and credit requirements should be submitted for approval by the dean of the graduate school. The MS program must include a minimum of 26 semester hours of graduate credit course work plus a minimum of 4 hours thesis research. The required courses are not predetermined by the department.

The curricular program is usually first outlined by the student and adviser, presented to the graduate committee for discussion, and then revised to the satisfaction of all parties. The program form must carry the approval of the faculty adviser and department head before being submitted to the graduate school dean.

e. Distance delivery of program

The Botany MS degree is delivered only at the UW main campus with close engagement with faculty mentors in Laramie and with no option for distance delivery.

f. Quality of assessment plan

The Botany department has a strong culture of assessment for its graduate degree programs, including the Botany MS degree program. Currently, our Botany MS program assessment efforts remain at Tier 3, but we have initiated rigorous assessment activities on which we report bi-annually (last report for AY 2014-15). Upon completing the Botany MS degree, students are expected to meet the following learning outcomes:

- a) have a readily accessible (memory-based), intermediate knowledge of biology and botany at the level of college textbooks,
- b) possess an intermediate familiarity with research literature in a restricted area of plant biology,
- c) capacity to locate information through a wide range of search engines and methods,
- d) facility with a particular suite of laboratory analyses or field methods,
- e) ability to analyze data derived from such methods through standard numerical or statistical techniques,
- f) ability to carry out routine research under senior direction,
- g) ability to write reports, prepare graphic displays, and give articulate, scientific presentations to local and regional organizations, and to organize and present lectures and laboratories up to the community college level.

Assessment is carried out by the graduate committee at final defense of the thesis using a rubric sheet to score competency of the learning outcomes listed above.

g. Strategic plan

Botany is part of the Science Initiative and intends to move to a state-of-the-art new building within 2-3 years depending on funding for capital construction in the

University's next biennium budget. Botany faculty also are playing a key role in the next state NSF EPSCoR project. New faculty hires from the Science Initiative and EPSCoR projects will allow Botany to grow its MS degree program. In addition, replacement of Ron Hartman, former Director of the Rocky Mountain Herbarium who retired last year, with a new faculty hire to direct our world-class herbarium is anticipated when the budgets of A&S and the university stabilize. These initiatives, projects and new faculty hires will greatly strengthen and grow the Botany MS degree program.

Botany developed a draft UP4 strategic plan in spring 2014. The following elements of the draft plan pertain directly to building capability and modernizing the Botany MS degree program.

BOT-1 Goal: Improve plant biology research, teaching and outreach infrastructure at UW.

Metrics: 1) Develop new building and facilities for the Botany Department; 2) Add two support staff to manage new facilities

Actions: 1) Tie building to state-wide Science Project [now Science Initiative]; 2) Establish state-of-the-art building and facilities for plant research, teaching and outreach that include modern laboratories, growth chambers, greenhouses, and experimental field plots; 3) Recruit two staff positions for greenhouses, growth chambers and field facilities

Timeline: 1) 2014--Level-1 Planning; include scope of plan in Science Initiative Task Force Report to Governor; 2) 2015--Level-2 Planning; 3) 2016-2017--Construction and occupation

Resources: State funding for new building, facilities and support staff

BOT-3 Goal: Strengthen the Department's role and commitment to excellence in teaching in the life sciences and the environment.

Metrics: 1) Students who complete undergraduate majors and minors offered in the Botany Department and undergraduate interdisciplinary programs will achieve specific learning objectives; 2) Students who complete graduate programs offered in the Botany Department and interdisciplinary programs will achieve specific learning objectives

Actions: 1) Collaborate with interdisciplinary graduate programs to strengthen distinguished speakers program; establish Botany brown bag series for department graduate students; 2) Develop undergraduate and graduate degree requirements and courses based on specific learning outcomes; 3) Establish joint Botany and Zoology committee to modernize the Biology B.S. degree

Timeline: 1) Improved seminar series and brown bag beginning Spring 2015; 2) New curricula for Biology and Botany Major and Minors approved by Spring 2015; 3) Improved assessment of all undergraduate and graduate degrees in operation Fall 2015

Resources required: Travel and honoraria costs for speakers, summer faculty support for assessment

7. Mission centrality

a. Describe how the program supports the mission, vision and strategic goals of UW.

The Draft UP4 Strategic Plan for the university (October 21, 2014) proposes areas of distinction for research and education at UW, including in 1) STEM and 2) Environment, Agriculture and Natural Resources. These two areas of distinction are directly addressed by the Botany MS degree program. Training students at the MS level in the field of botany explicitly meets Goal 1, Objective 1 through the application of rigorous and measurable standards for critical and creative thinking and Goal 2, Objective 8 by involving Botany MS students in laboratory and field research mentored by some of the top faculty researchers in the world.

A 2013 US News and World Report article⁽¹⁾ noted the precipitous decline nationally in degrees earned in Botany since the 1980s, and argued that this was counter to the importance and need for such expertise in the future job market. The Botany MS program at UW is filling this essential need within the state, the region and nationally.

¹<http://www.usnews.com/news/articles/2013/11/12/the-academic-decline-how-to-train-the-next-generation-of-botanists>

b. Describe how the program contributes to other programs across campus.

Faculty in Botany serve on graduate committees for students in other MS and PhD degree programs and offer graduate level Group 1 courses in ecology, physiology, evolution, taxonomy, systematics, and computation. These courses, listed below, are heavily prescribed for students in other graduate degree programs across campus.

BOT graduate courses (all are cross-listed with 4000 level courses):

- 5111 Remote Sensing of the Environment
- 5130 Applied Remote Sensing for Agricultural Management
- 5211 Advanced Remote Sensing of the Environment
- 5280 Paleobotany
- 5395 Symbiosis
- 5550 Computational Biology
- 5680 Plant Taxonomy
- 5700 Vegetation Ecology
- 5730 Plant Physiological Ecology
- 5745 Terrestrial Ecosystem Ecology
- 5775 Forest Ecology
- 5780 Biogeochemistry

c. Include placement data for graduates and indicate if graduates are working in the field.

Many of the Botany MS graduates are trained through our floristics program in the Rocky Mountain herbarium. Skills developed in this disciplinary area are highly marketable in private industry (e.g., environmental consulting for endangered species management and mineland reclamation) and federal land management agencies (e.g., the US Forest Service, BLM, and National Park Service). Other students who obtain MS training in Botany go on to pursue doctoral studies. Unfortunately

the department has not developed a system or database to track graduates, and thus no comprehensive data are available beyond anecdotes from faculty and staff about former MS students.

d. Describe the uniqueness or duplication of this program across UW

The Botany MS degree program, because of the breadth of basic studies pursued in ecology, evolution, taxonomy, physiology and systematics, may overlap to a limited degree with MS degree programs in other units on campus in Arts and Sciences (e.g., Geography, Zoology, and Geology) and Agriculture and Natural Resources (Rangeland Ecology and Watershed Management, Plant Sciences, and Molecular Biology). Most of the MS projects in Botany, however, focus on floristics, which does not overlap in any manner with research areas pursued by students in the other MS programs listed above.

7. Cost: Is the program financially viable?

a. Ratio of student credit hours per FTE

Total student credit hours (CH; graduate courses) and CH/FTE (9 FTE program total; total program FTE calculated from all faculty in Botany except Academic Professional Research Scientists and faculty with administrative appointments). All of the graduate 5000 level BOT courses taught in the department (listed above) are cross-listed with 4000 level offerings to advanced undergraduates. The credit hour production below does not account for the 4000 level cross listing.

Academic year	Total credit hours (CH)	CH/FTE
2010-2011	668	74
2011-2012	566	63
2012-2013	542	60
2013-2014	440	49
2014-2015	374	42

b. Direct instructional expenditures

Expenditures from the state support budget provided to Botany, and the funds generated from course fees and summer school and outreach (the sources of funds used for direct teaching expenses, both for personnel and non-personnel expenditures) are not tracked to specific degree programs, or in the case of the state support budget even to teaching as an activity. Expenditure classifications (e.g., IT services, office supplies, copying, etc) do not parse funds used for teaching from other mission areas such as research, general administration, and outreach. The financial management system within the department does not have the capacity to generate detailed and customized reporting on direct instructional expenditures from the support budget. Simply, the data do not exist. In February 2016 the department adopted a financial management & database system (QuickBooks; QB) that provides the capability to customize expenditure classes and reports. QB will be extremely valuable for reporting needs, but reports specifying expenses related to a

single degree program were not anticipated when QB was established and information was captured for the QB database. Based on guidance from the college and university administration, Botany will adopt a more rigorous data management plan using QuickBooks to account for future reporting needs related to specific degree programs.

The state support budget, income from course fees, and income from summer school are provided below. The support budget is used for a multitude of purposes related to instruction at the undergraduate and graduate levels, including copying needs of the LIFE Program, and for general administrative support for research and outreach activities. Expenses related specifically to teaching and graduate student research in the Botany MS program can not be reported for this fund (*see above*).

Year	State support budget	Course fees	Summer school
2012	\$65,495	\$4,889	\$2,100
2013	\$68,587	\$6,416	\$5,116
2014	\$57,330	\$16,415	\$1,943
2015	\$63,000	\$10,811	\$4,034
2016	\$63,000		

c. Course enrollment

Very few graduate Group 1 “BOT” courses taught from 2011 to 2016 failed to meet enrollment minima. Over this period only BOT 5211 (advanced course for remote sensing), BOT 5395 (a new course started in 2015), and BOT 5680 (course cancelled due to faculty FMLA) have not met minimum enrollments. Because most Group 1 “BOT” courses are heavily prescribed or recommended for graduate students in other degree programs, enrollment generally well exceeds minimums.

d. Other instructional cost drivers

i. Section fill rates.

It is not clear how to define “fill rate”. We have not reported this parameter.

ii. Course completion rates

The course completion rate for all Group 1 “BOT” courses and sections for 2011 to 2016 is **96%** (calculated from registrar’s office uber report).

iii. Curricular complexity. The Botany MS program coursework varies with each student and is determined by the student’s graduate committee. There is no set curriculum for the Botany MS, and no single required course. Each student’s program of study is tailored to the needs of the student.

iv. Faculty course loads. Tenured and tenure-track faculty in the Botany department with a standard 35% teaching appointment have a 1:1 teaching load for Group 1 courses. But these faculty teach quite a few student credit hours of Group 2 courses,

including very intensive one-on-one instruction with undergraduate and graduate student researchers.

Appendix. Grant awards to Botany faculty over the last 5 years.

Award Yr	Faculty PI	Co-PI	Total \$ Award	Title of Grant
2011-2015	Buerkle		\$253,756	Genomic outcomes of repeated hybrid speciation
2012-2016		Buerkle	\$72,310	CAREER: Isolation by Distance or Adaptation: The Extent of Population Genetic Distance that Results from Adaptive Divergence in Sexual Signals and Migratory Behavior
2015-2016	Currano		\$2,500	The Bearded Lady Project visits the PaleoFire Lab and Lyme Regis
2014-2019	Currano		\$450,720	CAREER: Plants, insects, and the Early Paleogene hothouse: Using the past to assess the future, which challenging the face of science.
2015-2016		Currano	\$5,000	Continuum of life: fossils to living plants.
2015		Currano	\$21,388	Paleontological explorations and excavations at the Napudet, a new Middle Miocene site, Turkana Basin, Kenya
2011-2015		Currano	\$78,171	Collaborative Research: A multi-proxy approach to early Miocene community, landscape, and climate reconstruction, Ethiopian Plateau
2016-2021	Ewers		\$4,960,000	Predicting genotypic variation in growth and yield under abiotic stress through biophysical process modeling
2012-2017	Ewers		\$20,000	Water in a Changing West: the Wyoming Center for Environmental Hydrology and Geophysics
2016-2019		Ewers	\$500,000	Systems analysis of shade-avoidance responses as a mechanism of crop yield loss due to weeds
2015-2020		Ewers	\$3,544,609	A systems analysis of plant growth promotion by the rhizosphere microbiome. NSF PGRP
2014-2017		Ewers	\$750,000	WSC-Category 2 Collaborative Research: Planning and Land Management – Tropical Research in Ecosystem Services
2011-2017		Ewers	\$1,477,770	TRMS-Genetic analysis of natural variation in the control of water use efficiency and response to drought stress in Brassica rapa.
2014-2016	Lauenroth		\$50,000	Synthesis and modeling of conifer forest regeneration after mountain pine beetle epidemics: the role of drought and climate change. U. S. Forest Service
2013-2016	Lauenroth		\$154,869	Modeling Plant Community Composition and Vegetation Structure in Core Sage Grouse Habitats, U.S.Fish & Wildlife Service/Department of the Interior
2013-2017	Lauenroth		\$163,147	Assessing Future Ecohydrological Suitability for Sagebrush Ecosystems, U. S. Geological Survey/Department of the Interior.
2014-2015	Lyford		\$7,800	Junior Science and Humanities Regional Symposium for Wyoming and Eastern Colorado, Academy of Applied Sciences
2015-2016	Lyford		\$7,800	Junior Science and Humanities Regional Symposium for Wyoming and Eastern Colorado, Academy of Applied Sciences
2010-2015	Miller		\$570,000	Collaborative Research: High Fidelity or Fatal Attraction: Symbiosis and Repercussions of Extreme Ecological Specificity
2015-2017	Miller		\$89,476	Using Next-Gen Sequencing to Identify Heirloom, Historic and Novel Apple Cultivars in 100 year-old Orchards in Wyoming and Montana

2015-2017	Miller		\$24,000	Using Molecular Techniques to Identify Apple Cultivars from 100 year-old Orchards in Wyoming and Montana”
2015-2017	Miller		\$18,500	The Wyoming Heritage Apple Preservation Project.” SL Miller. Wyoming Department of Agriculture
2013-2016		Miller	\$24,000	Growing Mushrooms at the Acres Farm
2015-2017		Miller	\$30,000	Using Molecular Techniques to Identify Apple Cultivars from 100 year-old Orchards in Montana
2013-2015		Nelson	\$1,450	Imaging of the BLM, NRCS, USFS collections in and near Pinedale
2014-2016		Nelson	\$12,000	Imaging of the BLM, Soil Conservation, Forest Service Herbarium in and near Pindale.
2013-2015		Nelson	\$14,500	Imaging Macrofungi in the Solheim Mycological Herbarium
2013-2016		Nelson	\$30,000	Floristic Inventory of the Selway-Bitterroot Wilderness
2014-2016		Nelson	\$7,000	Mounting and imaging the Medicine Bow Mountains project
2015-2018		Nelson	\$31,500	Imaging Microfungi in the Solheim Mycological Herbarium
2014-2019		Nelson	\$25,000	Flora of the Wind River Basin, Wyoming.
2014-15	Sivanpillai		\$24,900	AmericaView StateView Program development/operations for the state of Wyoming,
2009-15	Sivanpillai		\$28,530	Integrating Remote Sensing Technology for Developing Sustainable Agriculture Management Practices in Small Acreage Farms
2015-16	Sivanpillai		\$23,500	AmericaView StateView Program development/operations for the state of Wyoming
2015-16	Sivanpillai		\$5,000	Identifying hot-zones of human-elephant conflict in the Coimbatore Forest Division, India
2015-17	Sivanpillai		\$51,704	Generating land cover maps in 3-year time steps depicting progression of bark beetle infestation for Snowy range and Laramie range watersheds
2012-15		Sivanpillai	\$85,661	Decadal Scale Estimates of Forest Water Yield after Bark Beetle Epidemics in Southern WY
2014-18		Sivanpillai	\$1,440,000	Collaborative Research: Wyoming Interns to Teacher Scholars
2015-2016	Tinker		\$24,997	Impacts of vegetation feedbacks on fire regime regulation under future climate scenarios in Yellowstone National Park
2013-2018		Tinker	\$401,506	Sustainable biofuel feedstocks from beetle-killed wood: Bioenergy Alliance Network of the Rockies
2016-2019	Wagner		\$34,968	uuangane: Creating a healthy future for people and the natural resources they depend on
2016-2017	Wagner		\$89,689	Extent of Yellowstone cutthroat trout hybridization with rainbow trout in the North Fork Shoshone River drainage
2015-2018	Wagner		\$756,000	Unraveling the evolutionary origin and consequences of the largest known recent vertebrate radiation by a comprehensive analysis of complete cichlid genomes,
2010-2016	Weinig		\$1,200,000	TRMS : Agroecological annotation of gene function and network model reconstruction
2015-20	Weinig		\$3,400,000	A systems analyses of plant growth promotion by the rhizosphere microbiome
2011-2017		Weinig	\$1,500,000	Genetic basis of circadian clock function and drought responses in Brassica rapa

none given	Weinig	\$115,000	Characterization of microbial diversity and function, and impact of the microbial rhizosphere on performance in Brassica rapa
2016-2019	Weinig	\$500,000	Andrew Kniss (PI), Brent Ewers (coPI), Cynthia Weinig (coPI). Some name, USDA,
2013-2016	Weinig	\$207,000	Genome-wide associations between anatomy, crop-specific allocation, and water use efficiency
2016-2021	Williams	\$25,000	Tracing pollution sources and pollution hotspots with nitrogen isotopes
2015-2016	Williams	\$50,000	Telling the story of Earth's changing cryosphere: From molecules to alpine lakes to adventure film festivals
2014-2017	Williams	\$75,000	Temporal and spatial variations of soil phosphorus speciation in a cold semi-arid climate
2011-2015	Williams	\$1,044,169	Data-model synthesis of grassland carbon metabolism: Quantifying direct, indirect and interactive effects of warming and elevated CO2
2012-2017	Williams	\$450,000	Water in a Changing West: The Wyoming Center for Environmental Hydrology and Geophysics
2015-2017	Williams	\$75,000	Hillslope Hydrology at NoName Watershed: Connecting surface and subsurface water budget measurements and modeling
2015-2017	Williams	\$75,000	Tracking Water Balance, Snowmelt, and Surface-Groundwater Interactions using Lakes in Sub-Alpine Watersheds
2016-2018	Williams	\$77,841	Fire-induced tree mortality: underlying processes and leaf-to-region consequences for the recovery and management of Mediterranean forests
2011-2014	Brown	\$109,909	Greater Yellowstone Raptor Experience
2012-2015	Ewers	\$338,700	Decadal scales estimates of forest water yield after bark beetle epidemics in southern WY
2013-2014	Ewers	\$30,000	Cottonwood mortality along the Powder River
2013-2014	Ewers	\$120,000	Supplemental: TRMS-Genetic analysis of natural variation in the control of water use efficiency and response to drought stress in Brassica rapa
2009-2014	Ewers	\$1,477,770	TRMS-Genetic analysis of natural variation in the control of water use efficiency and response to drought stress in Brassica rapa
2013-2016	Hartman	\$37,000	Processing/imaging 80,000 specimens from Shoshone NF for USFS
2013-2015	Hartman	\$30,000	Floristic Inventory of the Selway-Bitterroot Wilderness
2013-2015	Hartman	\$1,450	Imaging of the BLM, Soil Conservation, Forest Service Herbarium in and near Pindale, WY BLM
2013-2015	Hartman	\$14,500	Imaging Macrofungi in the Solheim Mycological Herbarium
2012-2014	Lauenroth	\$92,000	Climate change and ecohydrology in temperate dryland ecosystems: a global assessment
2013-2014	Lauenroth	\$69,976	North Central Climate Science Center University Consortium Research Plan FY13
2011-2014	Miller	\$21,000	The Wyoming Apple Project
2015-2017	Miller	\$18,500	The Wyoming Heritage Apple Preservation Project
2009-2014	Nelson	\$37,000	Processing/imaging 80,000 specimens from Shoshone NF for USFS
2013-14	Sivanpillai	\$24,500	AmericaView StateView Program development/operations for the state of Wyoming
2013-14	Sivanpillai	\$22,273	Mapping annual surface area changes since 1984 of lakes and reservoirs in Wyoming that are not gauged using multi-temporal Landsat data

2014-2015	Tinker		\$5,000	Evaluating the effects of projected climate change on forest fire susceptibility using a novel forest fuel moisture model
2014		Wright	\$24,499	Transforming LIFE 1010 Instruction
2009-2013	Ewers		\$219,261	ETBC: Collaborative Research: Quantifying the Effects of Large-Scale Vegetation Change on Coupled Water, Carbon, and Nutrient Cycles: Beetle Kill in Western Montane Forests
2012-2017		Ewers		Water in a Changing West: The Wyoming Center for Environmental Hydrology and Geophysics
2009-2013	Hartman		\$127,000	Imaging Type specimens in RM. Mellon Foundation
2013	Hartman		\$30,000	Floristic Inventory of Valley and Phillips cos., MT. BLM
2013-2017	Lauenroth		\$81,249	Assessing Future Ecohydrological Suitability for Sagebrush Ecosystems
2013-2013	Lauenroth		\$161,004	Vulnerability Assessment of Ecological Systems and Species to Climate and Land Use Change within the North Central Climate Change Center and Partner Land Conservation Cooperatives
2012-2013	Lyford		\$234,886	Science for the Future: Redesigning Science Education via the Energy-Water-Climate Nexus (Year 1),
2009-2013	Lyford		\$749,685	Targeted Partnership: Culturally Relevant Ecology, Learning Progressions and Environmental Literacy
2012-13	Sivanpillai		\$23,673	AmericaView Stateview Program development/operations for the state of Wyoming
2012-16		Tinker	\$998,367	Sustainable biofuel feedstocks from beetle-killed wood: Bioenergy Alliance Network of the Rockies
2010-15	Weinig		\$1,200,000	Agroecological annotation of gene function and network model reconstruction.
2013-14	Williams		\$7,420	Are Spatial Patterns and Sources of Atmospheric Nitrogen Deposition in the Wind River Range Recorded in the Isotopic Composition of Lichens?
2013-14	Williams		\$3,966	Plant productivity in a high CO ₂ world
2013-14	Williams		\$2,000	Plant productivity in a high CO ₂ world
2013-14	Williams		\$4,414	Plant productivity in a high CO ₂ world

Academic Program Review: **Botany MS**

Section 8 – Cost

a) Ratio of student credit hours per FTE (AY 2014/15): **304**

b) Direct instructional expenditures (FY 2015): **\$2,129,940**

i) Per student FTE: **\$14,730**

ii) Per total degrees awarded: **\$69,834**

iii) Non-personnel expenditures / total academic FTE: **\$10,614**

c) Course enrollment (AY 2014/15)

i) Classes falling under university minimums: **6**

ii) Lower-division courses falling under university minimums: **0**

e) Research expenditure per tenure-track FTE (FY 2015): **\$230,657**