COLORADO MESA
UNIVERSITY

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Program Review

Environmental Science and Technology

PROGRAM REVIEW
2015

BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY

COLORADO MESA UNIVERSITY

Prepared by

The Environmental Science and Technology Faculty

Compiled and completed by

Russ Walker, Head
Department of Physical and Environmental Sciences

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1. Program description

Environmental scientists examine the relationships among humans, other organisms, and the physical environment with an emphasis on the impacts of human activities. Wise use of technology contributes to the solution of current environmental problems and the prevention of new problems. Our Environmental Science and Technology program focuses on the use of science and technology for understanding, protecting, and restoring air, water, land, and ecosystem resources.

The Environmental Science and Technology program at Colorado Mesa University (CMU) is a stand-alone program with its own faculty and curriculum. Our arrangement contrasts with that of environmental science programs in many other colleges and universities, which have buffet-style programs made up of pertinent courses in related programs taught by instructors from those programs. Our approach promotes a well-integrated curriculum created and maintained by faculty who are completely invested in the Environmental Science program.

The administrative unit that houses this degree program is the Department of Physical and Environmental Sciences, which also includes degree programs in chemistry, geosciences, physics, and mechanical engineering. Although all of these degree programs are overseen by a single department head, they are managed as independent units. Each program has its own faculty, labs, and budget, controls its own curriculum, schedules its own classes, and sets its own priorities.

2. Program history

The precursors of our Environmental Science and Technology program date back to 1989, when an Associate of Applied Science in Environmental Restoration Engineering Technology was created through a joint effort between the Mesa State College Department of Computer Science, Mathematics, and Engineering and UNC Geotech, Inc., the operating contractor at the U.S. Department of Energy Grand Junction Projects Office. Geotech and the Department of Energy supplied considerable early support for the program. Through spring 1991, Geotech provided all instructors for courses in the program. The Department of Energy provided operating funds totaling $200,000 for the first five years of the program. The Environmental Restoration Engineering Technology program trained students to become technologists supporting engineers and scientists engaged in hazardous waste management, pollution control, contaminated sites, and regulatory compliance.

Not long after the establishment of the Environmental Restoration Engineering Technology degree, both students and local employers expressed a desire for a four-year degree that would build on the two-year degree. In response, we offered a Bachelor of Science in Environmental Restoration and Waste Management beginning in fall 1993. This four-year degree program continued the emphasis on hazardous waste management, pollution control, contaminated sites, and regulatory compliance with the addition of advanced courses.

In the late 1990s, many students expressed a desire for a track focusing on protection and restoration of natural resources as an alternative to the focus on hazardous waste and pollution. We responded to this need by creating the Bachelor of Science in Environmental Science and Technology, first offered in fall 2000. The new program included the old Environmental Restoration and Waste Management curriculum as a concentration along with new concentrations in Environmental Science, focusing on natural resource management, and Environmental Science Education, for middle and high school teaching. Faculty turnover in the early 2000s provided an opportunity to enhance the new Environmental Science concentration by adding two new faculty members with expertise in ecology. Significant improvements in the curriculum for that concentration resulted from this new expertise.

The Environmental Science concentration garnered by far the greatest interest from students. Only about 15% of our students selected the Environmental Restoration and Waste Management concentration and even fewer selected the Environmental Science Education concentration. (Only two students graduated from the latter concentration over an eight-year period.) As a result of our 2007 program review and a campus-wide program prioritization effort, we terminated the Environmental Science Education concentration and combined the remaining two concentrations into a single degree program, Environmental Science and Technology (hereafter referred to as Environmental Science). We designed this program so that all students would receive a foundation in both pollution-focused and ecosystem-focused work and then select additional environmental science coursework according to their interests. This is the program currently in place.

3. Mission and goals

The mission assigned to CMU by the Colorado Legislature includes the statement "Colorado Mesa University shall offer liberal arts and sciences programs." As a degree program in science, our B.S. in Environmental Science and Technology contributes to the fulfillment of this legislative mandate.

The University community recently identified several values as part of its institutional vision (2015-16 CMU Catalog, pages 7-8), of which two are especially well-addressed by our program. One such value is "a learning environment that develops and promotes the skills of inquiry, reflection, critical thinking, problem-solving, innovation, teamwork, and communication in students." We guide students' development of these skills through numerous projects (including group projects) in which students analyze environmental problems, plan and implement studies, and interpret results. Another value is that CMU provides "opportunities that engage students in applied learning." We believe that *application* is a distinguishing characteristic of our program. Our students experience not just the science of the environment, but also how the science is used as the basis for environmental protection and restoration.

Prior to 2014, the University's philosophy and goals for a baccalaureate education included seven emphases (e.g., 2013-2014 Colorado Mesa University Catalog, page 49), at least three of which were directly supported by the B.S. in Environmental Science and Technology. As a science discipline, we strive to convey "the scientific perspective" in all of our courses.

Environmental issues and their "impact on society" are highlighted throughout our curriculum. Our courses for majors focus on "advanced competencies within a specific discipline."
The goal of our program is to produce graduates having an understanding of environmental science and the ability to contribute to the resolution of environmental problems. Our approach to this goal is to establish a foundation of scientific knowledge through courses in the traditional disciplines of biology, chemistry, geology, mathematics, and statistics. We build on this foundation in environmental science courses, in which students learn environmental science as an interdisciplinary application of the traditional sciences. We also seek to provide non-majors and members of the local community with the opportunity to enhance their insight into the wide range of environmental issues affecting our quality of life on local, national, and global scales, and thereby create a better-informed public.

We developed student learning outcomes in 2013 as part of a new framework for assessment. In terms of these student learning outcomes, our goal is to graduate students who are able to:

1. Demonstrate an understanding of terminology, concepts, theories, and practices in environmental science. (Specialized knowledge)

2. Demonstrate the ability to design an environmental study. (Quantitative skills, critical thinking skills)

3. Demonstrate the ability to analyze quantitative environmental data, effectively translate data into graphs or tables, and interpret the results. (Quantitative skills, critical thinking skills)

4. Demonstrate the ability to use appropriate tools, technology, and methods for measuring and analyzing environmental data. (Technology skills)

5. Identify and evaluate assumptions, hypotheses, alternative views on environmental problems, then articulate implications and form conclusions. (Critical thinking)

6. Construct an organized argument (oral and written) supported by current research on a technical issue in environmental science appropriate for a specialized audience. (Communication skills)

7. Complete a field-based project that evaluates and proposes a solution for a local problem or need by effectively synthesizing applicable concepts from environmental science and related disciplines. (Applied learning)

We describe our assessment of these student learning outcomes in Section E.

4. Support of other programs

ENVS 101 Introduction to Environmental Science is one of twenty-six courses that CMU students may take to fulfill the Essential Learning requirement in the natural sciences. In order to graduate with an associate or bachelor degree, students must take two of these courses, of

which at least one must have a lab. Over the past five years, we offered five to six sections of ENVS 101 per academic year and enrolled an average of 38 students per section.

Use of Environmental Science courses by other programs is very limited, as shown in Table 1. This is not surprising given the nature of our field. In contrast to disciplines like chemistry, physics, and mathematics, ours does not provide students with fundamental knowledge and skills that are required for completion of other degree programs. Few students from other disciplines take Environmental Science courses—on the order of just two or three per year. Still, given the applied nature of our curriculum, students from other majors would find many of our courses to be a valuable complement to courses in their major. For example, courses that are especially relevant to Biology majors include ENVS 312/312 Soil Science and Sustainability, ENVS 350/350L Ecology and Management of Shrublands and Grasslands, and ENVS 455/455L Restoration Ecology. Chemistry majors could benefit from courses such as ENVS 331/331L Water Quality and ENVS 340 Applied Atmospheric Science. Environmental Geology majors

Table 1. Environmental Science Courses Used by Other Programs

	Program	Courses
Required courses	AAS in Wildland Fire Management	ENVS 101 Introduction to Environmental Science
	Minor in Watershed Science	ENVS 331/331L Water Quality
Options under restricted electives	AAS in Wildland Fire Management	ENVS 204/204L Introduction to Ecosystem Management ENVS 360/360L Fire Ecology
	Minor in Watershed Science	ENVS 312/312L Soil Science and Sustainability ENVS 433 Restoration of Aquatic Systems
	BS in Geosciences, Concentration in Environmental Geology	ENVS 312/312L Soil Science and Sustainability

would benefit from ENVS 221/221L Science and Technology of Pollution Control, ENVS 331/331L Water Quality, and ENVS 420/420L Pollution Monitoring and Investigation, among others. A minor managed by the Geosciences program, Watershed Science, does make use of three of our courses.

5. Locational and comparative advantages

We are located among diverse natural systems that provide us with a host of field sites to work with. Life zones range from the semi-desert shrublands on the floor of the Grand Valley (4,500 feet above sea level) through pinyon-juniper woodlands and montane up to the sub-alpine zone on the adjacent Grand Mesa (10,000 feet above sea level), with riparian zones found throughout our area. Mesa County, where CMU is located, is 71% public land. We are adjacent to 1,061,000 acres managed by the Bureau of Land Management (BLM), 347,000 acres in the Grand Mesa National Forest, and 20,500 acres in the Colorado National Monument. Included in these lands are two national conservation areas (McInnis Canyons and Dominguez-Escalante Canyons) and two wilderness areas (Black Ridge Canyons and Dominguez Canyon). Four state parks are also found in the surrounding area.

We make good use of the opportunities provided by our natural setting. We access a variety of sites on BLM land, in the Colorado National Monument, and in Colorado state parks within a thirty-minute drive from campus. In a typical year we take students to the field approximately75 times during lab periods and on occasional weekends. We teach students the same field skills that are used by environmental professionals, including plant identification, quantitative survey of plant coverage, identification of soil structure and function, field measurements of water chemistry, collection of environmental samples, and assessment of riparian condition, among others. Field data collected by our classes have been used by local organizations such as the Tamarisk Coalition and the Colorado Division of Parks and Wildlife. We also focus our research efforts on local systems, using sites in the Colorado National Monument and BLM lands.

6. Unusual characteristics

We may not be familiar enough with environmental science programs elsewhere to judge what is truly unusual about our program. However, there are characteristics that we do find remarkable.

As described in Section A.1, we have a stand-alone program with its own faculty and an integrated curriculum with a scope that is different than that of many other programs. We offer courses focused on pollution monitoring and the investigation of hazardous waste sites; we also offer courses focused on ecosystem restoration.

Class sizes are noteworthy. Classes for majors are small, ranging from 3 to 45 students, with 10 to 20 being most typical. Students experience a great deal of close interaction with faculty. We get to know a good deal about most of our students, which is an advantage when we provide references for employers and graduate schools.

In spite of the small size of our faculty, we cover a broad range of topics in our curriculum, as shown in Section B.1, below. CMU's Minor and Certificate in Geographic Information Science

and Technology, Minor in Watershed Science, and Certificate in Sustainability Practices provide valuable opportunities for our students to supplement their major.

ENVS 492 Capstone, required for seniors, provides students with important experience. Students work in groups of three to four on projects that have off-campus organizations as clients. Students analyze a problem, develop a study plan, carry out the work, interpret the results, and make recommendations to their client. In order to complete a Capstone project, students must recall knowledge gained from their course work and use their critical thinking and analytical skills. Most of the graduates that we know to be in the environmental profession work for environmental consulting firms. Capstone projects are a useful transition between college work and the kind of projects that students do in a consulting setting. Capstone groups also gain valuable experience by presenting their work at the annual campus-wide Student Showcase.

As a means of enhancing student success, we promote student participation in faculty research projects outside of normal classroom activities. We find these projects to be highly effective in developing the desired breadth of student abilities, and they create a sense of energy and vitality that excites and motivates students. Students receive credit for their work through ENVS 497 Structured Research. Since the last program review in 2007, students have earned 87 credit hours by participating in research.

7. Recommendations from 2007 program review

The full recommendations from Dr. Will Focht, our 2007 external reviewer, are provided in Appendix 1. A summary of his comments and our actions (in italics) is shown below.

1. Embrace the CMU mission more strongly by including more policy, economics, quality of life, and cultural issues into Environmental Science and Technology courses to make them more relevant to an informed citizenship.

    We require students completing our Ecosystem Restoration option to take POLS 488 Environmental Politics to learn more about policy. Understanding policy choices is an important component of ENVS 321 Environmental Risk Analysis. Social issues such as environmental justice are included in ENVS 104 Environmental Science: Global Sustainability.

2. Combine the two principal concentrations (Environmental Science, and Environmental Restoration and Waste Management) into a single concentration focusing on human interactions with natural systems, and create a new concentration in sustainability.

    We combined these two concentrations into a single degree program that took effect in fall 2008. This is the program that is currently in place. Although we did not create a new concentration in sustainability, we did create a Technical Certificate in Sustainability Practices that took effect in fall 2012.

3. Revisit the rationale for the Environmental Science Education concentration, which has had only two graduates in its seven years of existence. If there are sound reasons for

continuing the program, then the program faculty should develop a strategy for increasing enrollment. Otherwise, the program should be deleted.

We found no reason to continue this concentration and deleted it in 2008.

4. Re-organize the introductory sequence of courses so as to start with topics that are more likely to excite and inspire students.

   This change took effect in fall 2008. Under the old program, the first course was divided equally between an introduction to ecosystem restoration and an introduction to pollution investigation and prevention. Students then took a field- and lab-based course that gave them basic hands-on skills used in environmental science. The third course in the introductory sequence was a classic introductory environmental science course surveying major issues and topics from a global perspective.

   The new introductory sequence starts with ENVS 104 Environmental Science: Global Sustainability, which surveys major issues and topics from a global perspective. All students then complete ENVS 204/204L Introduction to Ecosystem Management and ENVS 221/221L Science and Technology of Pollution Control. With this sequence, students start with the global view then move on to two applied courses that give them foundation knowledge and skills in the two main areas of our program.

5. Establish an advisory board of successful environmental professionals to provide external input on career trends, curriculum, partnerships, marketing, and fundraising.

   Although we have discussed possible board members we have not yet created a new advisory board.

6. Consider establishing new degree programs that will enhance visibility and enrollment. Possibilities include: resurrecting the Associate of Applied Science degree in Environmental Restoration Engineering Technology, which was discontinued in about 2000; a certificate program based on continuing education courses for working professionals; and a Bachelor of Arts degree in Environmental Studies.

   The AAS degree was dropped for lack of student and employer interest, thus we have a degree of skepticism about this recommendation. To our knowledge, the conditions that led us to delete this degree have not changed since the 1990s. An occasional continuing education course for local professionals may make sense but our regular course load has prevented us from pursuing this. We have mixed feelings about a BA program. Our focus has been on educating students specifically for well-defined technical and scientific positions. Through informal feedback from employers we know that our graduates are more qualified for these positions than a typical Environmental Studies graduate. It is unclear to us what career paths are a good fit for students from a typical Environmental

Studies program and how our existing expertise and courses would fit into such a program.

7. Implement a marketing campaign to inform high school students in CMU's 14-county region about the existence of the Environmental Science major, minor, and career opportunities. The campaign should emphasize the role of environmental science in sustainable development. Given the desirable features of Grand Junction, CMU, and the Environmental Science program, active recruitment beyond the 14-county region should make a significant contribution to higher enrollment.

   Two Mass Communications majors produced a ten-minute promotional video for our program in 2008. Both we and CMU's marketing and recruiting staff have handed this out on DVD to prospective students at recruiting events. As described later in Section C.1 of this review, enrollment has grown considerably and is not currently as much of a concern as it was in 2007.

8. Propose metrics of program success other than those based on enrollment. In consultation with the administration and other stakeholders, the program should develop meaningful alternative metrics that demonstrate program success.

   We have not done this. Current high enrollments make this recommendation less important for now.

9. Consider establishing an Environmental Science alumni group and an environmental science student group. Both organizations can help with on- and off-campus recruiting. The same is true of the external advisory board mentioned above.

   We would like to establish an alumni group but have not yet done so. At this time, perhaps the greatest benefits of such a group would be as an employment network and as a fundraising group. There has been an Environmental Science student group but its activity level waxes and wanes from year to year depending on the motivation of the students involved. Our local chapter of Sigma Gamma Epsilon, the earth science honor society, is active but we have not used this group for recruiting purposes.

10. Explore partnership opportunities with other CMU programs, such as Energy Management/Landman, Construction Management, and the Natural Resources and Land Policy Institute.

    In its early years, the Energy Management/Landman program required its students to take specific courses in the Environmental Sciences and Geosciences programs. However, it has become more autonomous as its curriculum and faculty have become more developed. We have not had any further partnership beyond having a Landman faculty member give a guest presentation in our Renewable Energy course. We have not considered any partnership with Construction Management. Several years ago an Environmental Science faculty

member and the Natural Resources and Land Policy Institute collaborated on two unsuccessful proposals to conduct projects for local governments. We have not pursued any further collaboration since then.

11. Hire a fourth faculty member with interdisciplinary training and the ability to teach courses on human systems related to the environment.

    We believe we have a keen need for an additional faculty member. We discuss our current thinking on desirable expertise in Section F.2 of this review.

12. Take the lead in encouraging CMU to form an inter-departmental task force on sustainability, which would enter into partnerships with outside organizations to foster sustainable local development strategies.

    We did not pursue this recommendation to the extent that Dr. Focht envisioned. However, not long after the 2007 program review a CMU Sustainability Council was started. Both our faculty and students have been active on the Council.

B. Curriculum

1. Program curriculum

We designed our curriculum to provide each student with a broad foundation in environmental science and an opportunity for a modest degree of specialization. As shown in the top part of Table 2, every Environmental Science major takes basic courses in mathematics, statistics, and chemistry along with basic Environmental Science courses in ecosystems, pollution, water, and air. Each student completes one of the two options shown in the middle part of Table 2. Finally, each student completes a certain number of credit hours drawn from the restricted electives shown in the bottom part of Table 2.

We designed the ecosystem restoration option for students who are drawn to future work in revegetation of disturbed lands and ecosystem protection, and positions with organizations like the Bureau of Land Management, National Forest Service, and National Parks Service. Students take courses in plants, soils, and restoration ecology along with a course in environmental politics offered by the political science program.

The pollution monitoring and control option is designed for students who favor future work in investigation and cleanup of contaminated sites, pollution monitoring, hazardous waste management, compliance with environmental regulations, and positions with environmental consulting firms and industry. Students take courses in geology, pollution monitoring and investigation, environmental health and safety, and regulatory compliance.

Our restricted electives cover a broad range of topics within environmental science. Some, such as Ecology and Management of Shrublands and Grasslands, Fire Ecology, and Forest Ecology clearly align with the option in Ecosystem Restoration. Others, such as Environmental Risk Analysis, Contaminant Fate and Transport, and Water and Wastewater Treatment, align with the

option in Pollution Monitoring and Control. However, many courses are relevant to both types of work. For example, Mined Land Rehabilitation involves both contamination and revegetation problems, and Stream Biomonitoring enhances students' understanding of stream ecology but also gives students a tool they can use to assess the presence and effects of water pollutants. We also offer three courses that focus on specific areas of sustainability: Permaculture Design, Renewable Energy, and Sustainable Building. These are popular courses among our students regardless of which option they have selected.

In addition to courses specific to the major, our program of study includes Essential Learning courses in English, Mathematics, Humanities, Social and Behavioral Sciences, Natural Sciences, History, and Fine Arts, culminating in Milestone and Essential Speech. Other requirements include courses in Wellness and Electives. The program sheet for the B.S. degree is provided in Appendix 2.

In terms of content, our curriculum is designed to achieve the student learning outcomes identified in Section A.3. Towards this end, we start with beginning-level expectations and gradually bring the students to an advanced level as seniors. For example, in ENVS 104 Introduction to Environmental Science: Global Sustainability we focus on reading and

Table 2. Environmental Science Curriculum

Required for all Environmental Science majors			
ENVS 104	Environmental Science: Global Sustainability	MATH 146 *or* 151	Calculus for Biological Sciences *or* Calc I
ENVS 204/204L	Introduction to Ecosystem Management	CHEM 121/121L & CHEM 123	Principles of Chemistry *and* Introduction to Environmental Chemistry
ENVS 221/221L	Science and Technology of Pollution Control	*or*	*or*
ENVS 331/331L	Water Quality	CHEM 131/131L & CHEM 132/132L	General Chemistry I *and* General Chemistry II
ENVS 340	Applied Atmospheric Science		
ENVS 492	Capstone		
STAT 200	Probability and Statistics		
Ecosystem Restoration Option		**Pollution Monitoring and Control Option**	
ENVS 312/312L	Soil Science and Sustainability	ENVS 212/212L	Environmental Health and Safety
ENVS 455/455L	Restoration Ecology	ENVS 420/420L	Pollution Monitoring and Investigation
POLS 488	Environmental Politics	ENVS 410	Environmental Regulatory Compliance
BIOL 107/107L	Principles of Plant Biology	GEOL 111/111L	Introduction to Physical Geology
Restricted Electives			
ENVS 278/278L	Permaculture Design	ENVS 374	Sustainable Building
ENVS 301	Environmental Project Management	ENVS 394	Natural Resources of the West Topics
ENVS 315	Mined Land Rehabilitation	ENVS 396	Contaminant Fate and Transport
ENVS 321	Environmental Risk Analysis	ENVS 413	Water and Wastewater Treatment
ENVS 332/332L	Introduction to GIS	ENVS 431	Restoration of Aquatic Systems
ENVS 337	Stream Biomonitoring	ENVS 433	Fire Management
ENVS 350/350L	Ecology/Management Grasslands	ENVS 460/460L	Experimental Design and Statistical Analy.
ENVS 354	Shrublands	ENVS 475	Topics
ENVS 360/360L	Forest Ecology	ENVS 496	Structured Research
ENVS 370	Fire Ecology	ENVS 497	
	Renewable Energy		

developing questions. Students advance to data collection and full lab write-ups in our 200-level courses. Our upper division courses require independent projects, leading to ENVS 492 Capstone in which students do semester-long group projects.

Although not required, we offer internship credit for students. Internships are based on entry-level professional work completed for an off-campus organization and can be either paid or unpaid. Internships sometimes lead to permanent employment with the host organization. The typical internship occurs as a full-time summer job but occasionally students complete internships on a part-time basis during the semester. In addition to being evaluated by their supervisor, students are required to identify learning objectives at the outset of their internship and complete a self-evaluation of how well they met those objectives at the end.

Students also have the option of participating in faculty research through ENVS 497 Structured Research. Each faculty member has projects underway that lend themselves to meaningful student involvement. Students discover the challenges and rewards of real-life studies and gain more in-depth knowledge about the research topic. This experience is a valuable complement to regular coursework.

We offer a Minor in Environmental Science and Technology, also shown in Appendix 2. The minor provides interested students with a great deal of flexibility—ENVS 104 Environmental Science: Global Sustainability is the only course specifically required. Students must complete twelve additional credit hours of Environmental Science courses, of which five credit hours must be upper division (numbered 300 or higher).

We began offering a Technical Certificate in Sustainability Practices in the 2012-13 academic year. The program sheet is shown in Appendix 2. Students take ENVS 104 Environmental Science: Global Sustainability to acquire an overview of the problems that sustainable practices are designed to improve, such as industrialized agriculture, depletion of energy and mineral resources, loss of ecosystem services, and others. Students complete the certificate by taking two courses selected from Permaculture Design, Renewable Energy, and Sustainable Building. These courses have a practical slant and are designed to inform the personal choices that students will make in the future about how they obtain food, energy, and shelter. Aside from our motivation of providing students with a way to fulfill their goals for ethical living, our intent is modest—we do not envision that this nine-credit hour program prepares a person for a career as a sustainability specialist. Rather, we view the certificate as an enhancement to their bachelor degree that may provide them with the distinction in qualifications they need in order to be assigned some sustainability responsibilities in addition to their basic job.

2. Program currency

We do a number of things to stay current. We have guest speakers give presentations on current local problems, both in regular courses and in our seminar course, ENVS 394 Natural Resources of the West, held every fall. Each faculty member uses current local problems as a source of research topics. Findings and experiences from this research are shared with classes. Several courses include readings from the current research literature. The faculty maintains contacts with local environmental professionals and land managers to stay on top of emerging issues. We

update our field and lab equipment with new technology. Each faculty member has been on sabbatical during the last five years and attends, on average, roughly one conference per year, including those especially pertinent to our location, such as the High-Altitude Revegetation Conference, Colorado Watersheds Conference, Tamarisk Symposium, and Conference on Science and Management on the Colorado Plateau.

C. Analysis of Student Demand and Success

1. Enrollment, credit hours, and graduates

Table 3 shows numbers for enrollment and credit hours for the period since our last program review, starting with the 2008 academic year (i.e, the 2007-2008 school year, or AY08) through academic year 2015 (the 2014-2015 school year, or AY15). The figures for enrollment in the major count all students who declared the Environmental Science major, including those for whom this would be a second major. Figures for enrollment in courses and student credit hours are based on the number of students enrolled in each course at the end of the semester. The following discussion considers both the period since our last program review (AY08-AY15) and the most recent five years (AY11-AY15).

Environmental Science experienced a 97% increase in the number of majors since our last program review, from 73 in AY08 to 144 in AY15. In the most recent five-year period, the number of majors increased by 22%, from 118 in AY11 to 144 in AY15. For context, the total enrollment at CMU increased by 51% since our last program review, from 6,111 in fall 2007 to 9,221 in fall 2015. CMU enrollment increased by 13% over the last five years, from 8,149 in fall 2010 to 9,221 in fall 2014. Regardless of which time period one looks at, the number of Environmental Science majors has grown faster than total CMU enrollment (97% versus 51% since the last program review, 22% versus 13% in the last five years).

Enrollment and student credit hours in Environmental Science approximately doubled since the last program review. Enrollment increased by 109%, from 399 in AY08 to 832 in AY15, while credit hours increased by 94%, from 1,036 to 2,014. For the most recent five-year period, enrollment increased by 30%, from 641 to 832, while credit hours increased by 31%, from 1,540 to 2,014. CMU total credit hours increased by 50% since our last program review, from 74,257 in fall 2007 to 111,234 in fall 2014. During the last five years, CMU credit hours increased by 13%, from 98,199 in fall 2010 to 111,234 in fall 2014. Again, growth in the Environmental Science program outpaced CMU growth (94% versus 50% for credit hours since the last program review, 31% versus 13% for credit hours in the last five years).

ENVS 101 Introduction to Environmental Science is one of 26 courses students can take to fulfill the requirement for natural science Essential Learning courses. In an average year, 29% of our enrollment and 35% of our student credit hours come from this course. Nearly all of the rest of our enrollment and credit hours come from students majoring in Environmental Science. (Only two or three students from other disciplines take our major courses in a typical year.)

Table 4 shows numbers of graduates. Since our last program review 119 majors graduated for an average of 15 per year. Graduates increased by 20% from AY08 to AY15. However, the annual

number of graduates showed considerable fluctuation, ranging from a low of three to a high of 24. Given this year-to-year fluctuation, a comparison of the first three years of this period with the last three years may be more meaningful. When viewed this way, the number of graduates increased by 67%, from 33 in the first three years (average of 11 per year) to 55 in the last three years (average of 18 per year). Over the last five years, BS graduates increased by 20%, from 12 to 18.

Table 3. Environmental Science Majors, Enrollment, and Student Credit Hours

	AY08	AY09	AY10	AY11	AY12	AY13	AY14	AY15	Annual average	Percent Change AY11 to AY15	Percent Change AY08 to AY15
Number of majors	73	79	107	118	140	136	144	144	118	+22%	+97%
Enrollment	399	483	595	641	796	765	809	832	665	+30%	+109%
Student credit hours	1036	1170	1459	1540	1944	1855	1872	2014	1611	+31%	+94%
Enrollment in ENVS 101 (percentage of all ENVS)	123 (31%)	118 (25%)	176 (30%)	188 (30%)	240 (31%)	277 (34%)	184 (24%)	216 (27%)	190 (29%)	+15%	+76%
Enrollment in other ENVS (percentage of all ENVS)	271 (69%)	363 (75%)	407 (70%)	439 (70%)	540 (69%)	530 (66%)	593 (76%)	598 (73%)	468 (71%)	+36%	+121%
Credit hours in ENVS 101 (percentage of all ENVS)	369 (36%)	354 (30%)	528 (37%)	564 (37%)	720 (38%)	681 (37%)	552 (31%)	648 (33%)	552 (35%)	+15%	+76%
Credit hours in other ENVS (percentage of all ENVS)	659 (64%)	807 (70%)	913 (63%)	955 (63%)	1200 (62%)	1162 (63%)	1272 (69%)	1339 (67%)	1038 (65%)	+40%	+103%

Table 4. Numbers of BS Degrees, Minors, and Technical Certificates Awarded

	AY08	AY09	AY10	AY11	AY12	AY13	AY14	AY15	Annual average	Percent Change AY11 to AY15	Percent Change AY08 to AY15
BS degrees awarded	15	3	15	12	19	13	24	18	15	+50%	+20%
Number of minors awarded	0	1	3	1	2	0	1	0	1	-100%	-100%
Number of Sustainability Practices certificates awarded	n/a	n/a	n/a	n/a	n/a	1	0	5	2	n/a	n/a

The number of students declaring a Minor in Environmental Science varied from 3 to 10 over the reporting period for an average of 5.6 in any given year (Table 4). Eight students completed the minor for an average of one per year. As noted in Section A.4, our little-used minor could be useful to students in other disciplines. More promotion of the minor may be worth pursuing as a way to increase students completing the minor.

The Technical Certificate in Sustainability Practices is only three years old. Through AY15, six students have completed this certificate, all majoring in Environmental Science. Again, more promotion would alert students outside of our major to these courses and the opportunity to complete a certificate program. (It is worth noting that the number of students graduating in May 2016 with the certificate will more than double the current total.)

2. Student retention

Snapshots of student retention referenced to the fall 2011 semester are presented in Table 5. Numbers and percentages are reported for students continuing with or graduating from our major relative to those who were present in fall 2010 (a one-year snapshot) and those who were present in fall 2007 (a four-year snapshot).

Looking first at the four-year snapshot and combining students retained in the major with graduates, we retained 74% of our majors, with 67% graduating. Taking the same approach to the one-year snapshot, we find that only 41% of our majors were retained, with 11% graduating. The four-year result is fairly good but the one-year result is poor. It is not clear why we fared so much better over the four-year period than over the one-year period; one would predict that one-year retention would be better.

Table 5. One-Year and Four-Year Snapshots of Retention

Fall 2011 Status of Students Enrolled in Fall 2010				Fall 2011 Status of Students Enrolled in Fall 2007			
Retained in Major, Not Yet Graduated		Retained in Major, Graduated		Retained in Major, Not Yet Graduated		Retained in Major, Graduated	
Number	Percent	Number	Percent	Number	Percent	Number	Percent
28	30%	10	11%	3	7%	30	67%

We generally find that 90% or more of students who reach the junior-level courses in the major finish their degree. For example, over the period from 2010 through 2014, between 90% and 96% of the students in ENVS 331 Water Quality (required for the major) did complete the degree. Lower

percentages were observed for students in the sophomore-level courses in the major. A few of the sophomores are known to switch to another major, but most appear to have problems with motivation. Sometimes complications in their personal lives are a factor.

Retention in Environmental Sciences (as well as other CMU degrees in the physical sciences) is problematic. We observe that most of the students in our program were not strongly science-oriented in high school. These incoming students tend to be weaker in math and science and experience more difficulty passing those kinds of courses. We do recognize the diversity in preparation among our students and strive to bring these students up to speed without slowing the pace down to the point that we do not challenge the better-prepared students. We meet with students outside of class to answer questions and develop mentoring relationships, and encourage students to use the Tutorial Learning Center. We strive to make classes engaging and discuss career opportunities in order to provide motivation. We will continue to identify more ways to increase retention.

3. Student successes and recognition

Our graduates have been successful in finding employment as environmental professionals or being admitted to graduate school. Of the 119 graduates since the last program review, 58 are known to have obtained positions using their Environmental Science degree. This number includes twenty-five graduates who found work with environmental consulting firms, eight with industry, ten with the federal government, one with state government, two with county government, two with water utilities, one as a grade-school teacher in Mexico, and three with non-profits. Six students had seasonal work. Four additional students went to graduate school before taking an environmental position; two more went to graduate school while working. Of the remaining students, we know that a few are seeking environmental work but we have not heard from the rest.

Two graduates formed their own companies (Ruby Canyon Engineering, Grande River Environmental). Three graduates became co-owners of the company that hired them (Westwater Engineering). Another graduate led an expedition to create a video documenting pollution of the Rio Grande de Santiago in Mexico (http://santiagoriver.com/).

D. Program Resources

1. Faculty

Faculty headcount and rank—The number of faculty present in each year is shown in Table 6. Environmental Science had three tenured or tenure track faculty throughout the review period. We hired a full-time temporary person during AY 12 when one tenured faculty member was on sabbatical. We draw from the pool of local environmental professionals to teach courses beyond the expertise of the tenured staff, such as Permaculture Design, Mined Land Rehabilitation, Stream Biomonitoring, and Environmental Science in Community Planning. We also hire local professionals to cover courses that the tenured faculty cannot fit within their normal workloads, such as Introduction to Environmental Science and Environmental Regulatory Compliance. One course, Introduction to Geographic Information Systems, is co-numbered as a geoscience course and is always taught by a member of the geoscience faculty. A second course, Introduction to Environmental Science, has sometimes been taught by a geoscience faculty member.

Faculty qualifications—All three tenured environmental science professors have doctorate degrees in related disciplines. Two of the thirteen temporary faculty members have doctorate degrees and eight have master's degrees. The remaining three temporary faculty members have bachelor's degrees. A listing of faculty and curriculum vitae are shown in Appendix 3.

Credit hour generation—Numbers of full-time equivalent students (FTES) and full-time equivalent faculty (FTEF) are shown in Table 6. During the period since the last program review, full-time equivalent faculty increased by 0.3 (8%) while full-time equivalent students increased by 32.2 (94%). Our ratio of FTES to FTEF increased by 7.3, from 9.0 to 16.3, an increase of 81%. During the five-year period leading up to this review, full-time equivalent faculty increased by 0.4 (11%) while full-time equivalent students increased by 16.9 (34%). Our ratio of FTES to FTEF increased by 2.6, from 13.7 to 16.3, an increase of 19% during the five-year period.

A comparison of student credit hours generated by faculty type is also presented in Table 6. Except for years when sabbatical replacements are a major factor (AY13), the tenured/tenure track faculty produce between 71% and 98% of the credit hours. Taking out the sabbatical year, an average of 85% of the credit hours are generated by tenured/tenure track faculty. However, the proportion has been only 76% and 71% in the most recent years, AY14 and AY 15, respectively.

Measures of teaching effectiveness—All Environmental Science faculty members have students fill out semester-end evaluations in each of their courses. Our campus-wide survey form, shown in Appendix 4, includes twelve positive statements, such as: "The teaching methods/techniques used by the professor are effective"; "The exams and assignments are consistent with course content"; and "The course is appropriately challenging". Students assign a rating to each statement ranging from "1–strongly disagree" to "5-strongly agree". A median response is determined for each statement, and a single overall median of medians is calculated for all twelve statements. More recently, an overall average response has also been provided. Our tenured and tenure-track professors, and many of the part-time instructors, receive mostly 5s as the median of medians for their courses, with averages ranging from about 4.2 to 4.8.

Table 6. Number of Faculty by Type, Full-Time Equivalents, and Credit Hour Generation

	AY 08	AY 09	AY 10	AY 11	AY 12	AY 13	AY 14	AY 15	Annual average	Change AY 11 to 15	Change AY 08 to 15
Number of faculty											
Tenured	2	2	2	2	2	3	3	3	2.4	+1	+1
Tenure-track	1	1	1	1	1	0	0	0	0.6	-1	-1
Full-time temporary	0	0	0	0	0	1	0	0	0.1	0	0
Part-time	1	3	1	5	3	5	6	6	3.8	+1	+5
Full-time equivalents											
Students	34.3	38.7	48.0	50.6	64.0	61.4	60.8	66.5	53.0	+15.9 (31%)	+32.2 (94%)
Faculty	3.8	3.9	4.3	3.7	4.5	4.2	4.0	4.1	4.1	+0.4 (11%)	+0.3 (8%)
Faculty:student	9.0	10.0	11.2	13.7	14.1	14.7	15.0	16.3	13.0	+2.6 (19%)	+7.3 (81%)
Credit hour generation by faculty type											
Tenured/tenure track	98%	84%	98%	83%	91%	52%	76%	71%	82%	-12 (14%)	-27 (29%)
Full-time temporary	0	0	0	0	0	36%	0	0	4%	0	0
Part-time	2%	16%	2%	17%	9%	11%	24%	29%	14%	+12 (71%)	+27 (1300%)

Another measure of teaching effectiveness can be found in the results of a 2014 survey of Environmental Science alumni (Appendix 5). When asked to identify the "greatest strengths of the program", 64% of alumni mentioned the experience and expertise of the faculty. When asked about the quality of instruction, the following areas had the most positive results (number in parentheses is the sum of "very strong" and "strong" responses):

- Quality of lab and field instruction and activities (100%)
- Quality of classroom instruction and activities (94%)
- Availability of faculty for help (88%)
- Commitment of faculty to teaching (94%)
- Diversity of faculty expertise (82%)
- Advising on CMU courses and requirements (77%)

Overall satisfaction among Environmental Science alumni was also high:

- 76% of our alumni were very satisfied with their education (versus 57% of all CMU alumni)
- 94% of our alumni rated the overall quality of their education as high or very high (versus 85% of all CMU alumni)
- None of our alumni were ambivalent or dissatisfied with their education (versus 7% of all CMU alumni who were)
- 76% of our alumni would encourage a high school senior to attend CMU (versus 63% of all CMU alumni who would).

We make good use of a variety of approaches to instruction, including:

- Lecture, using PowerPoint, whiteboard, and document camera
- Note-taking handouts for students
- In-class and on-line discussions
- In-class group exercises
- Short on-line videos
- Documentary videos
- Guest presentations (by representatives of the Army Corps of Engineers, Bureau of Land Management, National Weather Service, and consulting firms, to name a few)
- In-class and on-line quizzes, in-class exams
- Peer-reviewed literature (read, summarize, discuss in class)
- Group and individual projects
- Team-building activities
- Peer review of student projects
- Hands-on use of field and lab equipment
- Field studies (design, implement, report)

We routinely take part in professional development sessions provided by CMU. Examples include sessions led by outside presenters such as Ken Bain (author of "What the Best College Teachers Do") and Mark Taylor (Meet Generation NeXT—Understanding Today's Learners) as well as internal sessions, such as those organized by our Teacher2Teacher group (faculty discussions of various teaching techniques and problems), distance learning staff (use of D2L

course management software, on-line techniques), and staff (PTSD in the classroom, suicide prevention).

Advising—Students who decide to major in Environmental Science are referred to the administrative assistant in the Department of Physical and Environmental Sciences, who enters their choice into the campus-wide data base and assigns them to a tenured/tenure-track professor for advising. We accommodate student requests for a specific advisor provided that the individual is not overloaded with advisees. Otherwise, the administrative assistant makes assignments so as to keep the advising loads roughly equal. Although our advising loads were temporarily unbalanced due to one of us being on sabbatical, our professors each currently have roughly 40 to 60 advisees. Students are not required to see an advisor, but the majority of our active majors do. We also do group advising in our courses at registration time.

Service—The Environmental Science faculty provides considerable service, both on-campus and off. Examples of on-campus service include serving as the head of the Department of Physical and Environmental Sciences, and serving on a variety of committees, such as Distance Learning and Technology, Assessment, Academic Policies, Sabbatical, Department Scholarships, Sustainability Council, and Campus Tree Advisory Board, along with search committees and other ad hoc committees.

Off-campus service includes membership on several advisory groups and boards:

- Member, Advisory Council, Dominguez-Escalante National Conservation Area
- Member, Subcommittee on McInnis Canyons National Conservation Area, reporting to the Bureau of Land Management's Northwest Colorado Resource Advisory Council
- Member, Board of Directors for Colorado Canyons Association
- Member, Board of Directors for Mesa Land Trust

Examples of additional off-campus service are membership on an oil and gas reclamation working group, science fair judging, wildflower walks, nature scavenger hunts, field demonstrations for Colorado National Monument staff, peer reviews for journals, collection of field data for local non-profit organizations, vegetation surveys, development of educational apps, and panel discussions.

Research—Being active in research is important to us, both as a means of satisfying our own curiosity and as a way to take students beyond classroom learning. Our interests are in applied research and projects that benefit the local environment and provide opportunities for participation by undergraduate students. Past and present research interests include:

- Effect of tamarisk defoliation on plant diversity and fuel loads
- Fire history, spatial structure, and mortality in an old-growth pinyon-juniper woodland
- Effects of soil heterogeneity on vegetation recovery on natural gas pads
- Competition of native plants and introduced crested wheatgrass with invasive cheatgrass
- Dynamics of selenium leaching from Grand Valley soils and its effects on surface water quality

2. Financial information

Internal funding—The head of the Department of Physical and Environmental Sciences submits a budget request to the administration each January for the upcoming fiscal year, which begins on July 1. Inasmuch as it has been many years since we have had to endure budget cuts, our working assumption is that we will receive the same amount as in the preceding year. The administration approves requests for one-time additional funds and base-building increases based on need and the availability of funds. Environmental Science receives additional funding by way of a $50 fee that is attached to all lab courses. In a typical year approximately 75% of the funds collected from this fee are used to rent CMU vans for our field sessions, with the remainder going to equipment and supplies used in the lab and field. Table 7 shows costs for AY15. Hourly compensation is for student assistants. Other current expenses include supplies, software, equipment purchase and repair, copier lease, and similar costs. Travel costs in the budget allocation category are specifically for faculty travel. (Each program is allocated $600

Table 7. Environmental Science Expenditures in Academic Year 2015

Expenditure of budget allocation	
Contract regular wages	$ 204,996
Contract part-time wages	$ 20,161
Contract benefits	$ 65,996
Hourly compensation	$ 110
Other current expenses	$ 6,220
Travel	$ 1,776
Internal charges	$ 1,210
Total	$ 300,469
Expenditure of course fees	
Hourly compensation	$ 0
Other current expenses	$ 1,525
Travel	$ 5,673
Total	$ 7,198
Total expenditure	$ 307,667
Student credit hours generated	1,872
Dollars per credit hour	$ 164

per tenured/tenure track faculty member for conference travel.) Travel costs in the course fee category are for van rental for field work during lab periods and other field trips. Internal charges are for phones and phone calls.

External funding—We have received significant external funding to conduct projects and research:

- Exxon-Mobil, 2008. $93,915 for "Restoring Soil Primary Processes to Promote Successful Vegetation and Habitat Restoration Following Natural Gas Development in the Piceance Basin."
- Bureau of Reclamation, 2008. $84,610 for "Passive Selenium Bioreactor—Pilot Scale Testing."
- S&K Aerospace LLC, 2009. $2,897 for "Bench-Scale Study of Ammonia in Ground Water."
- National Park Service, 2010. $20,000 for "Determining Age-Class Structures of Pinyon Pine and Juniper Populations in Old-Growth Woodlands in Colorado National Monument."
- Golder Associates, Inc., 2011. $6,227 for "Bench-Scale Treatability Study for Ground Water from the Atlas Mill Site."
- Roaring Fork Conservancy, 2012. $5,000 for "Water Quality in the Crystal River and Coal Creek Basin."
- Colorado National Monument Association, 2015. $5,600 for "Health Assessment of Cottonwood Stands in the Colorado National Monument."
- Desert Ecosystem Analysis and Restoration, 2015. $6,785 for "*Amsonia jonesii* Demographic Study at the Three Sisters Park, Grand Junction, Colorado."

3. Library assessment

We are generally satisfied with the relevant library holdings. A book-buying budget averaging approximately $2100 per year has allowed us to acquire a good collection of books and videos supporting our curriculum. In-house holdings of relevant periodicals are not very extensive, but we do have on-line access through the library to a broad range of journals. The analysis of library holdings conducted by the library staff is shown in Appendix 6.

4. Physical facilities

Lecture courses are distributed among all of the classroom buildings on campus. Each classroom has an instructor computer, network and internet access, DVD player, document camera, data projector, and projection screen. Our laboratory facilities are on the second floor of the Science Lab wing of Wubben-Science. The labs were completed and occupied in 1997 and renovated in 2011. Environmental science has its own dedicated space for laboratories and storage that include:

- One 1,131 square foot 24-student multipurpose instructional lab
- Two 580 square foot project labs primarily for faculty and student research
- One 261 square foot project lab primarily for faculty and student research
- Two storage rooms totaling 670 square feet

- One instrumentation laboratory that is shared with chemistry
- A temperature-controlled greenhouse for coursework as well as faculty and student research that is shared with Biology

5. Instructional resources

We believe that our equipment collection is a very good reflection of the equipment that is used most commonly in the environmental profession. All of this equipment is used by students.

Laboratory-based equipment includes:

- Perkin-Elmer Optima 2000 inductively-coupled plasma optical emission spectrometer for analysis of dissolved metals
- Dionex D-120 ion chromatograph for analysis of major ions
- Aurora Biomed microwave digestion system for preparation of samples for analysis
- Hach BOD-Trak for measurement of biochemical oxygen demand
- Hach BOD incubator
- constant-temperature refrigerator
- drying oven
- soil grinder

Our field equipment includes:

- pH meters
- turbidity meters
- various test kits for water chemistry
- metric measuring tapes
- waders
- water samplers
- compasses
- tree corers
- sanders
- spring scales
- double-ring infiltrometers
- calipers
- digital camera
- infrared gas analyzer for measuring photosynthesis
- conductivity meters
- dissolved oxygen meters
- redox potential meter
- water velocity meters and wading rods
- nets for collecting aquatic insects
- trowels, augers, corers for soil sampling
- clinometers
- fire weather kits
- magnifying lamps
- portable balances
- soil penetrometers
- GPS units
- pressure chambers for measuring plant water status
- time domain reflectometer for measuring soil water content

6. Efficiencies in program operations

We strive for efficiency in our operations. We share equipment as needed among the different courses, labs, professors, and research projects within Environmental Science.
The ion chromatograph, inductively-coupled plasma atomic emission spectrometer, and x-ray fluorescence spectrometer along with their maintenance and repair costs are shared between

Environmental Science and Chemistry. The Department of Biological Sciences loans microscopes to us on an as-needed basis. When campus-wide limitations on available classroom space occurred due to enrollment increases and remodeling projects, we held lecture courses in our lab. We sometimes share our lab with other programs; both CHEM 123 Introduction to Environmental Chemistry and AGRS 240/240L Introduction to Soils Science take place in our lab.

E. Student Learning Outcomes and Assessments

1. Student learning outcomes

The CMU faculty engaged in a campus-wide reconsideration of student learning objectives in 2012 using the Degree Qualifications Profile developed by the Lumina Foundation as a guide. The Degree Profile organizes student learning outcomes (SLOs) into six areas of learning: specialized knowledge; broad, integrative knowledge; intellectual skills; applied learning; civic learning; and institution-specific areas of learning. The profile calls for SLOs specific to each degree level, with the understanding that baccalaureate graduates will also have attained the SLOs for associate-level graduates. The SLOs themselves are concise statements of the measurable competencies to be demonstrated by graduates and used as the basis for assessment. Campus-wide SLOs were drafted in early 2012, then each program created SLOs specific to its own graduates. Our program SLOs are shown below.

Students graduating with a B.S. in Environmental Science and Technology will be able to:

1. Demonstrate an understanding of terminology, concepts, theories, and practices in environmental science. (Specialized knowledge)

2. Demonstrate the ability to design an environmental study. (Quantitative skills, critical thinking skills)

3. Demonstrate the ability to analyze quantitative environmental data, effectively translate data into graphs or tables, and interpret the results. (Quantitative skills, critical thinking skills)

4. Demonstrate the ability to use appropriate tools, technology, and methods for measuring and analyzing environmental data. (Technology skills)

5. Identify and evaluate assumptions, hypotheses, alternative views on environmental problems, then articulate implications and form conclusions. (Critical thinking)

6. Construct an organized argument (oral and written) supported by current research on a technical issue in environmental science appropriate for a specialized audience. (Communication skills)

7. Complete a field-based project that evaluates and proposes a solution for a local problem or need by effectively synthesizing applicable concepts from environmental science and related disciplines. (Applied learning)

2. Assessment of student learning outcomes

We developed an assessment plan in early 2013 for six of the seven student learning outcomes listed in Section E.1, above. The first four columns of the report presented in Appendix 7 show this plan. Outcomes 2 and 3 in the above list are combined into a single outcome (outcome 2) in the plan. Outcome 5 in the above list was not included in our current plan but will be included in a future revision.

ENVS 492 Capstone plays a central role in our plan. Because the course is cumulative in nature and is taken by all of our senior Environmental Science majors, it is a logical setting in which to assess how well our students meet the SLOs at an advanced level. Students work in groups of three to four to plan, implement, and report (both orally and in writing) on projects that they do for an off-campus client. Thus, we are able to use the Capstone projects to evaluate their communication skills, quantitative skills, critical thinking skills, technology skills, and applied learning skills. For the evaluation of students' specialized knowledge, we instead rely on tests. Students take a test on their knowledge of environmental processes as freshmen at the beginning of ENVS 104 and again as seniors in ENVS 492. We then compare their senior scores to their freshman scores. We also examine their performance on four exit exams that we administer as part of ENVS 492.

We collected and evaluated assessment data in 2014. Scores and quantitative data are included in the report shown in Appendix 7. Our conclusions and actions are shown below.

- Outcome: Construct an organized argument (oral and written) supported by current research on a technical issue in environmental science appropriate for a specialized audience. (Communication skills)

  Conclusion: Our students generally do a better job of oral communication than written communication. This may be a reflection of having to do more oral presentations than research papers. Project sponsors tended to be satisfied with our students work.

  Actions: Since the literature review portion of the written work received the lowest score, more emphasis will be placed on this in the future in Capstone. For example, students will be required to generate outlines of knowledge gained in prior courses and new knowledge needed for their Capstone project. This assignment will be started the second week of the semester rather than mid-semester to allow more time for feedback from the professors and revision by the students.

  Although not identified as a direct result of this assessment effort, it has been noted that our students do not always take advantage of the information in their literature review when they interpret and discuss the results of their study. We will focus on improving

this deficiency in ENVS 350/350L Ecology and Management of Shrublands and Grasslands and ENVS 455/455L Restoration Ecology, and ENVS 492 Capstone.

- Outcome: Demonstrate the ability to design a study, collect and analyze quantitative environmental data, effectively translate results into graphs or tables, and interpret these results. (Quantitative skills, critical thinking skills)

  Conclusion: Developing a detailed and complete work plan is one of our students' weaker skills. A likely explanation is that planning requires more critical thinking than the other skills assessed here. Also, students do not get practice developing work plans in any required classes, but they do get practice at other skills, such as interpreting and displaying data, in many of our classes starting at the 200-level.

  Actions: More emphasis will be placed on work plan development in Capstone. The level of detail required in the technical approach section of the work plans will be increased. We will also try to find better examples of professional work plans for students to use as examples. Additional emphasis on work plan development will take place in three other courses, as well—ENVS 221/221L Science and Technology of Pollution Control, ENVS 331/331L Water Quality, and ENVS 420/420L Pollution Monitoring and Investigation.

- Outcome: Demonstrate the ability to use tools, technology, and methods appropriate for measuring and analyzing environmental data (e.g., field and laboratory instrumentation and equipment, computer software for processing scientific data). (Technology skills)

  Conclusion: Developing appropriate methods and procedures for a capstone project is a thought process that occurs during the development of the Capstone work plans. We have already identified work plans as a weak point of our students. Again, this may be because students were not getting practice developing work plans in required classes.

  Actions: The actions listed under the preceding bullet apply here, too.

- Outcome: Demonstrate an understanding of terminology, concepts, theories, and practices in environmental science. (Specialized knowledge)

  Conclusion: Students are learning and retaining basic knowledge in this program.

  Actions: We believe no action is warranted.

- Outcome: Complete a field-based project that evaluates and proposes a solution for a local problem or need by effectively synthesizing applicable concepts from environmental science and related disciplines. (Applied learning)

  Conclusion: In order to assess this outcome, Capstone reports were evaluated for understanding of the basic science underlying the problem, understanding of the system nature of the problem components, and the extent to which alternative plans and

explanations were considered. Capstone groups were also evaluated on how well they interacted with the client in a professional manner.

Capstone projects scored higher in these applied aspects than in other criteria. This may be a reflection of the strong applied nature of our program— students do and see a lot of applied projects in the many lab courses required for our major.

Project sponsors tended to be satisfied with our students during these capstone projects. The Capstone instructor gives them a handout on professional communication which may have helped with this.
Actions: We will consider actions to take after re-evaluating this outcome in 2015.

3. Program improvements resulting from assessment

Additional emphasis on work plan development will take place in three courses—ENVS 221 Science and Technology of Pollution Control, ENVS 331 Water Quality, and ENVS 420 Pollution Monitoring and Investigation. Students already learn how to carry out field investigations of pollution problems in these courses. A logical next step is for the professor to explain how investigations should be planned and have students develop actual plans. This effort was started in ENVS 331 and ENVS 420 in the fall 2015 semester with the addition of specific presentations and assignments; these improvements will be made to ENVS 221 in the spring 2016 semester.

Specific changes will also occur in the Capstone course, such as increasing the emphasis on project literature reviews, identification of relevant knowledge from coursework along with identification of new information needed, and finding better examples of project work plans.

4. Modifications to student learning outcomes and assessment plan

We will continue to use our current set of SLOs. This will allow us to see whether the changes described in the preceding section bear fruit. We do expect to modify our assessment plan, perhaps as early as 2016. We can add the evaluation of planning skills at the beginning level in ENVS 221 and intermediate level in ENVS 331 and/or ENVS 420. Given that we were satisfied with students' specialized knowledge, we may delete that outcome from our revised assessment plan. We may also add outcome 5 from Section E.1 on critical thinking to the plan.

F. Future Program Plans

1. Vision

Our graduates are skilled at analyzing environmental problems and identifying the key questions that need to be answered. Through their knowledge gained in our coursework and their ability to find additional information, they quickly understand the problems and can formulate studies or investigations to answer the key questions. They are confident and skilled at field work and can

provide an insightful interpretation of the data they collect. Their reports are concise, logical, complete, and well-written; their presentations are clear, articulate, and stimulating. Our graduates are sought by employers throughout Colorado and the region.

Our program and its curriculum are a good match for the environmental problems of the future, whatever they may be. Our graduates understand the causes and consequences of both regional and global environmental issues, and are committed to being a part of the solution to these problems. Our faculty members are valued for their contribution to understanding and solving local, regional, and global environmental problems. We have a reputation for scientific excellence and bringing an impartial eye to issues.

2. Strengths and challenges

Strengths

We have a stand-alone program with its own faculty and curriculum. (Many Environmental Science programs at other colleges and universities are entirely made up of faculty and courses housed in other disciplines.)

Our location provides opportunities for a wide variety of field activities and studies. We make good use of these opportunities and our students learn the field skills used routinely by environmental professionals and researchers.

Class sizes in most of our courses are small enough to allow higher-quality interaction with professors. Smaller sizes also allow us to offer more assignments and assessments that focus on written work and presentations—something that is logistically more difficult in larger classes.

Projects are widely used in our program. Students learn to plan studies, collect data, analyze and interpret their data, and report their conclusions and recommendations. We initiate this effort in the second course for majors, then continue by using projects in later courses with progressively more complexity and higher expectations. Projects typically include a quantitative component and require critical thinking and synthesis.

Projects are the heart of our Capstone course, which all majors must take in their senior year. Students work in groups of three to four to complete semester-long projects for off-campus organizations, allowing them to gain hands-on experience with planning and implementing a real-life project, tracking progress, and presenting results.

We provide research-based learning opportunities outside of the classroom, which enhance student preparation for professional work and post-baccalaureate studies.

Students frequently complete one or more of three related minors and certificate programs that enhance their knowledge and skills: the minor in Watershed Science, the minor in Geographic Information Systems and Technology, and the Technical Certificate in Sustainability Practices.

We have local professionals with considerable expertise in their specialties who are eager to teach an occasional course or class in their specialty.

Local environmental services firms have hired many of our graduates. Three such firms are owned in part or whole by our graduates (Ruby Canyon Engineering, Westwater Engineering, Grande River Environmental).

Challenges

We have a good collection of equipment and instrumentation but funding the maintenance and replacement of aging equipment is an on-going challenge. In recent years we have been able to draw on modest funding (up to $5,000 per year) from an endowment for the Department of Physical and Environmental Sciences at the CMU Foundation to help fund repairs.

While most of our class sizes remain relatively small (roughly twenty students), enrollment in our required courses is now routinely in the 30's or higher. As an example, in the years leading up to our last program review, enrollment in ENVS 331 Water Quality, a required course, ranged from eight to twenty. For 2014 and 2015, enrollment was 36 and 44, respectively. In order to maintain the same level of instructional quality, we maintain the same hands-on work, written assignments, and feedback to students that we did when classes were smaller. The increased workload takes away from time for research and program development.

Also, we now must offer two lab sections for courses that formerly needed just one (ENVS 204/204L, 221/221L, 312/312L, 331/331L, 455/455L). We also need to offer a second section of ENVS 492 Capstone in 2016. This increase in sections forces us to rely more heavily on part-time faculty. While we have several part-time instructors that do an excellent job, our overall experience with part-time faculty is hit-or-miss and there are times when it is a struggle to find someone with both the right expertise and availability. Our part-time instructors typically have a full-time job elsewhere and thus have limited time. If circumstances prevent them from teaching the course more than once, they do not have the opportunity to improve on their initial work. Part-time pay is considered low by those instructors and is sometimes an obstacle.

Instruction for ENVS 312/312L Soil Science and Sustainability is problematic. We do not have a soils specialist on the Environmental Science faculty. In earlier years, we used a member of the Geosciences faculty, who focused on soil development and classification, consistent with his expertise. In order to make the course a better complement to our other courses, one of our Environmental Science faculty members, a plant ecologist, taught the course for most of the last ten years, broadening the course to include topics relevant to revegetation and restoration projects. In other years, we have used part-time instructors with specialized knowledge of soils. However, we currently have no one who we consider to be a permanent, best-case solution to the problem of an instructor for this course.

Availability of CMU vans is sometimes an issue. For example, there was never a van available for ENVS 420L during the fall 2015 semester. Student car pools usually work out but occasionally students have trouble finding the field site, are late arriving, or have difficulty with availability of personal vehicles.

For most of the last ten years there has been a strong demand for our environmental science majors at local consulting firms doing environmental service work for the oil and gas industry. However, with the recent lull in this industry in Colorado, there have been fewer employment opportunities here in the Grand Valley, which is a disadvantage for those students who need or hope to stay here. This problem may become more acute for the next couple of graduating classes, which will be larger. (Thirty-eight Environmental Science majors are planning to graduate in May and December of 2016.)

Local environmental services firms hold us in high regard and commonly hire our graduates. However, we are less well-known and have fewer contacts with firms outside the Grand Valley. This makes it more difficult for us to help students find job opportunities outside the local area. With the decrease in local employment opportunities, it is crucial for our graduates to be hired elsewhere.

Permanent jobs with government agencies are not plentiful, but we would like to see more students obtain these positions. In order to help students compete for those jobs, we can show them how their coursework meets the specific qualifications required for selected federal job classifications. This was done a number of years ago for the ecologist series (GS-408). We can do the same for other relevant classifications.

The principle career path that connects with our major is the environmental services profession. This is a limited niche for our graduates. We have discussed the idea of expanding the focus of our program so that it leads to other types of environmental work as well. However, we have struggled to determine what direction this would take. Among the possibilities that we have on the table are:

- Sustainability specialists—These specialists would be consultants or corporate employees who guide organizations in their efforts to make their operations and products or services more environmentally sustainable. This work involves scientific and technical knowledge of air, water, soils, ecosystems, energy systems, and building systems but also involves a host of non-science knowledge and skills.

- Environmental planners—One form of planning is that done for federal land management agencies such as the Bureau of Land Management and National Forest Service and state agencies such as the Colorado Department of Transportation. This type of planning is largely the management of multidisciplinary efforts within the framework of the National Environmental Policy Act. Positions occur both within the agencies themselves and in consulting firms. The other form of planning is urban/community planning, which involves considerations of air quality, water quantity, water quality, solid and hazardous waste, energy, habitat and natural areas, and climate change adaptation—all elements of environmental science. Potential employers include nearly every county and sizable municipality in the nation.

- Energy science specialists—These specialists would be consultants or industry employees who know the science of energy systems, renewables in particular. They

would advise organizations on energy-related decisions and assist in the development and management of new energy installations and operations. Knowledge of energy economics and energy policy would also be involved.

In each case, it is unclear to us how feasible it would be to meld the new dimension with our existing program. We are interested in a new branch within our existing program, not a new major. Each of these specialties involves work outside of the sciences, raising the question of how well they would fit within our science program. An additional faculty member would clearly be necessary, but it is not clear whether the people with the expertise would necessarily have science degrees.

We have also discussed other desirable roles for an additional faculty member within the scope of our current program. As described earlier in this section, we would benefit from having a soils scientist on the faculty. A wetlands specialist may be useful, especially if he or she is well-versed in soils. We also identified an atmospheric scientist or air quality specialist as a possibility. Regardless of which specialty a new faculty member would have, an additional consideration would be the extent to which they can also teach other existing courses within the program; we do not necessarily envision a new faculty member teaching only new courses.

3. Trends

We are experiencing two key trends. One is enrollment growth. As described in Section C.1, the number of Environmental Science majors has doubled since 2008 and enrollment is currently at an all-time high. A second trend pertains to post-graduation employment opportunities. With the current lull in oil and gas activity in Western Colorado, the demand for our graduates at Western Colorado environmental services firms has decreased.

4. Use of program review to improve teaching and learning

Specific actions for improving the ability of our students to meet the desired learning outcomes were identified in Section E.2. The goals of these actions are to improve the ability of our students to plan studies and interpret data while making effective use of information acquired from coursework and the scientific literature.

5. Recommendations for addressing challenges

Our primary recommendation is to request an additional tenure-track position for the Environmental Science program. An additional position will alleviate work load pressures on the existing faculty due to dramatic growth in the number of majors. The person filling this position will diversify our expertise and strengthen our ability to cover important topics. The new person will play a key role in carrying the program into a future of expanded opportunities for our graduates.

In order to position our program for the future, we need to consider very carefully what expertise that person should have. We will resurrect our advisory board with new membership specifically designed to help us evaluate the options that we have identified along with any other suggestions

that board members might have. We also hope that our external reviewer will be able to offer insight based on knowledge of other environmental programs across the country.

Given that we have an increasing number of graduates but fewer local job openings, it is important for us to focus on employment opportunities. Thus, our second recommendation is to identify more opportunities for our graduates. One strategy is to cultivate contacts on the Front Range. Another strategy is to help students tailor their studies so as to meet the qualifications required for various federal government positions. Still another approach is to maintain better contact with program alumni who can alert us to openings. Ultimately, we want to have a network of well-placed graduates who we can use as a resource.

Appendix 1

Recommendations from 2007 Program Review

EXTERNAL REVIEW OF THE ENVIRONMENTAL SCIENCE AND TECHNOLOGY PROGRAM AT MESA STATE COLLEGE

Will Focht, Ph.D.
Director, Environmental Science Graduate Program, Oklahoma State University

Executive Summary

Mesa State College's strategic plan begins with a quote from Leonard Sweet: "The future is not something we enter. The future is something we create." The responsibility for creating a better future for the fourteen-county region that MSC serves is consistent with the Environmental Science and Technology (EST) program's mission of preparing tomorrow's environmental professionals. The field of environmental science is concerned with the interface of human and natural systems. The goal of environmental science is to maintain the health and integrity of this interface so that human quality of life can be sustainably improved. Environmental science, therefore, is essential to creating a better future.

A program review presents an ideal opportunity to examine where the program is heading and whether changes in direction are needed. This review reveals that an impressive collection of interdisciplinary courses comprises the EST curriculum. The EST program's integration of natural sciences focuses on both of the main interactions of human and natural systems: pollution and resource conservation. The applied experiences that all three faculty members bring to their courses enhances their value significantly. The program's three faculty members are competent in interdisciplinary teaching and mentoring and their career experience outside of academia is a powerful asset both in and out of the classroom. All graduates desiring an environmental career have succeeded in gaining employment in the field. This is indeed an enviable record of success. Nevertheless, the program should now consider directing its resources to taking advantage of new opportunities that are likely to arise over the next five years relating to the rapid growth in the region. I suggest that the program seek to enter into multiple partnerships and collaborations outside of MSC to advance sustainable development. Such collaborations could include, but not be limited to, high schools, community colleges, other regional colleges and universities, local businesses, extraction industries, tourism interests, retirement communities, ranching and farming operations, service industries, medical organizations, educational institutions, and government agencies. The EST program should also seek to exert a more demonstrable impact in the region, particularly in sustainable development, pollution prevention and abatement, resource conservation, and ecosystem restoration.

The major problem facing the program concerns not the curriculum (as is the case with most other programs with which I am familiar), but rather student enrollment. Over the last five years, enrollment has fallen 40%. Though the program remains the largest of the four programs administered by the Department of Physical and Environmental Sciences, the enrollment decline is troublesome. This decline is due not to problems of retention, but rather recruitment. This report offers several suggestions for improving recruitment. Among these are redesign of the introductory ENVS course, more aggressive marketing, establishment of new credit and non-credit course initiatives, increased use of distance education, close attention to course scheduling, increased collaboration with program stakeholders and partners, stronger relationships with alumni, and increased fundraising activity.

Interdisciplinary program success cannot be fully captured using only one or two metrics of productivity such as student/faculty and program cost/student ratios. This report suggests other metrics of productivity that should be used to judge the quality of this program. Such metrics include course preparations, fundraising, stakeholder satisfaction, entry of graduates into environmental careers, and others.

Program improvement will require the faculty to dedicate its time to negotiating partnerships, developing marketing materials, developing strategic plans and resource justifications, and pursuing new academic initiatives. It is important that faculty be provided course releases to accomplish these activities over the next year or two. These course releases need not compromise student matriculation or ENVS credit hours if they are appropriately selected.

Introduction

I was retained by Mesa State College (MSC) to conduct a review of the Environmental Science and Technology (EST) program, located within the Department of Physical and Environmental Sciences. This review is based on documents provided before and during my site visit as well as on conversations held during the visit on October 8-9, 2007. I met with administration officials, program faculty, faculty representatives from the College's Curriculum and Assessment Committees, program students and alumni, and staff from Institutional Research, Library, and Information Technology. A detailed itinerary follows.

DATE	TIME	REPRESENTATIVES	TOPICS
Oct 8	8:00 – 8:10 am	Russ Walker, PES Head and EST program director	Travel from hotel to campus
	8:15 – 10:00 am	Russ Walker	Breakfast and overview of program
	10:00 – 10:25 am	Carol Futhey, VPAA	Discussion of review
	10:25 – 10:40 am	Tim Foster, President, and Carol Futhey	Discussion of review
	10:45 – 11:50 am	Sue Yeager, Chair of Curriculum Committee; Bill Tiernan, Faculty Senate	Discussion of curriculum development and review procedures
	12:00 – 1:00 pm	Russ Walker and Deb Kinnard, EST Faculty	Lunch and curriculum discussion
	1:00 – 2:00 pm	Russ Walker and students	Observation of teaching
	2:00 – 2:45 pm	Elizabeth Brodak, Library Director; Jamie Walker, EST Liaison; Jeremy Brown, IT Director	Discussion of library and IT services
	3:00 – 4:30 pm	Russ Walker, Deb Kinnard, and Tamera Kinnick, EST faculty	Discussion of curriculum

	4:30 – 6:00 pm	Alumni	Comments on program
	6:00 – 6:15 pm	Deb Kinnard	Transport to hotel
Oct 9	8:30 am	Deb Kinnard	Pick up from hotel
	8:40 – 9:00 am	Deb Kinnard	Campus tour
	9:00 – 10:00 am	Students	Comments on program
	10:00 – 11:30 am	Russ Walker	Discuss program collaboration opportunities, outreach, marketing, and degree options
	11:30 – 12:00 am	Sonia Brandon, Institutional Research Director; Jessica Herrick, Assessment Coordinator	IR services, assessment metrics, and assessment procedures
	12:00 – 1:30 pm	Russ Walker, Tamera Minnick, and Deb Kinnard	Lunch and discussion of program vision, metrics of success, enrollment, and resources
	1:30 – 2:00 pm	Russ Walker	Discussion of sustainability opportunities in the region and EST role
	2:00 – 2:45 pm	Alone	Prepare for exit interview
	2:45 – 3:15 pm	Julie Fredlund	Discussion about staff support\
	3:15 – 3:40 pm	Alone	Prepare for exit interview
	3:40 – 4:15 pm	Cathy Barkley, Assistant VPAA; Russ Walker	Exit interview
	4:30 – 5:00 pm	Tamera Minnick	Discussion of curriculum and program success metrics
	5:00 pm	Russ Walker	Travel to airport

On Program Mission

The overview of MSC presented on page 7 of the MSC Catalog states:

> *By promoting the acquisition of skills as well as the discovery and application of knowledge, the College develops the intellectual, ethical, and aesthetic sensibilities that enable a student to pursue a rewarding career and assume a responsible and productive role in society. The College seeks to liberate persons from narrow interests and prejudices, to help them observe reality precisely, to judge opinions and events critically, to think logically, and to communicate effectively. The College offers programs of value in areas of civic and cultural life, research, and recreation, and desires to play a constructive role in improving the quality of human life and the environment.*

This laudable and well-articulated vision could be better incorporated into the EST curriculum. Currently, ENVS courses are dominated by natural sciences. I recommend that these courses be modified, where appropriate, to add considerations of policy, economics, quality of life, and

culture to make them more robust and relevant to informed citizenship. I am not suggesting that natural science rigor be lessened; rather I am suggesting that social relevance be added to reinforce the relationships between human and natural systems.

On Curriculum

Interdisciplinarity

Environmental science education is necessarily an interdisciplinary enterprise. Its success lies not in depth in a single discipline but an integration of several disciplines to better understand the functioning of complex systems. Interdisciplinary curricula include courses that are themselves interdisciplinary, i.e., they include content from several disciplines organized so as to reveal systemic relationships organized around a single theme such as watershed management or ecosystem restoration. Many programs struggle to develop truly interdisciplinary courses, opting instead for a multidisciplinary approach that includes several single disciplinary courses. Multidisciplinary curricula fail because students are left to integrate disparate disciplinary knowledge and discover systemic relationships by themselves.
The EST program has achieved a remarkable level of interdisciplinarity in its curriculum. The program faculty is commended for its development of sophisticated and comprehensive interdisciplinary courses that prepare students for competent service as environmental professionals.[1] This achievement is all the more noteworthy in that it was accomplished through the efforts of only three faculty members.

Program Concentrations

The program currently offers three areas of concentration: environmental restoration and waste management (ERWM), environmental science (ES), and environmental education (secondary teaching certificate).

The ERWM concentration focuses on human impacts on the natural environment (e.g., pollution and remediation) and is the oldest of these areas. The ES concentration is newer and focuses on natural resources (e.g., conservation and ecosystem restoration). The number of students enrolled in ERWM has declined in recent years whereas the number enrolled in ES has grown; ES enrollment now exceeds that in ERWM. Interestingly, most ES graduates end up in careers more appropriate to ERWM graduates. Examination of the curricula in these two concentrations does not reveal enough difference to prevent graduates of either to enter into environmental careers in both areas. Therefore, I recommend that these two concentrations be combined into one, whose focus is on the interactions of human and natural systems via both pollution impacts and natural resources.

The environmental education concentration has graduated only one student to date, and two more students will graduate by Spring 2009. The program should revisit the original rationale for the creation of this concentration to decide whether the program should continue. If it should continue, a strategy for improving enrollment should be developed. My personal bias is that this

[1] It is important to note that environmental science and the environmental profession should not be confused with environmentalism and environmental advocacy. Environmental science is a rigorous and scientifically legitimated field of inquiry into the complex relationships between human and natural systems. Environmentalism is an ideology and social movement that seeks social change to reduce human impact on natural systems. Environmental science takes no normative position on change; rather, it seeks to inform deliberations about change.

concentration should continue but it will need more support from education constituencies outside of MSC.

Finally, I recommend that EST establish a new concentration in sustainability. The region served by MSC is undergoing rapid growth, which creates a critical need for sustainable development in order to avoid repeating the mistakes of the past. Moreover, sustainable development is a "hot" area in environmental science now and MSC should take steps not to be left behind. Finally, sustainability, when properly conceived, is the best way to think about integrating economic prosperity, social well being, and environmental health in the common pursuit of continuing improvements in quality of life. As such, sustainability should garner ample support from business, energy industry, agriculture and ranching, mining, tourism, retirement, and government sectors alike.

External Advisory Board

I strongly recommend that the EST program recruit successful environmental professionals to an external advisory board that can provide suggestions to the program about its curriculum, career trends, marketing, recruitment, resource needs, partnerships, and fundraising. It is important that the program maintain a communication channel with the region to assure competence, compatibility between curriculum and professional advancements, and responsiveness to regional needs.

Course Content and Pedagogy

Former and current students are generally satisfied with the technical content and relevancy of the courses offered by the EST program. They believe that the curriculum adequately prepares them for careers in the environmental profession.

I asked students if they thought that the EST curriculum focuses too much on the public sector. The students were surprised by the question and reported that perhaps it focused too little on the public sector. It is important that both private and public sector issues are included in the curriculum and that the mix of public and private sector opportunities is appropriate. I do not recommend any change in this area.

Though students admit that the curriculum is not aimed at graduate school preparation, they state that the faculty is quite willing to work with them individually if they were interested in an advanced degree. I can assure the program that its training in environmental science is quite adequate for admission to graduate school. I would be happy to admit any student who succeeds in the EST program at MSC to my graduate program at Oklahoma State University.
The capstone course is a valuable conclusion to the EST program. Care must be taken however to ensure that the client is clear about its role in the internship and that the student and client reach agreement early on what is expected.

I suggest that the faculty explore adding new courses, or modify existing courses, to deal with NEPA environmental impact assessments and ISO 14001 environmental management systems as these are important career opportunities.

Students are quite satisfied with the quality of teaching in courses at MSC and in the program. They appreciate the real-life experience that the faculty brings to its courses. They are particularly impressed with the willingness of the faculty to allow students to enroll in individualized structured-research classes when normally scheduled classes are canceled or conflict with other important classes occurs. The students did suggest however that the teaching of the Characterization of Contaminated Sites course should be improved.

I congratulate EST faculty members for their commitment to students and their willingness to accommodate students' individual needs. Their practical experience in the field is a welcome addition to the expertise that they bring to instruction and mentorship.

Learning Outcomes Assessment

The EST program administers tests of knowledge of new majors and then retests them near the time of their graduation. Results indicate that new majors achieve an average score of 63%. This suggests that the test is not rigorous enough and deflates its usefulness as an instrument to measure knowledge acquisition. I recommend that the test be made more difficult so that the value of the program can be more accurately and comprehensively measured.

Distance Education

Distance education has been conducted on an older version of WebCT. I understand that IT has recently upgraded to a newer version of WebCT (version CE 6). Distance education is a useful way to recruit students and serve a wider audience. I recommend that the EST program should explore the offering more distance courses.

Encouragement of faculty to offer distance education courses depends in part on the ease of use of the distance education platform. IT should continue to explore adoption of platforms that are flexible and easy to use. Desire-to-Learn is one such candidate.

General Education Requirements

All MSC students must complete 34 hours of general education courses that include 7 hours in the natural sciences. This requirement applies even if the student is majoring in environmental science and the content of these courses are covered in the ENVS courses. The outcome of this situation is that EST students are forced to take single-discipline science courses at the expense of important interdisciplinary science courses, which are the foundation of the EST program. By eliminating the gen-ed natural science courses, EST students could take two more ENVS courses, which would increase the number of student credit hours recorded in these courses. The EST program should also investigate whether one or more of its courses could be designated as a general education requirement for other majors, or at least serve as valuable electives.

Math Requirements

EST students believe that required electives in math and statistics (e.g., STAT 200) should be dropped. ENVS classes (particularly those offered by Dr. Minnick) provide sufficient coverage of these areas. If math and statistics courses are indeed not important prerequisites for ENVS courses, then I agree that they should be dropped as a program requirement. This change would also allow students to take more ENVS courses and thus increase the number of credit hours taken in the program.

Course Consolidation

Current students suggest that ENVS 200 and 221 be consolidated into one course by eliminating some of the fieldwork components. I recommend that the program should consult with alumni and employers about the importance of fieldwork to determine the optimal mix of knowledge acquisition and field application.

Course Scheduling

One student reported that environmental chemistry is not offered frequently enough and that lecture/lab courses sometimes overlap. However, the students also recognize that the EST lacks enough professors to offer more sections at a time or courses more frequently. I recommend that students, alumni, and employers be consulted to determine appropriate course frequency and timing so as to maximize benefit to students.

Course Registration

Current students are rather emphatic that the course schedule severely restricts freshmen interested in an EST degree from registration in required courses. This forces them to "burn up" their elective hours early in their program. This limits the number of electives that they would like to take in their junior and senior years after they have become better informed about the courses they would like to take. I recommend that the EST program (and affiliated programs) make it easier for freshmen to enroll in required courses – either by offering more sections or expanding the number of students who can enroll in a section – so that electives can be preserved for later in students' matriculation through the EST program.

Anticipation and Adaptation

Western Colorado is undergoing rapid change and growth. This presents both a challenge and an opportunity to the EST program. The challenge is to anticipate the direction and magnitude of change and to adapt the program's curriculum to it. Successful adaptation will allow the program to take advantage of new niches in order to grow the program.

In particular, unplanned growth during previous boom and bust cycles creates an opportunity to learn from past mistakes and pursue more rational growth strategies that will yield long-term benefits. I recommend that the EST program (along with other programs at MSC) join with various public and private sector planners, developers, investors, technologists, and other stakeholders in the design and deployment of more sustainable development plans, technologies, and practices.

On Enrollment

MSC is dissatisfied with the size of student enrollment in the EST program. Enrollment figures provided by Institutional Research confirm an enrollment declining from 75 in fall of 2003 to 42 in fall 2007. Nevertheless, enrollment in the EST program over the last decade has been, and continues to be, the largest program in the department (geology = 40, chemistry = 35, physics = 25).

I did not find any obvious retention problem that is unique to EST. Approximately 70% of EST sophomores go on to graduate, which was reported to me as similar to other departmental graduation rates. The faculty is congratulated for its work in moving students to graduation. I

recommend however that students who quit the program be interviewed to identify reasons for leaving. These reasons may point the way to increasing retention.

This leaves recruitment as the primary challenge to increasing enrollment. Suggestions for improving program enrollment follow.

Switch ENVS 110 and ENVS 210

ENVS 110 is the first course required of EST majors and thus is an ideal vehicle to recruit students into the program. Recently however, the number of students recruited has declined to only two out of 30 thirty per semester. Current students and alumni report that some students find the course dull and elementary while others find it too technical. Ideally, this course should excite and inspire students to become EST majors. As it is currently structured, the course instead exposes students to environmental science as a science and introduces them to environmental research methods and scientific reporting. While this is indisputably important to competence as an environmental science professional, it is not necessary in the first course. ENVS 210 is the second course for EST majors. It offers a survey of the environmental science field and exposes the students to career opportunities. This is much closer to what the first course should do.

Therefore, I recommend that these two courses be switched, renumbered, and appropriately modified so that the new ENVS 110 serves as a stimulus for program enrollment. I do not suggest that the course be made less rigorous. On the contrary, it should provide an exciting description of the full breadth of the field, the challenges that are presented in it, and the opportunities for rewarding careers. Qualified alumni and employers could deliver guest lectures. Field trips to work sites should be offered. Each student should prepare a report on an interesting (to the student) subfield of environmental science, which describes the subfield's contribution to the achievement of environmental goals, summarizes the knowledge and skills required for career success, explores possibilities for useful professional experiences, anticipates opportunities for career advancement, and so on. Such a survey course, properly designed and offered, can help students discover how environmental science can serve both the student's individual interests and career aspirations.

Marketing Message

Part of the reason that EST enrollment is not higher is cultural and historical. I was told that enforcement of environmental regulations in the region is less than aggressive. Moreover, the regional political culture tends toward individualism, which is not typically hospitable toward government intervention in the economy. If this is true, then the EST program should adopt a recruitment strategy that embraces sustainable development (the achievement of both economic growth and environmental quality). Initiatives labeled as smart growth, low impact development, design for the environment, industrial ecology, sustainable development, renewable energy, resource conservation, pollution prevention, green manufacturing, green product design, green architecture, and sustainable communities all seek to advance environmentally benign economic development strategies to improve quality of life.

Recruit beyond the Fourteen-County Region

I asked current students why they chose MSC and the EST program. Reasons for choosing MSC included residence nearby, desire to attend a small-town college, and regional quality of life. Reasons for choosing the EST program included desire to work out-of-doors, interest in environmental issues, and availability of a teacher certification in environmental science. The students report that the EST program is not well known outside of the region. These findings suggest that MSC should do more to advertise its programs, including the EST program, outside of the region. MSC and the region have much to offer to students from other parts of the State and environmental issues are growing in importance among students everywhere. Coupling the high quality of life associated with the natural environment in the region to the growing awareness of environmental issues among the public provides a perfect opportunity to recruit students to MSC's EST program.

Intensify Recruitment in High Schools

Current students indicate that high school students are generally ignorant of, or confused about, environmental science. Many believe that environmental scientists are radical environmentalists ("tree huggers"); this belief discourages consideration of environmental science as a major and career. Alternatively, other students assume that environmental science is not a rigorous scientific field and thus seek other scientific degrees. Such popular misconceptions must be overcome early in order to attract EST majors. EST alumni agree that marketing of the program to high schools has been unimpressive. I therefore recommend that MSC immediately embark on an aggressive marketing campaign in high schools to educate students about what environmental science is and the careers available in it, with the specific goal of dispelling misconceptions.

Pursue Other Marketing Opportunities

MSC should work with EST to develop public marketing campaigns that could attract students to the EST program along with other programs.

The EST program should also consider establishing an alumni association. Such an association can provide at least three benefits. First, alumni can help recruit new students to the program. Second, alumni can employ and sponsor internships for current students. Third, alumni can support the program through financial gifts and in-kind donations of services and equipment. In addition, the EST program should encourage the establishment of an environmental science student organization. This builds a sense of community among students, encourages a sense of loyalty to the program and to each other, empowers students to participate in program activities, and fosters their active involvement in an alumni association after graduation. The organization can also help with student recruitment through its activities both on and off campus.

Finally, the EST program used to participate in an environmental design competition that stimulate student interest and inspired their creativity. Several years ago, however, their participation was halted due to lack of student interest. I recommend that the program consider restarting participation in this or other contests to stimulate student involvement, build awareness of the program, and improve program reputation.

Develop Certificate and Continuing Education Programs

Professional certificates and seminars are two other ways to grow the EST program by providing opportunities for working environmental professionals to update their knowledge and skills. Certificate programs will increase enrollment in those courses included in the program. Continuing education short courses and seminars can attract students to the degree and certificate programs. Both initiatives will increase the visibility of the program and address a niche that is not being served now in the region.

Market the EST Minor

The EST program should consider recruiting more students to enroll in a minor in environmental science that could attract students from other majors. The program should work with other departments to determine their interest in collaborating in such a minor. The program should also develop posters, brochures, and other materials that can attract interest in its minor.

Restore the Associate Degree

The EST program should consider restoration of an associate (AAS) degree in environmental science. This vehicle would attract more students and serve as a recruitment tool for the four-year degree program. The associate degree would also provide a gateway for students who need more preparation for baccalaureate programs to increase their skills and knowledge. The program should work with the Bureau of Land Management, US Fish and Wildlife Service, Bureau of Reclamation, US Geological Survey, Colorado Division of Wildlife, and regional businesses to define the associate degree program and recruit students to it.

Consider Establishment of a BA Degree

The EST program should consider offering a BA degree in environmental science. As stated above, the environmental field is concerned with the interaction of human and natural systems. Some environmental science programs tend to look at these interactions from a natural science perspective. Other programs look at the interactions more from a social science perspective. In either case, science is at the core of their investigations.

The BA program I recommend would emphasize economics, planning, law, policy analysis, risk perception, communication, conflict management, community relations, governance, stakeholder participation, quality of life assessment, natural capital valuation, decision sciences, and other elements of social systems as they relate to the environment.

The BS degree would retain its focus on the natural sciences such as earth sciences, life sciences, geography, pollution control and prevention, ecosystem restoration, ecosystem modeling, risk assessment, risk management, climate change, and conservation technologies.

Both degree programs would study the human-nature interface and thus would include applied science courses in natural ecology, human ecology, pollution ecology, conservation science, and engineering science.

I should add a caveat here. BA degrees sometimes carry a stigma as being less rigorous than BS degrees and therefore create a disincentive to both prospective majors and potential employers. If the EST creates a BA degree program, it should work with potential employers to design marketing strategies that communicate the value of the social sciences in dealing with the

complex environmental challenges that face us. It is important to emphasize that technology alone will not solve environmental problems; behavioral change is also essential. Therefore, the behavioral sciences have an essential role to play in fashioning and successfully implementing solutions to problems of pollution and resource depletion.

On Metrics of Program Success

MSC generates metrics to measure program success such as student/faculty and program cost/student ratios. However, success can be defined in many ways. It is important to create metrics that tap into these alternative definitions of success. The Institutional Research Director stated that new metrics can be generated at the request of departments and that databases can be modified or created to store data that can be used in calculating these new metrics.

I recommend that the EST program enter into discussions with MSC administration, faculty, students, alumni, employers, donors, advisors, and members of the general public about definitions of success and then develop appropriate metrics. For example, internal metrics aimed at assessing the donations that have been given to the program, faculty service to the field (e.g., guest lectures, professional service, community service), outreach to the region (e.g., community-based learning, service-learning, internships, field projects), alumni satisfaction, client satisfaction, number of field and lab projects designed in courses, number of course preparations, number of independent study courses offered, number of new course preparations, student evaluations of courses, and number of career placement activities are some of the metrics that can be added to the existing metrics to demonstrate program productivity. External metrics that demonstrate impact in the region are also important. Such metrics could include percentage of graduates finding employment in the environmental profession, business start-ups by graduates, number of persons taking professional development seminars and short courses, employer satisfaction, estimates of environmental risk reduced through EST projects, number and scale of sustainable development projects in which EST was involved, and so on.

On Resources

Resources and productivity are, of course, recursively linked. Without resources, productivity is stifled. Without productivity, resources are wasted. More resources should stimulate productivity, which will stimulate the production of more resources. The key to program success is to allocate resources efficiently so that they are not wasted and productivity is maximized. A program must make a successful case for resource additions based on the likelihood of achieving compensating benefits. What constitutes a benefit and how benefits should be measured must be determined *a priori.*

I recommend that the EST program think of resources as investments in productivity rather than entitlements. I also recommend, however, that EST be forthright in developing rationales for the allocation of resources. This will involve development of rational plans that justify investments with a high probability of productivity gains. Here are my suggestions for resource allocations.

EST Program Administration, Staff and Faculty Workload

The head of the Department of Physical and Environmental Sciences, which houses the EST program as well as programs in geology, chemistry, and physics, will teach 12 semester hours each semester this academic year. I recommend that the department head teach at least one less course each semester to engage in strategic planning for improvement of the program.

Otherwise, it is difficult to see how he could devote sufficient time to implement the suggestions offered in this review. I would also recommend that the program coordinator also be granted a course release each semester for the next year or two to dedicate time to program improvement. The department employs one administrative staff member who dedicates about 15% of her time to the EST program. She spends most of her time providing room access to students (using key cards) and advising students on courses. I believe that she is under-utilized by the program. I recommend that the department head, program coordinator, and third faculty member delegate more work to her. For example, she could assist in student recruitment (e.g., help prepare and distribute video and brochure marketing materials) and process student admissions. A student work-study could be hired to help her if the work rises to justify it. Work-study students could also be used to help more with grading and lab preparation. Increased delegation by faculty would free up time for other activities aimed at program improvement.

The average teaching load is 12 hours per semester, which amounts to four preparations per semester since multiple sections of ENVS courses are not offered. This does not count student advisement, independent study courses, and professional service. Such a workload does not leave much time for new initiatives. I recommend that release time or overload compensation be provided to faculty members who submit high quality proposals to grow and improve the program. Careful course scheduling and/or judicious use of adjunct instructors would of course be required.
I believe that it is important to recognize that the development of an interdisciplinary curriculum is much more challenging than a unidisciplinary curriculum that relies on existing texts, teaching techniques, and application activities. In many cases, high quality teaching materials do not already exist, which requires the faculty member to develop these *de novo*.

Library and IT Support

The library serves departments through library liaisons that work with departments to order materials and provide support. The library also allocates funds to each department for purchases. Journal subscriptions are funded from college resources. Interlibrary loans are free to faculty. The library subscribes to 70 databases, many of which contain full text articles, which are searchable through an online reference service. Library research is facilitated through "Jump Start" on the library's home page.

At-risk students are referred to an advising center through the "early alert" system.
IT reports that it replaces all personal computers no less frequently than six years, using standard configurations. Software upgrades are free. A new web portal is under construction to standardize the look and feel of MSC websites.

It appears to me that the library and IT departments offer high quality support to the EST program. However, I understand that the library does not subscribe to some of the journals that are important to the faculty. While I was not provided a complete list of these (*Ecological Applications* and *Journal of Range Management* are two that should be added), I recommend that the program work with the library to carry or provide electronic access to those that are needed.

Use of a Van for Transport of Students to Field Sites

The EST program needs access to another van to transport students to field sites. EST offers ten

field courses – seven of which are offered in the fall semester. I was informed that it is not uncommon that a van is not available for some of these trips. Ideally, the program would own its own van; alternatively, it would share a van with one or more departments that also operate field courses. The program could assist in the effort to obtain a dedicated van by soliciting donation of a van or money dedicated to a van purchase.

Fundraising

The EST could do more to raise external funds for its operation and growth. Three opportunities should be investigated and pursued. First, the program should recruit an external advisory board. Such a board, properly constituted with successful alumni and other benefactors who want the EST program to succeed, can both provide valuable advice for the direction of the program but also help solicit funds for program activities. Second, the program should establish an alumni association, which can also provide financial and other support. Third, the program should seek to enter into partnerships with more employers, internship sponsors, and environmental service providers to mutual advantage.

Faculty Hire

I recommend that the program develop a convincing case for the employment of one additional faculty member to teach courses that focus on human systems related to the environment. I recognize that it is important to tie faculty positions to student enrollment. This presents a chicken-and-egg problem however: more faculty could teach more courses which could draw more students – but more students are needed to justify more faculty. I suggest that the problem should be addressed from both ends simultaneously. In other words, the program should develop a convincing justification for a new faculty member (e.g., new courses to be offered, improved curriculum quality, new research interests, new collaborative opportunities) along with a rational plan for improving student enrollment (e.g., new degrees, professional certificates, professional development seminars, improved marketing, improved alumni and employer relations, new collaborative partnerships, creation of an external advisory board, and so on). In particular, I recommend that the program seek to decrease its reliance on other departments to provide foundation courses based on single disciplines and instead develop its own interdisciplinary courses that integrate several disciplines. This would increase the number of student hours in ENVS courses.

Future Faculty Hiring Priorities

I have already stated that the EST program should be commended for their development and implementation of an interdisciplinary curriculum. However, an even better curriculum could be developed if the faculty were more interdisciplinarily trained. I therefore recommend that future faculty hires be restricted to interdisciplinarily-trained candidates. This makes development of interdisciplinary courses much easier and provides improved mentorship of interdisciplinary students.

Internal Partnerships

I recommend that the EST program do more to explore partnership opportunities with the Petroleum and Energy Land Management and Construction Management concentrations in the bachelor of business administration program, and the Natural Resources Institute in the Social and Behavioral Sciences Department – especially as these relate to sustainability.

External Partnerships

I recommend that the EST program take the lead in encouraging MSC to form an inter-departmental Task Force on Sustainability. Since the region is undergoing rapid growth, the time is ripe for a focus on sustainable development. The Task Force should involve faculty from business administration, natural resources institute, energy land management, policy programs, and other programs to coordinate sustainability research, education, and outreach. It should seek to enter into partnerships with outside organizations (businesses, landowners, government agencies, investors, etc.) to investigate development strategies that foster both economic return and environmental quality. To kick things off, the Task Force could help sponsor a regional sustainable development conference to define an agenda for advancing sustainability and to recruit participants to that effort.

Conclusion

The EST program is healthy and well designed but it needs to do more to grow enrollment and obtain resources. Continuing declines in enrollment will threaten its existence. Fortunately, the convergence of ascendant awareness of environmental issues among the public, rapid population and economic growth in the region, and dedicated program faculty and staff provide an opportunity to strengthen the program. The faculty should dedicate some of its time to planning, forging productive partnerships, and aggressive marketing to a wider audience. With the cooperation of other units at MSC and partners outside of the College, I believe that the EST program will continue to prosper.

I want to thank Mesa State College, and in particular Assistant Vice President Cathy Barkley, for extending this opportunity to review the Environmental Science and Technology program. I also want to thank the program's faculty and students, and other members of the MSC community, for their cooperation. The program coordinator, Russ Walker, was gracious, accommodating, patient, and responsive to my inquiries, which I sincerely appreciate. I always learn much from these program reviews and the present case is no exception. If I can assist further, please do not hesitate to ask. I look forward to hearing about how the program fares as it moves forward.

Will Focht
November 18, 2007

Appendix 2

Program Sheets

COLORADO MESA UNIVERSITY

2015-2016 PETITION/PROGRAM SHEET
Degree: Bachelor of Science
Major: Environmental Science and Technology

About This Major . . .

We educate students in the science, protection, and restoration of our natural resources—air, water, land, and ecosystems. Our students develop a solid foundation in biology, chemistry, mathematics, statistics, and communication skills, then apply this knowledge to the study and solution of environmental problems. We balance theory with hands-on practice, and include considerable work outdoors in our spectacular local environment. Individual and group projects are a key part of our courses. Our students have opportunities to take part in work done through partnerships with organizations such as the Colorado National Monument and the Bureau of Land Management. Students must choose either the Pollution Monitoring & Control option, which focuses on pollution prevention as well as investigation and cleanup, or the Ecosystem Restoration option, which focuses on strategies for managing natural resources.

The majority of our graduates take positions as environmental professionals with consulting firms, industry, and government agencies (e.g., U.S. Bureau of Land Management, U.S. Geological Survey, and U.S. Army Corps of Engineers). Some continue their studies in graduate school (e.g., Colorado School of Mines, Colorado State University, University of Denver).

For more information on what you can do with this major, go to http://www.coloradomesa.edu/career/whatmajor.html.

All CMU baccalaureate graduates are expected to demonstrate proficiency in critical thinking, communication fluency, quantitative fluency, and specialized knowledge/applied learning. In addition to these campus-wide student learning outcomes, graduates of this major will be able to:

1. Demonstrate an understanding of terminology, concepts, theories, and practices in environmental science. (Specialized Knowledge)
2. Demonstrate the ability to design an environmental study. (Applied Learning)
3. Demonstrate the ability to analyze quantitative environmental data, effectively translate data into graphs or tables, and interpret results. (Quantitative Fluency)
4. Demonstrate the ability to use appropriate tools, technology, and methods for measuring and analyzing environmental data. (Applied Learning)
5. Identify and evaluate assumptions, hypotheses, and alternative views on environmental problems, then articulate implications and form conclusions. (Critical Thinking)
6. Construct an organized argument (ral and written) supported by current research on a technical issue in environmental science appropriate for a specialized audience. (Communication Fluency)

NAME:_____ **STUDENT ID #:** _____

LOCAL ADDRESS AND PHONE NUMBER: _____

_____ ( ) _____

I, (Signature)_____, hereby certify that I have completed (or will complete) all the courses listed on the Program Sheet. I have read and understand the policies listed on the last page of this program sheet. I further certify that the grade listed for those courses is the final course grade received except for the courses in which I am currently enrolled and the courses which I complete next semester. I have indicated the semester in which I will complete these courses.

_____ _____ 20_____
Signature of Advisor Date

_____ _____ 20_____
Signature of Department Head Date

_____ _____ 20_____
Signature of Registrar Date

DEGREE REQUIREMENTS:

- 120 semester hours total (A minimum of 28 taken at CMU in no fewer than two semesters).
- 40 upper division credits (A minimum of 15 taken at the 300-400 course levels within the major at CMU).
- Pre-collegiate courses (usually numbered below 100) cannot be used for graduation.
- 2.00 cumulative GPA or higher in all CMU coursework.
- A "C" or higher is required in all courses listed as major requirements.
- A student must follow the CMU graduation requirements either from 1) the program sheet for the major in effect at the time the student officially declares a major; or 2) a program sheet for the major approved for a year subsequent to the year during which the student officially declares the major and is approved for the student by the department head. Because a program may have requirements specific to the degree, the student should check with the faculty advisor for additional criteria. It is the student's responsibility to be aware of, and follow, all requirements for the degree being pursued. Any exceptions or substitutions must be approved by the student's faculty advisor and Department Head.
- When filling out the program sheet a course can be used only once.
- See the "Undergraduate Graduation Requirements" in the catalog for additional graduation information.
- Essential Learning Capstone should be completed between 45 and 75 hours.
- See the "Undergraduate Graduation Requirements" in the catalog for additional graduation information.

ESSENTIAL LEARNING REQUIREMENTS (31 semester hours)
See the current catalog for a list of courses that fulfill the requirements below. If a course is an Essential Learning option and a requirement for your major, you must use it to fulfill the major requirement and make a different selection for the Essential Learning requirement.

Course No	Title	Sem.hrs	Grade	Term/Trns

English (6 semester hours, must receive a grade of "C" or better and must be completed by the time the student has 60 semester hours.)

ENGL 111	English Composition	3		
ENGL 112	English Composition	3		

Math MATH 113 **or higher** (3 semester hours, must receive a grade of "C" or better, must be completed by the time the student has 60 semester hours.)

MATH 113	College Algebra	4*		

*3 credits apply to the Essential Learning requirements and 1 credit applies to elective credit

Humanities (3 semester hours)

Social and Behavioral Sciences (6 semester hours)

Natural Sciences (7 semester hours, one course must include a lab)

L

History (3 semester hours)
HIST

Fine Arts (3 semester hours)

WELLNESS REQUIREMENT (2 semester hours)

KINE 100	Health and Wellness	1		
KINA 1		1		

ESSENTIAL LEARNING CAPSTONE (4 semester hours)

ESSL 290	Maverick Milestone (see English & math pre-reqs)	3		
ESSL 200	Essential Speech (co-requisite)	1		

FOUNDATION COURSES (9-10 semester hours) A "C" or higher is required in all Foundation Courses.
Must choose either CHEM 121/121L **and** CHEM 123 **or** CHEM 131/131L **and** CHEM 132/132L. Students who plan to attend graduate school should take CHEM 131/131L and CHEM 132/132L.

CHEM 121	Principles of Chemistry	4		
CHEM 121L	Principles of Chemistry Lab	1		
CHEM 123	Introduction to Environmental Chemistry	4		
OR				
CHEM 131	General Chemistry	4		
CHEM 131L	General Chemistry Lab	1		
CHEM 132	General Chemistry	4		
CHEM 132L	General Chemistry Lab	1		

ENVIRONMENTAL SCIENCE AND TECHNOLOGY–MAJOR REQUIREMENTS (57 semester hours) A "C" or higher is required in all courses listed as major requirements.

Core Environmental Science Courses (28-29 semester hours) All students complete the following courses:
ENVS 104 Environmental Science: Global Sustainability (3) **OR** ENVS 101 Introduction to Environmental Science (3) **AND** ENVS 105 Readings in Environmental Science (1):
ENVS
ENVS

ENVS 204	Introduction to Ecosystem Management	3		
ENVS 204L	Introduction to Ecosystem Management Lab	1		
ENVS 221	Science & Technology of Pollution Control	3		
ENVS 221L	Science & Technology of Pollution Control Lab	1		
ENVS 331	Water Quality	3		
ENVS 331L	Water Quality Lab	1		
ENVS 340	Applied Atmospheric Science	3		
ENVS 492	Capstone in Environmental Science & Technology	2		
STAT 200	Probability & Statistics	3		

Must choose either MATH 146 **or** MATH 151:

MATH 146	Calculus for the Biological Sciences	5		
OR				
MATH 151	Calculus I	5		

Environmental Science Options (14-15 semester hours) Students complete either the Pollution Monitoring & Control Option or the Ecosystem Restoration Option.

Course	No	Title	Sem.hrs	Grade	Term/Trns

Pollution Monitoring & Control Option (14 semester hours)

ENVS 212	Environmental Health & Safety	2		
ENVS 212L	Environmental Health & Safety Lab	1		
ENVS 410	Environmental Regulatory Compliance	3		
ENVS 420	Pollution Investigation & Monitoring	3		
ENVS 420L	Pollution Investigation & Monitoring Lab	1		
GEOL 111	Physical Geology	3		
GEOL 111L	Physical Geology Lab	1		

Ecosystem Restoration Option (15 semester hours)

ENVS 312	Soils & Sustainability	3		
ENVS 312L	Soils & Sustainability Lab	1		
ENVS 455	Restoration Ecology	3		
ENVS 455L	Restoration Ecology Lab	1		
POLS 488	Environmental Politics	3		
BIOL 107	Principles of Plant Biology	3		
BIOL 107L	Principles of Plant Biology Lab	1		

Restricted Electives (13-15 semester hours)
Students select additional ENVS courses to bring total credit hours for this section to 57: ENVS 212/212L, ENVS 301, ENVS 312/312L, ENVS 315, ENVS 321, ENVS 332/332L, ENVS 337, ENVS 350/350L, ENVS 354, ENVS 360/360L, ENVS 370, ENVS 374, ENVS 394, ENVS 396, ENVS 413, ENVS 420/420L, ENVS 431, ENVS 433, ENVS 455/455L, ENVS 460/460L, ENVS 475, ENVS 496, ENVS 497

Course	No	Title	Sem.hrs	Grade	Term/Trns

ELECTIVES (All college level courses appearing on your final transcript, **not listed above** that will bring your total semester hours to 120 hours. Includes upper division courses required to bring total upper division credit hours to 40. 16-17 semester hours.)

*MATH 113	College Algebra	1			

Restricted Electives – 13-15 semester hours chosen from

ENVS 212 Environmental Health & Safety
ENVS 212L Environmental Health & Safety Lab
ENVS 301 Environmental Project Management
ENVS 312 Soil Science & Sustainability
ENVS 312L Soil Science & Sustainability Lab
ENVS 315 Mined Land Rehabilitation
ENVS 321 Environmental Risk Analysis
ENVS 332 Introduction to GIS
ENVS 332L Introduction to GIS Lab
ENVS 337 Stream Biomonitoring
ENVS 350 Ecol/Mgmt. Shrublands/Grasslands
ENVS 350L Ecol/Mgmt. Shrublands/Grasslands Lab
ENVS 354 Forest Ecology and Management
ENVS 360 Fire Ecology
ENVS 360L Fire Ecology Lab
ENVS 370 Renewable Energy
ENVS 374 Sustainable Building
ENVS 394 Natural Resources of the West
ENVS 396 Topics
ENVS 413 Env. Fate & Transport of Contaminants
ENVS 420 Pollution Investigation & Monitoring
ENVS 420L Pollution Investigation & Monitoring Lab
ENVS 431 Water & Wastewater Treatment
ENVS 433 Restoration of Aquatic Systems
ENVS 455 Restoration Ecology
ENVS 455L Restoration Ecology Lab
ENVS 460 Fire Management
ENVS 460L Fire Management Lab
ENVS 475 Experimental Design & Statistical Analysis in Environmental Science
ENVS 496 Topics
ENVS 497 Structured Research

SUGGESTED COURSE SEQUENCING FOR A MAJOR IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY

Pollution Monitoring & Control Option (PMC) or Ecosystem Restoration Option (ER)

This is a recommended sequence of course work. Certain courses may have prerequisites or are only offered during the Fall or Spring semesters. It is the student's responsibility to meet with the assigned advisor and check the 2 year course matrix on the Colorado Mesa website for course availability.

FRESHMAN YEAR

Fall Semester		Hours	Spring Semester		Hours
ENVS 104	Env Science: Global Sustainability	3	GEOL 111/111L	Princ of Physical Geology with Lab (**PMC**)	4
ENGL 111	English Composition	3	OR		
MATH 113	College Algebra	4	BIOL 107/107L	Principles of Plant Biology with Lab (**ER**)	4
KINE 100	Health and Wellness	1	ENGL 112	English Composition	3
ESSL	Natural Science with Lab	4	STAT 200	Probability and Statistics	3
		15	ESSL	Social/Behavioral Science	3
			ESSL	Natural Science	3
					16

SOPHOMORE YEAR

Fall Semester		Hours	Spring Semester		Hours
ENVS 204/204L	Intro to Ecosystem Management with Lab	4	ENVS 221/221L	Sci & Tech of Pollution Control with Lab	4
CHEM 121/121L	Principles of Chemistry with Lab	5	CHEM 123	Introduction to Environmental Chemistry	4
OR			OR		
CHEM 131/131L	General Chemistry with Lab	5	CHEM 132/132L	General Chemistry with Lab	5
ESSL	History	3	MATH 146	Calculus for Biology	5
Restricted Elective		1	OR		
KINA	Activity	1	MATH 151	Calculus I	5
		14	ESSL	Social/Behavioral Science	3
					16-17

JUNIOR YEAR

Fall Semester		Hours	Spring Semester		Hours
Restricted Electives (**PMC**)		3	ENVS 212/212L	Env Health & Safety (**PMC**)	3
OR			OR		
ENVS 312/312L	Soils & Sustainability with Lab (**ER**)	4	Restricted Electives (**ER**)		2
ENVS 331/331L	Water Quality with Lab	4	ENVS 340	Applied Atmospheric Science	3
ESSL	Humanities	3	ENVS 410	Env Regulatory Compliance (**PMC**)	3
ESSL 200	Essential Speech	1	OR		
ESSL 290	Maverick Milestone	3	POLS 488	Environmental Politics (**ER**)	3
		14-15	Restricted Electives		3
			ESSL	Fine Arts	3
					14-15

SENIOR YEAR

Fall Semester	Hours	Spring Semester		Hours
Restricted Electives	7	ENVS 492	Capstone in ENVS	2
Unrestricted Electives	7-8	ENVS 420/420L	Poll. Inv. & Monitoring w/ Lab (**PMC**)	4
	14-15	OR		
		ENVS 455/455L	Restoration Ecology with Lab (**ER**)	4
		Unrestricted Electives		9
				15

POLICIES:

1. Please see the catalog for a complete list of graduation requirements.
2. This program sheet must be submitted with your graduation planning sheet to your advisor during the **semester prior to the semester of graduation, no later than October 1 for spring graduates, no later than March 1 for fall graduates.** You must turn in your "Intent to Graduate" form to the Registrar's Office **by September 15 if you plan to graduate the following May, and by February 15 if you plan to graduate the following December**.
3. Your advisor will sign and forward the Program Sheet and Graduation Planning Sheet to the Department Head for signature. Finally, the Department Head will submit the signed forms to the Registrar's Office. (Students cannot handle the forms once the advisor signs.)
4. If your petition for graduation is denied, it will be your responsibility to reapply for graduation in a subsequent semester. Your "Intent to Graduate" does not automatically move to a later graduation date.
5. NOTE: During your senior year, you will be required to take a capstone exit assessment/project (e.g,, Major Field Achievement Test)

2015-2016 PETITION/PROGRAM SHEET
Minor: Environmental Science and Technology

COLORADO MESA UNIVERSITY

About This Minor . . .

We educate students in the science, protection, and restoration of our natural resources—air, water, land, and ecosystems. Our students develop a solid foundation in biology, chemistry, geology, mathematics, statistics, and communication skills, then apply this knowledge to the study and solution of environmental problems. We balance theory with hands-on practice, and include considerable work outdoors in our spectacular local environment. Individual and group projects are a key part of our courses. Our students have opportunities to take part in work done through partnerships with organizations such as the Colorado National Monument and the Bureau of Land Management.

The Environmental Science minor is an invaluable asset to students who are majoring in biology, chemistry, or geology and planning to work in an environmental profession.

POLICIES:

1. Please see the catalog for a complete list of graduation requirements.
2. This program sheet must be submitted with your graduation planning sheet to your advisor during the **semester prior to the semester of graduation, no later than October 1 for spring graduates, no later than March 1 for fall graduates.** You must turn in your "Intent to Graduate" form to the Registrar's Office **by September 15 if you plan to graduate the following May, and by February 15 if you plan to graduate the following December.**
3. Your advisor will sign and forward the Program Sheet and Graduation Planning Sheet to the Department Head for signature. Finally, the Department Head will submit the signed forms to the Registrar's Office. (Students cannot handle the forms once the advisor signs.)
4. If your petition for graduation is denied, it will be your responsibility to reapply for graduation in a subsequent semester. Your "Intent to Graduate" does not automatically move to a later graduation date.
5. NOTE: During your senior year, you will be required to take a capstone exit assessment/project (e.g,, Major Field Achievement Test)

NAME:_____ **STUDENT ID #** _____

LOCAL ADDRESS AND PHONE NUMBER: _____

_____ ( ) _____

I, (Signature)_____, hereby certify that I have completed (or will complete) all the courses listed on the Program Sheet. I further certify that the grade listed for those courses is the final course grade received except for the courses in which I am currently enrolled and the courses which I complete next semester. I have indicated the semester in which I will complete these courses.

_____ _____ 20_____
Signature of Environmental Science and Technology Advisor — Date

_____ _____ 20_____
Signature of Department Head — Date

_____ _____ 20_____
Signature of Registrar — Date

Students should work closely with a faculty advisor when selecting and scheduling courses prior to registration. See the "Undergraduate Graduation Requirements" in the catalog for additional graduation information.

Minor Requirements:

- At least 33 percent of the credit hours required for the minor must be in courses numbered 300 or above.
- 2.00 cumulative GPA or higher in the minor is required
- The number of minors a student may receive at Colorado Mesa University shall not exceed two.
- A student must follow the CMU graduation requirements either from 1) the program sheet for the major in effect at the time the student officially declares a major; or 2) a program sheet for the major approved for a year subsequent to the year during which the student officially declares the major and is approved for the student by the department head. Because a program may have requirements specific to the degree, the student should check with the faculty advisor for additional criteria. It is the student's responsibility to be aware of, and follow, all requirements for the degree being pursued. Any exceptions or substitutions must be approved by the student's faculty advisor and Department Head.

REQUIRED COURSES (15 Semester Hours)

See the current catalog for a list of courses that fulfill the requirements below. (Either ENVS 104 or ENVS 101/ENVS 105 may be taken for credit, but not both.)

Course No	Title	Sem.hrs	Grade	Term
ENVS 104	Environmental Science: Global Sustainability	3	____	_____
OR				
ENVS 101	Introduction to Environmental Science	3	____	_____
AND				
ENVS 105	Critical Readings in Environmental Science	1	____	_____

Select courses from Environmental Science and Technology to bring total semester hours to 15. At least 5 of the semester hours required for this minor must be upper division.

Course No	Title	Sem.hrs	Grade	Term
ENVS ____	_____	____	____	_____
ENVS ____	_____	____	____	_____
ENVS ____	_____	____	____	_____
ENVS ____	_____	____	____	_____
ENVS ____	_____	____	____	_____
ENVS ____	_____	____	____	_____
ENVS ____	_____			
		____	____	_____

2015-2016 PETITION/PROGRAM SHEET
Award: Technical Certificate
Program of Study: Sustainability Practices

About This Certificate . . .

"Sustainability" is a way of living that meets the needs of the present without compromising the ability of future generations to meet their own needs. In order to achieve sustainability, we must examine our approach to energy, food, shelter, transportation, and other aspects of everyday life. Can we continue our current approach indefinitely? What changes need to occur to make our approach sustainable? What can we do to make those changes?

Through the Certificate in Sustainability Practices, students learn the principles of sustainability along with specific ways to implement them. Anyone seeking to understand and practice this approach will benefit from completion of the program. For some, the program can serve as a first step toward a more in-depth knowledge that may lead to a career. This certificate could help professionals distinguish their business practices, community leaders better understand future trends in community planning, and any student, educator or citizen wanting to make a positive difference in the environment.

For more information on what you can do with this major, go to http://www.coloradomesa.edu/career/whatmajor.html.

NAME:_____ **STUDENT ID #** _____

LOCAL ADDRESS AND PHONE NUMBER: _____

_____ ( ) _____

I, (Signature)_____, hereby certify that I have completed (or will complete) all the courses listed on the Program Sheet. I have read and understand the policies listed on the last page of this program sheet. I further certify that the grade listed for those courses is the final course grade received except for the courses in which I am currently enrolled and the courses which I complete next semester. I have indicated the semester in which I will complete these courses.

_____ _____ 20_____
Signature of Advisor Date

_____ _____ 20_____
Signature of the Department Head Date

_____ _____ 20_____
Signature of Registrar Date

Students should work closely with a faculty advisor when selecting and scheduling courses prior to registration.

Degree Requirements:

- 2.00 cumulative GPA or higher in all CMU coursework and a "C" or better must be achieved in achieved in coursework toward major content area.
- Pre-collegiate courses (usually numbered below 100) cannot be used for graduation.
- Program sheets are for advising purposes only. Because a program may have requirements specific to the degree, check with your advisor for additional guidelines, including prerequisites, grade point averages, grades, exit examinations, and other expectations. It is the student's responsibility to be aware of, and follow, all guidelines for the degree being pursued. Any exceptions or substitutions must be approved by the faculty advisor and/or Department Head. Courses related to teacher licensure must also be approved by the Teacher Education Dept.
- When filling out the program sheet, a course can be used only once.
- See the "Undergraduate Graduation Requirements" in the catalog for additional graduation information.

CERTIFICATE: Sustainability Practices (9 semester hours)

Core Classes: (3 semester hours) Either ENVS 104 or ENVS 101 may be taken for credit, but not both.

Course No	Title	Sem.hrs	Grade	Term
ENVS 104	Environmental Science: Global Sustainability	3	____	_____
OR				
ENVS 101	Introduction to Environmental Science	3	____	_____

Restricted Electives: (6 semester hours) Select 6 hours of electives approved by department head.

Course No	Title	Sem.hrs	Grade	Term
ENVS 278	Permaculture Design	2	____	_____
AND				
ENVS 278L	Permaculture Design Lab	2	____	_____
ENVS 370	Renewable Energy	3	____	_____
OR				
GEOL 370	Renewable Energy	3	____	_____
ENVS 374	Sustainable Building	3	____	_____
ENVS ____	_____			
ENVS ____	_____		____	
ENVS ____	_____		____	
			____	

POLICIES:

1. Please see the catalog for a complete list of graduation requirements.
2. This program sheet must be submitted with your graduation planning sheet to your advisor during the **semester prior to the semester of graduation, no later than October 1 for spring graduates, no later than March 1 for fall graduates.** You must turn in your "Intent to Graduate" form to the Registrar's Office **by September 15 if you plan to graduate the following May, and by February 15 if you plan to graduate the following December**.
3. Your advisor will sign and forward the Program Sheet and Graduation Planning Sheet to the Department Head for signature. Finally, the Department Head will submit the signed forms to the Registrar's Office. (Students cannot handle the forms once the advisor signs.)
4. If your petition for graduation is denied, it will be your responsibility to reapply for graduation in a subsequent semester. Your "Intent to Graduate" does not automatically move to a later graduation date.
5. NOTE: During your final year, you will be required to take a capstone exit assessment/project (e.g,, Major Field Achievement Test).

Appendix 3

Faculty Curriculum Vitae

Name:
Deborah K Kenanrd

Start Year: 2005

Program:
Environmental Science and Technology

Department:
Physical and Environmental Sciences

Faculty Rank:
Professor

COLORADO MESA UNIVERSITY

Full-time FacultyVita

Highest Degree
Ph.D. University of Florida, Botany 2000

Education: (List all degrees beginning with most recent-include post docs and external certificates)
Ph.D., Botany, University of Florida, Gainesville, FL, 2000
M.S., Botany, University of Florida, Gainesville, FL 1996
B.A., Biology, Trinity University, San Antonio, TX, 1991

Teaching 2003-Present:

Courses Taught

ENVS101: Introduction to Environmental Science (traditional and on-line version)
ENVS104: Global Sustainability
ENVS105: Readings in Environmental Science
ENVS110: Environmental Science and Technology I
ENVS200: Field Methods in Environmental Science
ENVS204: Introduction to Ecosystem Management
ENVS204L: Introduction to Ecosystem Management Lab
ENVS354: Forest Ecology and Management
ENVS360: Fire Ecology
ENVS360L: Fire Ecology Lab
ENVS396: On-line Fire Ecology
ENVS396: On-line Forest Ecology
ENVS396: On-line Issues in Fire Management
ENVS396: Topics: Local Flora
ENVS460: Fire Management
ENVS460L: Fire Management Lab
ENVS492: Capstone
ISEV596: Topics: Environ. Science for Middle School Teachers
ISEV580: Topics: Student Centered Science

Evidence of Continuous Improvement

2015 Work Life Balance workshop – Leslie Myers
2014 Teacher 2 Teacher workshops (Spring)
Keeping the Garage Door Open workshop – Leslie Myers(August)
2013 Teacher 2 Teacher workshops (Spring and Fall)
PTSD in the classroom (April)
Mark Taylor workshop (October)
2012 Lumina Workshop (January 5-6)
Ken Bain seminar (August)
2011 Quality Matters for online instructors (completed 2 sessions and an online module)
LASSI training (October)
Access Seminar on informational literacy for online courses- Paul Mascarenas (October)
2010 "May the Tweet be with you" Using Web 2.0 Tools for Education- Kristyn Rose (May 2010)

Joy of Teaching and Promoting Learning (January 16 2010)

2009 Course Redesign and Revitalization - Barbara Millis (January)
Best Clicker Practices- Susan Becker (March)
Rethinking Design and Deliver of On-line classes (April)
Universal Design for Learning: Creating Accessible Course Materials, Nancy Conklin(May)

2008 Evaluating Critical Thinking - Ed Neal (May)
"How to Create an Inclusive Environment" Diversity Training(October)

2007 Advanced Teaching Online- William Draves (@ WCCC)
Faculty Development Workshops - Linda Nilson
Faculty GIS workshops - Verner Johnson (3 sessions: Beginning, Intermediate, and "Advanced")
GPS Workshop - Gigi Richard

2006 How to teach Online class in WebCT, Leslie Keeler (2006)

Innovative Materials/Activities

In my ENVS460 course and lab, students collect field data on fuel loads and forest structure in a ponderosa pine stand on the Uncompahgre Plateau and then use that data to model fire behavior using a computer model. They then design fuel treatments that would prevent a crown fire from developing and show the effectiveness of their treatment using a computer model. They also develop a formal prescribed burn and smoke management plan to show how they will maintain the fuel treatment. They apply concepts learned in the first half of the semester for this project and present it in a formal 10-20 page report. All of my upper division courses have group projects that require critical thinking similar to this project.

Supervision of Student Research/Project(s)

- Two students measured 36 cottonwood stands in five canyons of the Colorado National Monument for a health assessment (resulted in report to NPS, 2015)
- One student worked on an Assessment of Seeps and Springs for the COLM (resulted in report to NPS,2014)
- Five students collected ground truthing data for a remote sensing project in the Colorado National Monument (2013-2014)
- Two students worked with the Palisade Insectary collecting data on vegetation in tamarisk stands affected by the tamarisk beetle (Resulted in 3 conference presentations, manuscript to be submitted, 2011-2014)
- One student conducted a greenhouse study testing CMU's compost (2014)
- Two students conducted a wetlands delineation for the Fruita-Loma bike path (2013)
- Two students worked on a survey of the endangered hookless cactus (2013)
- One student studied amphibians in No Thoroughfare Canyon over a full breeding season (resulted in a report to NPS, 2013).
- Two students collected data on the dynamics of sage- woodland ecotones in the Colorado National Monument(2013)
- One student studied forest regeneration in the blowdown on the Grand Mesa (2011-12)
- One student created ~50 GIS maps on the resources of Mesa County for use in ENVS204 (2011)
- Two students researched plant species for the Local Flora database (2011)
- Supervised 16 students on structured research measuring pinyon pine and juniper woodlands in the Colorado National Monument (resulted in journal article with a student co-author, 2007-2012)

Sponsorship of Student Showcase Project Posters 2015

- *Remediation Assessment and Monitoring Plan of Gasoline Contaminated Groundwater from Underground Storage*
- *Tanks at Austin Country Store in Austin, CO*
- *Reclamation Plan for the Three Sisters Park in Grand Junction, CO*
- *Post Tamarisk Removal Baseline Data Collection for Basic Flow, Channel Morphology, and Vegetation of No Thoroughfare Wash*
- *Wetlands Restoration And Enhancement Plan in Mesa County, CO*

2014

- *Comparing the effectiveness of CMU compost and Mesa Magic on Radish (Raphanus sativus) growth*
- *Reclamation Plan for a Southwestern Mesa County Uranium Mine near Gateway, Colorado*

2013

- *What's Coming Back? Monitoring plant composition and tamarisk mortality in Western Colorado*
- *Comparing long-term effectiveness of three cut-stump methods of tamarisk control*
- *Comprehensive Analysis of Colorado Mesa University's Greenhouse Gas Emissions*
- *Density of burrowing insect burrows in burned and unburned sage shrublands*

2012

- *Does Soil Type Affect Tree Density of Piñon-Juniper Woodlands at Colorado National Monument?*
- *Grand Mesa Blowdown and Stand Recovery*
- *Designing a rooftop garden for the Eagle's Nest Restaurant at Vail Ski Resort*
- *Proposed Kokopelli extension of the Riverfront trail*

2011

- *The effects of a prescribed fire on the soil seed bank in the Colorado National Monument*
- *A Composting Feasibility Study for Mesa County*

Scholarship and Creative Work, 2003-Present:

Scholarship Related to Discipline

Journal Articles

1. Poorter, L. , F. Bongers , M. Aide, A. Almeyda-Zambrano, P. Balvanera, J. Becknell, V. Boukili, P. Brancalion, E. Broadbent, R. Chazdon, D. Craven, J. de Almeida-Cortez, G. Cabral, B. de Jong, J. Denslow, D. Dent, S. DeWalt, J. Dupuy, S. Durán, M. Espírito-Santo, M. Fandino, R. César, J. Hall, J. Hernandez Stefanoni, C. Jakovac, A. Junqueira, **D. Kennard**, S. Letcher, J. Licona, M. Lohbeck, E. Marín-Spiotta, M. Martínez-Ramos, P. Massoca, J. Meave, R. Mesquita, F. Mora, R. Muñoz, B. Muscarella, Y. Nunes, S. Ochoa-Gaona, A. de Oliveira, E. Orihuela-Belmonte, M. Peña-Claros, E. Pérez- García26, D. Piotto, J. Powers, J. Rodríguez-Velazquez, I Romero-Pérez, J. Ruíz, J. Saldarriaga, L. Sanaphre, A. Sanchez-Azofeifa, N. Schwarz, M. Steininger, N. Swenson, M. Toledo, M. Uriarte, M. van Breugel, H. van der Wal, M. Veloso, H. Vester, A. Vicentini, I. Vieira, T. Bentos, G. Williamson, D. Rozendaal. In Press. Biomass resilience ofNeotropical secondary forests. In press. **Nature.** (Reference number: 2015-05- 06337D)
2. Letcher, S.G., J.R. Lasky, R.L. Chazdon, N.Norden, S. J.Wright, A.Andrade, J.L.Andrade-Torres, P. Balvanera, J. M. Becknell, T.V.Bentos, R.Bhaskar, F.Bongers, V.Boukili, P.H.S. Brancalion, R.G.Cesar, D.A.Clark, D.B. Clark, D.Craven, A.DeFrancesco, J.M. Dupuy, B.Finegan, E.Gonzalez-Jimenez, J.S.Hall, K.E.Harms, J.L.Hernandez- Stefanoni, P.Hietz, **D.Kennard**, T.J.Killeen, S.G.Laurance, E.E.Lebrija-Trejos, M.Lohbeck, M.Martinez-Ramos, P.E.S.Massoca, J.A.Meave, R.C.G.Mesquita, F. Mora, R.Munoz, R.Muscarella, H.Paz, E.A.Perez- Garcia, F.Pineda- Garcia, J.S.Powers, R.Quesada- Monge, R.R.Rodrigues, E.Romero-Perez, M.E.Sandor, L.Sanaphre-Villanueva, E.Schuller, N.G.Swenson, A.Tauro, M.Uriarte, M.van Breugel, O.Vargas-Ramirez, R.A.G. Viani, A.Wendt, G. B.Williamson. 2015. Environmental gradients and the evolution of successional habitat specialization: a test case with 14 Neotropical forest sites." **Journal of Ecology** 103.5: 1276-1290.
3. Kennard, D.K., Moore, A. 2013. Fire history, spatial structure, and mortality in a piñon-juniper woodland in the Colorado National Monument. **Natural Areas Journal** 33(3):296-306.
4. Kennard, D.K. and K.W. Outcalt. 2006. Modeling spatial patterns of fuels and fire behavior in a longleaf pineforest in the southeastern USA. **Fire Ecology** 2(1): 31-52.
5. McDaniel, J., Kennard, D, and Fuentes, A. 2005. Smokey the Tapir: Traditional Fire Knowledge and Fire Prevention Campaigns in Lowland Bolivia. **Society and Natural Resources** 18:1-11.
6. Kennard, D. K., Outcalt, K.W., Jones, D., O'Brien, J.J. 2005. Comparing techniques for estimating flame temperature of prescribed fires. **Fire Ecology** 1: 70-84.
7. Kennard, D.K. and F.E. Putz. 2005. Differential responses of Bolivian timber species to prescribed fire and other gap treatments. **New Forests** 30: 1-20
8. Kennard, D.K. Rauscher, H.M., Flebbe, P.A. Schmoldt, D.L., Hubbard, W.G., Jordin, J.B., Milnor, W. 2005. Using hyperdocuments to manage scientific knowledge: the prototype Encyclopedia of Southern Appalachian Forest Ecosystems. **Forest Ecology and Management** 207: 201-213.
9. Kennard, D. K. 2004. Commerical tree regeneration 6 years after high-intensity burns in a seasonally dry forest in Bolivia. **Canadian Journal of Forest Research** 34: 1-9.

10-19. Ten additional peer-review journal articles published prior to 2003.

Journal Articles in review:

1. Chazdon, R., Poorter, L. , F. Bongers , M. Aide, A. Almeyda-Zambrano, P. Balvanera, J. Becknell, V. Boukili, P. Brancalion, E. Broadbent, D. Craven, J. de Almeida-Cortez, G. Cabral, B. de Jong, J. Denslow, D. Dent, S. DeWalt, J. Dupuy, S. Durán, M. Espírito-Santo, M. Fandino, R. César, J. Hall, J. Hernandez Stefanoni, C. Jakovac, A. Junqueira, **D. Kennard**, S. Letcher, J. Licona, M. Lohbeck, E. Marín-Spiotta, M. Martínez-Ramos, P. Massoca, J. Meave, R. Mesquita, F. Mora, R. Muñoz, B. Muscarella, Y. Nunes, S. Ochoa-Gaona, A. de Oliveira, E. Orihuela- Belmonte, M. Peña-Claros, E. Pérez-García26, D. Piotto, J. Powers, J. Rodríguez-Velazquez, I Romero-Pérez, J. Ruíz, J. Saldarriaga, L. Sanaphre, A. Sanchez-Azofeifa, N. Schwarz, M. Steininger, N. Swenson, M. Toledo, M. Uriarte, M. van Breugel, H. van der Wal, M. Veloso, H. Vester, A. Vicentini, I. Vieira, T. Bentos, G. Williamson, D. Rozendaal. Carbon mitigation potential of Neotropical second-growth forest. **Science Advances**. Manuscript Number: aad7291
2. Derroire, G., Balvanera, P., Castellanos-Castro, C., Decocq, G., **Kennard, D.K.**, Lebrija-Trejos, E., Leiva, J.A., Odén, P., Powers, J., Rico-Gray, V. Tigabu, M., Healey, J. Resilience of tropical dry forests – a meta -analysis of changes in species diversity and composition during secondary succession. **Oikos.** Manuscript ID: OIK-03229.

Journal articles for submission:

1. Kennard, D., N. Louden, D. Gemoets, S. Ortega, T. Johnson, A. Stahlke, D. Bean, E. Gonzalez. Tamarisk mortality and vegetation change following release of the tamarisk leaf beetle (*Diorhabda carinulata*) in Western Colorado. **Journal of Biocontrol.**
2. Gonzales, E. Berenger, G., Bean, D. Kennard, D.K., Reynolds, L., Shafroth, P., Sher, A. Tamarix restoration in the American West: can we control the weed while recovering riparian functionality? **Restoration Ecology**
3. Gonzales, E., Bean, D. Kennard, D.K., Reynolds, L., Shafroth, P., Sher, A. Are secondary invasions of noxious weeds controlled by restoration-related disturbance in riparian systems? **Restoration Ecology**

Conference Presentations

1. Kennard, D.K. 2014. Fire history and piñon-juniper dynamics in the Colorado National Monument, Dinosaur National Monument Vegetation Change and Fire History Science Symposium, April10, 2014, Jensen, UT
2. Kennard, D.K. 2013. Fire History of an old-growth pinyon-juniper woodland in the Colorado National Monument, Colorado- Implications for management. 12th Biennial Conference of Science and Management on the Colorado Plateau, Sept 16-19 2013, Flagstaff, AZ.
3. Johnson, T., Louden, S. Ortega, D. Kennard, D. Bean. 2014. Tamarisk Mortality and Plant Composition in Western Colorado. Tamarisk Coalition Annual Meeting, Feb 21-24, 2014, Grand Junction, CO
4. Johnson, T., Louden, S. Ortega, D. Kennard, D. Bean. 2013. What's Coming Back? Tamarisk Mortality and Plant Composition in Western Colorado. Tamarisk Coalition Annual Meeting, March 11-15, 2013, Grand Junction, CO
5. Kennard, D. 2012. Fire history and spatial structure of a persistent piñon-juniper woodland in the Colorado National Monument, CO. Association for Fire Ecology Annual Meeting, Feb 2012, Santa Fe, NM
6. Cunningham, P. N. Louden, S. Ortega, D. Kennard, D. Bean. 2012. Tamarisk Mortality and Plant Composition in Western Colorado. Tamarisk Coalition Annual Meeting, Feb 15-17, 2012, Grand Junction, CO.
7. Kennard, D., Burden, K., Wilsey, S. and Walker, Z. 2008. Determining prehistoric fire history of the Colorado National Monument, Colorado. Proceedings of the Association for Fire Ecology Regional Conference, Fire in the Southwest: Integrating fire into management of changing ecosystems. Jan 28-31, 2008, Tucson, AZ.
8. Kennard, D.K., Outcalt, K.W., Jones, D., Estes, B. 2003. Techniques and sampling strategies for comparing fires of different intensities. Proceedings of the Second International Wildland Fire Ecology and Fire Management Congress. American Meteorological Society. November 16-20, 2003, Orlando, Florida.

9. Outcalt, K.W. and D.K. Kennard. 2003. Developing management options for fuel reduction in pine flatwoods of the southeast. Proceedings of the Second International Wildland Fire Ecology and Fire Management Congress. American Meteorological Society. November 16-20, 2003, Orlando, Florida.
10. Kennard, D. K., Outcalt, K.W., Lockaby, G., and Governo, R. 2003. Spatial patterns of fuel loads, fire intensity, and microbial biomass in a longleaf pine forest. In: Uplands to Lowlands: Coastal Processes in a Time of Global Change. The Ecological Society of America 88th Annual Meeting. August 3-8, 2003 Savannah, Georgia.

Technical Reports

1. Kennard, D.K., K. Rogowski, A. Garcia, G.Richard. 2015. Health assessment of the cottonwood population inthe Colorado National Monument. Submitted to the National Park Service.
2. Kennard, D.K. 2012. Fire history, spatial structure, and mortality in a piñon-juniper woodland in the Colorado National Monument. Submitted to National Park Service.
3. Pye, John M.; Rauscher, H. Michael; Kennard, Deborah K.; Flebbe, Patricia A.; Jordin, J. Bryan; Hubbard, William G.; Fowler, Cynthia; Ward, James. 2007. Using web-based technology to deliver scientific knowledge: the Southern Forest Encyclopedia Network. Gen. Tech. Rep. PNW-GTR-726. Portland, OR: U.S. Department of Agriculture,
4. Forest Service, Pacific Northwest Research Station. Pp. 193-199.
5. Jordin, J.B., Hubbard, W.G., Kennard, D.K., Milnor, W.H.,Rauscher, H.M., Veal, B., 2003. Using the Zope web application framework to build and manage a large encyclopedia of scientific knowledge. In: Innes, T. (Ed.), Natural Resources Information Management Forum: Putting Knowledge to Work. B.C. FORREX Series, vol. 8. FORREX Natural Resources Extension Partnership, Kamloops, pp. 135–145.
6. Kennard, D.K., Rauscher, H.M., Flebbe, P.A., Schmoldt, D.L., Hubbard, W.G., Jordin, B., Milnor, W. H. 2003. The Encyclopedia of Southern Appalachian Forest Ecosystems: A Prototype of an Online Scientific Knowledge Management System. IN: Vacik, H., Lexer, M.J., Rauscher, H. M., Reynolds, K. M., Brooks, R. T. (eds.). 2003. Decision supportfor multiple purpose forestry. CD-Proceedings of a IUFRO Conference at the University ofNatural Resources and Applied Life Science, April 23-25, 2003, Vienna, Austria.

6-10. Five additional technical reports published prior to 2003.

Other publications (online ornewsletters)

1. Local Flora Database: An online guide to the flora of Mesa County with currently over 120 species (http://www.coloradomesa.edu/flora/) Developed in collaboration with 3 biology faculty.
2. Kennard, D.K. 2008. How long has it been since the Colorado National Monument has burned? The Monolith Spring/ Summer. Pp. 3,5.
3. Kennard, D.K. *Encyclopedia of Southern Fire Science* (http://fire.forestencyclopedia.net). PI, Editor, author2002-2005.
4. Kennard, D.K. *Encyclopedia of Southern Appalachian Forest Ecosystems* (http://www.forestencyclopedia.net). Editor and author 2000-2002.

Other:

Grants

1. Faculty Professional Development Fund, 2015, Awarded $1,684 for travel to Puerto Rico to continue research on the effects of warming temperatures on herbaceous tropical plants.
2. Colorado National Monument Association, 2015, Awarded $5,600 to assess the health of the COLM cottonwood population.
3. Faculty Professional Development Fund, 2012, Awarded $1,100 to present at the Association for Fire Ecology's annual meeting in Santa Fe, NM.
4. National Park Service, 2010. Awarded $20,000 to continue research on the fire history and woodland structure of the Colorado National Monument.
5. Faculty Professional Development Fund, 2010. Awarded $2,400 to continue develop of the "On-line Guide to the Flora of Mesa County". Co-PIs Carrie McVean Waring, Margot Becktell.

6. Faculty Professional Development Fund, 2009. Awarded $3,000 to develop an "On-line Guide to the Flora of Mesa County". Co-PIs Carrie McVean Waring, Margot Becktell, Kristy Duran
7. Strategic Planning Grant, 2008. Awarded $5,000 for "Creating a Culture of Sustainability" at MSC. Co-PIs Gigi Richard and Sue Kenney.
8. Faculty Professional Development Fund, 2008, Awarded $1,500 to present at the Association for Fire Ecology's annual meeting and attend a workshop at the Laboratory for Tree Ring Research in Tucson, AZ.
9. Joint Fire Science Program, 2004. Awarded $497,763 for grant proposal: An Internet-based portal for fire scienceand management in the southern region. Co-PI.
10. Joint Fire Science Program, 2004. Awarded $127,992 for grant proposal: Best Management Practices for Fuels Management in Sub-tropical Pine Flatwoods and Tropical Pine Rocklands. Co-PI.
11. National Fire Plan, 2002, 2003, 2004. Awarded $795,000 for grant proposal: An Internet-Based Encyclopediaof Southern Fire Science and Management Knowledge: Ready Access to the Right Information in the Right Form. Lead PI.

Unfunded Grants

1. National Park Service, 2012. Using remote sensing to detect early season invasives and investigatefire-cheatgrass interactions in the Colorado National Monument ($23,052). Lead PI
2. National Park Service, 2012. Ground Truthing WFMI Fire Locations within Colorado National Monument ($11,803). Lead PI

Unpublished research

1. Using remote sensing to detect early season invasives (DESI project). Two field seasons of ground trothing data collected (2013-2014). Dr. Ray Kokaly (Crustal Geophysics and Geochemistry Science Center- USGS) is currently analyzing the data and developing the model.
2. Dynamics of woodland-shrubland ecotones in the Colorado National Monument. Vegetation data and tree core data collected, entered, analyzed. Report pending.

Service 2003-Present:

University

2015

Mass Communications (2 tenure-track positions)- Search Committees Faculty Success Committee
Campus Tree Advisory Board

2014

Chemistry Instructor -Search Committee
Mammal Biologist (tenure-track) -Search Committee Faculty Success Committee
Campus Tree Advisory Board
Distance Learning and Technology Committee- Vice Chair (spring only)

2013

Campus Tree Advisory Board
Distance Learning and Technology Committee- Vice Chair

2012

AVPAA Distance Learning -Search Committee Campus Tree Advisory Board
Distance Learning and Technology Committee- Vice Chair

2011

Distance Learning and Technology Committee (fall only) Botanist (tenure-track) - Search Committee
Session chair Student Showcase
Served on Teaching Effectiveness panel for New Faculty Orientation Grade Appeal Ad-hoc committee

2010

Sustainability Council- Co-advisor (spring only) Instructional Designer- Search Committee
Learning Management System selection committee (WebCT to D2L)

2009
Sustainability Council- Co-advisor
Digital Media Specialist- Search Committee

2008
Sustainability Council Assessment Committee
Session chair and judge: Student Scholars Symposium

2007
Sustainability Council
Assessment Committee
Reviewer: Strategic Planning Grant proposals

2006
Assessment Committee

Department

2015
Program Assessment Report-Collected and analyzed data, compiled report.
Co-advisor SGE (Honor Society for Geology and Environmental Sciences students) Scholarship Selection Committee- Math and Sciences
Campus representative Barry Goldwater Scholarship (fall only)

2014
Co-advisor SGE (Honor Society for Geology and Environmental Sciences students) Scholarship Selection Committee- Math and Sciences
Campus representative Barry Goldwater Scholarship
Led tour of Wubben Science for 60 middle school students

2013
Co-advisor SGE (Honor Society for Geology and Environmental Sciences students) Scholarship Selection Committee- Math and Sciences
Campus representative Barry Goldwater Scholarship
Led tour of Wubben Science for 60 middle school students

2012
Co-advisor SGE (Honor Society for Geology and Environmental Sciences students) Scholarship Selection Committee- Math and Sciences
Campus representative Barry Goldwater Scholarship

2011
Co-advisor SGE (Honor Society for Geology and Environmental Sciences students) Scholarship Selection Committee- Math and Sciences
Campus representative Barry Goldwater Scholarship

2010
Scholarship Selection Committee- Math and
Sciences Campus representative Barry
Goldwater Scholarship Science Building
Courtyard Committee

2009
Scholarship Selection Committee- Math and Sciences Campus representative
Barry Goldwater Scholarship

2008
Math and Sciences Scholarship Committee
Campus representative Barry Goldwater Scholarship

2006, 2007
Math and Sciences Scholarship Committee

Community

2015
Peer-reviewer: Journal of Tropical Ecology

2014
STEM Fridays- Dual Immersion Academy: Developed/taught interactive science lessons for at-risk elementary students. Peer-reviewer: Fire Ecology
Participant: Uncompahgre Plateau Collaborative Forest Landscape Project, Project meeting
Organized 3 day float trip for Trinity University Environmental Studies Field Course

2013
Board Member, Colorado Canyons Association
Helped organize a scavenger hunt for 200+ elementary and middle school students at Devils Canyon, McInnis NCA. Led a wildflower walk, Pollock's Bench, Colorado Canyons Association (May)
Participated in BioBlitz for the USFWS searching for the endangered hookless cactus
Searched a proposed trail routes for the endangered hookless cactus for the Mesa Land Trust
Participant: Uncompahgre Plateau Collaborative Forest Landscape Project, 2 day restoration fieldtrip
Guest instructor: Trinity University Environmental Studies Field Course, High Lonesome Ranch

2012
Board Member, Colorado Canyons Association
Helped organize a scavenger hunt for 200+ elementary and middle school students at Devils Canyon, McInnis NCA.
Led a wildflower walk, Pollock's Bench, Colorado Canyons Association (May)
Presentation on dendrochronology, Jr. Scientist Series, Mesa County Library
Science Fair Judge: Jr. High Preliminary
Participant: Uncompahgre Plateau Collaborative Forest Landscape Project, 2 day data collection field trip

2011
Peer reviewer: Journal *Forest Ecology and Management*
Board Member, Colorado Canyons Association
Presented research at the Colorado National Monument "Walks and Talks" series
Helped organize a scavenger hunt for 200+ elementary and middle school students at Devils Canyon, McInnis NCA.
Led a wildflower walk, Pollock's Bench, Colorado Canyons Association (May)
Led a wildflower walk, Devil Canyon, Town of Palisade Seniors (June) Science Fair Judge: Jr. High Preliminary

2010
Peer reviewer: Journal *Biotropica*
Peer reviewer: *Fire Ecology*

2009
Peer reviewer: Journal *Biotropica*
Peer reviewer: USDA Pacific SW Research Station General Technical Report
Peer reviewer: Journal *Ecological Applications*
Presented research at the Colorado National Monument "Walks and Talks" series
Summer training for summer Colorado National Monument employees
Science Fair Judge: Jr. High Preliminary, Special Awards (March)
Mesa County *Green Guides,* Campus liason (2007-2009)

2008
Peer reviewer: Journal *Biotropica*
Peer reviewer: *Journal of Tropical Ecology*
Peer reviewer: Journal *Forest Ecology and Management*
District 51/Mesa State's MS^3 project: Toolkit development workshop (Nov2-3) District 51/Mesa State's MS^3 project: 2-day Capstone (May) Development/delivery of On-Line Issues in Fire Management course forBLM
Science Fair Judge: East Middle School(January)
Science Fair Judge: High School(February)
Grand Valley Environmental Education Advisory Group(2007-2008) Mesa County *Green Guides,* Campus liason (2007-2009)

2007
Peer reviewer: Journal *Forest Ecology and Management (2manuscripts)*
District 51/Mesa State's MS^3 project: Developed and taught 2-week 4-credit hour course: ISEV596Topics: Environmental Science for Middle School Teachers
District 51/Mesa State's MS^3 project: Team-taught a 8-week long on-line course: ISEV580 Topics: Student Centered Science
Development/delivery of On-Line Forest Ecology course forBLM Wingate Elementary Science Fair Judge (February)
Grand Valley Environmental Education Advisory Group(2007-2008) Mesa County *Green Guides,* Campus liason (2007-2009)

2006
Development/delivery of On-Line Fire ecology course forBLM

Advising 2003-Present:
University level
2015
Soar Sessions: 1
Mesa Experience Sessions: 1
Mav Scholar Sessions: 1
Middle School Career Fair: 1

2014
Soar Sessions: 1
Mesa Experience Sessions: 2
Mav Scholar Sessions: 1
Exploring a Major Fair: 1

2013
Soar Sessions: 2
Mesa Experience Sessions: 1
Mav Scholar Sessions: 1
Exploring a Major Fair: 1

2012
Soar Sessions: 1
Mesa Experience Sessions: 1
Mav Scholar Sessions: 0

2011
Soar Sessions: 2
Mesa Experience Sessions: 1
Mav Scholar Sessions: 0

2010
Soar Sessions: 2
Mesa Experience Sessions: 1
Mesa Madness: 1

2009
Soar Sessions: 2
Mesa Experience Sessions: 1

2008
Soar Sessions: 2
Mav Scholar Sessions: 2

2007
Soar Sessions: 2

Department level
2006-2015
Advisor for 20-40 students

Honors and Awards, 2003-present
Sabbatical Leave, Fall 2015

Professional Experience
Research Ecologist, U.S.D.A. Forest Service, SRS-4104,
Auburn, Alabama, 2001-2005

CURRICULUM VITAE

Tamera J. Minnick, Ph.D.
Department of Physical and Environmental Sciences
Colorado Mesa University
Grand Junction, CO 81501
phone: (970) 248-1663
email: tminnick@coloradomesa.edu

Academic Training:

Degree	Year	Institution	Major	Minors
B.S. with honors	1989	University of Nebraska - Lincoln	Biology	Math, Physics, Anthro
Ph.D.	1998	Colorado State University	Ecology	

Dissertation: Abiotic Factors Affecting Distribution and Dominance Patterns of Two C_4 Perennial Grass Species

Professional Experience:

2014–present **Professor**, *Colorado Mesa University*, Grand Junction, Colorado
2012-2013 **Visiting Research Fellow,** *University of Western Australia,* Crawley, Australia
2005-2014 **Associate Professor**, *Colorado Mesa University*, Grand Junction, Colorado (formerly *Mesa State College*)
2002-2005 **Assistant Professor**, *Mesa State College*, Grand Junction, Colorado
2000-2002 **Assistant Professor,** *Nebraska Wesleyan University,* Lincoln, Nebraska
1999-2000 **Visiting Assistant Professor**, *Nebraska Wesleyan University*, Lincoln, Nebraska.
1998-1999 **Post-doctoral Research Associate**, *University of Nebraska*, Lincoln, Nebraska.
1997-1998 **Plant Physiologist**, *U.S. Forest Service*, Rocky Mountain Forest and Range Research Station, Ft. Collins, Colorado
1993-1998 **National Science Foundation Pre-Doctoral Fellow** and Graduate Research Assistant, Graduate Degree Program in Ecology, *Colorado State University*, Ft. Collins, Colorado
1993 **Microbiologist**, *BioNebraska*, Lincoln, Nebraska
1992 **Science and Stewardship Outreach Program Director**, *The Nature Conservancy*, Niobrara Valley Preserve, Johnstown, Nebraska
1989-1991 **Secondary Science Teacher**, *U.S. Peace Corps* and Ministry of Education, Nairagie Engare, Kenya

Honors and Awards:

Desert Ecological Analysis and Research Grant $6785 2015
Amsonia jonesii Demographic Study at the Three Sister's Park, Grand Junction, Colorado
CMU Sabbatical Leave Award 2012-2013
MSC Professional Development Fund $600 2010
To cover page charges for publishing COLM paper in Rangeland Ecology and Management

Exxon Grant	$93,915	2008 - 2012
Restoring Soil Primary Processes to Promote Successful Vegetation and Habitat Restoration Following Natural Gas Development in the Piceance Basin		
BLM Grant and Cooperative Agreement	$7400	2010
BLM-CO-MCNCA Undergraduate Intern NLSC Monitoring and Research		
MSC Professional Development Fund	$2700	2008
Travel to Illinois to learn a nitrogen mineralization measurement technique		
Runner-up: Fulbright Fellowship to Namibia		2008
National Park Service Cooperative Grant	$11,085	2004-2009
Native Plant Restoration of a CCC Camp at the Colorado National Monument		
BLM Challenge Cost Share Grant	$10,000	2004-2005
Non-native Plant Site Revegetation		
Colorado River Salinity Forum Grants (Co-PI with USGS)	$120,000	2003 – 2006
Documenting the Effects of Grazing on Sediment, Water, and Salinity Production from Mancos Shale Soils		
National Science Foundation Pre-doctoral Fellow	$69,000	1994-1997
CSU Student Ecology Symposium presentation award		1996
Student award to attend spatio-temporal dynamics conference at NCEAS		1996
LTER Graduate Student Cross-Site Research Competition	$1500	1995
Colorado State Special Fellow	$12,456	1993-1994
Phi Beta Kappa, awarded 1989		
National Merit Scholar	$3000	1985-1989
University of Nebraska Regents' Scholar	$6000	1985-1989

University, Professional and Community Service:

- 2015 Chair, Sabbatical Committee
- 2015 Member, BLM Dominguez-Escalante Advisory Council
- 2015 Supervised 1 research student spring 2015 and 1 student fall 2015
- 2015 Supervised 2 student research assistants summer 2015
- 2015 Guest Speaker, Great Old Broads for Wilderness
- 2015 Reviewer for Journal of Vegetation Science paper
- 2004-2015 Co-organizer with Gigi Richard of the Seminar series on Natural Resources: Land and Water
- 2002-2015 Faculty Representative for Udall Scholarship
- 2014 Member, Sabbatical Committee
- 2014 Member, BLM Dominguez-Escalante Advisory Council
- 2014 Program Committee Member, High-Altitude Revegetation Conference
- 2014 Guest Speaker, American Association of University Women
- 2013 Reappointed BLM Dominguez-Escalante Advisory Council, representing science, research and education interests, appointed by Secretary of the Interior Sally Jewell
- 2013 Reviewer for Restoration Ecology manuscript
- 2013 Reviewer for Introductory Environmental Science textbook
- 2013 Guest Lecturer on the U.S. Peace Corps for ANTH396 on 25 Apr.

- 2012 Supervised one structured research student (Kim Kellerby)
- 2009-2013 BLM Dominguez-Escalante Advisory Council, representing science, research and education interests, appointed by Secretary of the Interior Ken Salazar
- 2012 Participated on an Ethics Panel coordinated by Alpha Chi at Colorado Mesa University, 29 Feb
- 2012 Guest Lecturer on the U.S. Peace Corps for ANTH396 on 20 Apr.
- 2012 Appeared before Colorado Oil & Gas Conservation Commission, May, to describe reclamation working group discussions
- 2011-2012 Environmental Network for Volunteering Students club advisor
- 2011 Supervised Two Structured Research Students (Spring, Brendan Swihart; Fall, Kim Kellerby) on two different projects
- 2011-2012 Reclamation working group member with industry reclamation specialists to explore reclamation of natural gas disturbance in western Colorado
- 2010 Public Testimony for District 51 School Board in opposition to a petition to prevent teaching global change science in our public schools; newspaper and radio interviews followed
- 2010 Two Panel Discussions of Dirt! The Movie at the Mesa County Library's Community Cinema
- 2010 Developed a Biodiversity Lab for Western Colorado Science Center
- 2010 Supervising Two Structured Research Students (Greg Pratz, Royce Young) on two different projects: Royce Young presented this work in the spring 2011 Student Showcase
- 2009-2011 Academic Policies Committee Member
- 2009-2010 Restoration Ecology course students analyzed restoration site potential for National Park Service
- 2009 Soils course students analyzed soils for Tamarisk Coalition
- 2009 Panel Discussion of Wallace Stegner Documentary at the Mesa County Library's Community Cinema
- 2009 Departmental Committee on Field Trips and Disabled Students
- 2009 Departmental Committee on Faculty Evaluation
- 2009 Supervised research technicians Mackenzie Gibson and Seth Wilson
- 2008 Supervised research technician Scott Distel
- 2006–2009 Advised for SOAR sessions
- 2006–2010 Bureau of Land Management's Advisory Committee for McInnis Canyons National Conservation Area
- 2007 Environmental Science Program Review and Follow-up Curriculum Modifications
- 2007-2009 Departmental Advisor to Tenure Track Faculty
- 2006-2007 Supervised Research Technician Kate Burden
- 2007 Faculty Development Fund Committee Member
- 2006-2007 Tenure and Promotion Committee
- 2006 Structured research credit with student project by Brett Fletcher
- 2006-2009 Science Fair Judge
- 2005 Structured research credit with student projects by Kay Lambert, Mario Pallone, and John Suchar + 12 Uravan students
- 2004 Structured research credit with student projects by Julia Christiansen and Brett Fletcher
- 2004 Science Fair Committee Member
- 2004 Outside Review Committee Member for Math Program Review
- 2004 Supervisor of student employee on USGS Badger Wash Project

- 2004 Applicant for BLM Colorado Canyon National Conservation Area Advisory Board
- 2003 Work with County Weed Manager Jude Sirota, Russ Walker and two students (Brad Kieding, Brandy Schell) on Tiara Creek Purple Loosestrife Project
- 2002 Reviewer for Ecological Applications manuscript

Papers and Posters Presented

1. Minnick, T.J. 2015. Successful ecological restoration provides diverse benefits to public, local government and industry. Southwest Colorado Gas and Oil Regulatory Team meeting (Aug 20, 2015).
2. Minnick, T.J., and R.D. Alward. 2015. Successful ecological restoration provides diverse benefits to public, local government and industry. Energy and Environment Symposium, Rifle, CO (Apr 29, 2014).
3. Minnick, T.J. 2014. Walkabout in restoration ecology: principles and practices from down under to up yonder. Colorado Mesa University Faculty Colloquium Series (Mar 5, 2014).
4. Minnick, T.J. 2013. Quantitative monitoring in oil and gas reclamation: What can it do for you? 2nd Wyoming Reclamation and Restoration Symposium and 30th Annual Meeting of the American Society of Mining and Reclamation Joint Meeting, Laramie, WY (Jun 1-7, 2013).
5. Minnick, T.J. 2012. Soil and vegetation heterogeneity of abandoned gas well pads in the Piceance Basin of western Colorado, USA. Invited talk. School of Plant Biology Seminar Series, University of Western Australia, Crawley, Western Australia, Australia, 10 Sept 2012.
6. Kellerby, K., and T.J. Minnick. Are native grass species and the introduced crested wheatgrass equally competitive with cheatgrass? Proceedings 3rd Annual Student Showcase, Colorado Mesa University, April 25, 2012.
7. Alward, R.D., and T.J. Minnick. 2012. Vegetation recovers slowly on abandoned natural gas well pads in the Piceance Basin. High Altitude Revegetation Workshop, Ft. Collins, CO (Mar 6-8, 2012).
8. Young, R., and T.J. Minnick. 2011. The correlation between soil organic carbon and soil texture as they relate to the presence of perennial vegetation. Student Showcase, Mesa State College (April 27, 2011).
9. Minnick, T.J., and R.D. Alward. 2010. Soil and vegetation heterogeneity of abandoned gas well pads in the Piceance Basin of western Colorado. Natural Resources in the West Seminar, Mesa State College (Sept 27, 2010).
10. Minnick, T.J., R.D. Alward, M. Gibson, and S. Wilson. 2010. Soil heterogeneity of abandoned gas well pads in the Piceance Basin of western Colorado. Ecological Society of America Annual Meeting, Pittsburgh, PA (Aug1-7, 2010).
11. Alward, R.D., T.J. Minnick, M. Gibson, and S. Wilson. 2010. Vegetation heterogeneity of abandoned gas well pads in the Piceance Basin of western Colorado. Ecological Society of America Annual Meeting, Pittsburgh, PA (Aug1-7, 2010).
12. Minnick, T.J., R.D. Alward, M. Gibson, and S. Wilson. 2010. Soil heterogeneity of abandoned gas well pads in the Piceance Basin of western Colorado. High Altitude Revegetation Workshop, Ft. Collins, CO (Mar 3-4, 2010).
13. Minnick, T.J., R.D. Alward, J.S. Christiansen, K.F. Lambert, and K.H. Burden. 2007. Resource enhancement techniques to aid shrub transplant success in an arid shrubland restoration. Bull. Ecol. Soc. Am. (Suppl.) 88.
14. Alward, R.D., A. Clements, H. Metz, and T.J. Minnick. 2005. Evaluating the efficacy of fuels reduction treatments: developing management tools for promoting biodiversity and controlling cheatgrass in west-central Colorado. Uncompahgre Plateau Project PJ & Sagebrush Conference, Montrose, Colorado (May 2005).
15. Minnick, T.J. 2004. Documenting the effects of grazing on sediment, water, and salinity production from Mancos shale soils: Reigniting the Badger Wash long-term experiment. Mesa State College Faculty Colloquium, Grand Junction, Colorado.

16. Minnick, T.J., L.K Piller, and R.L Flegel. 2002. Changes in ecosystem properties with landscape position in a Nebraska Sandhills prairie. 17th Annual Symposium, International Association of Landscape Ecology, Lincoln, Nebraska.
17. Flegel, R.L., and T.J. Minnick. 2002. The effect of mowing and grazing on soil water, nitrogen and biomass in Arapaho Prairie, a Nebraska Sandhills Prairie. Nebraska Academy of Sciences Annual Meeting, Lincoln, Nebraska.
18. Minnick, T.J. 2000. Abiotic factors affecting distribution and dominance patterns of two C_4 perennial grass species. Furman University, Greenville, South Carolina.
19. Wedin, D.A., M. Bullerman, and T.J. Minnick. 2000. Carbon balance of long-term experimental pine forests in the Nebraska Sandhills: A tradeoff between net carbon storage and soil carbon losses. Bull. Ecol. Soc. Am. (Suppl.) 81:354.
20. Minnick, T.J. 1999. Abiotic factors affecting distribution and dominance patterns of two C4 perennial grass species. TriBeta Meeting, Nebraska Wesleyan University.
21. Minnick, T.J. 1999. Invasiveness of plant species and invasability of ecosystems. Washington and Jefferson College, Washington, Pennsylvania.
22. Minnick, T.J., and D.A. Wedin. 1999. Consequences on ecosystem function of vegetation change along a grassland to forest continuum. Bull. Ecol. Soc. Am. (Suppl.) 79: 42.
23. Alward, R.D., T.J. Minnick, and J.K. Detling. 1999. Warmer nights versus warmer days: Different responses in the plains prickly pear cactus. Bull. Ecol. Soc. Am. (Suppl.) 79:151.
24. Minnick, T. J., and D. P. Coffin. 1997. Effect of soil texture on regional patterns of grass seedling establishment predicted from a soil water model. Bull. Ecol. Soc. Am. (Suppl.) 78: 149.
25. Minnick, T.J., and D. P. Coffin. 1996. Common garden study of *Bouteloua gracilis* and *Bouteloua eriopoda* in northern Colorado. Bull. Ecol. Soc. Am. (Suppl.) 77: 308.
26. Minnick, T.J., and D. P. Coffin. 1996. Cross-site comparisons of two North American C_4 perennial grasses: *Bouteloua gracilis* and *Bouteloua eriopoda*. 2nd Annual Ecological Research at CSU Student Symposium, Ft. Collins. CO.
27. Minnick, T. J., and D. P. Coffin. 1995. Predicting recruitment of *Bouteloua gracilis* and *Bouteloua eriopoda* across an environmental gradient using a soil water simulation model. Bull. Ecol. Soc. Am. (Suppl.) 76: 186.

Publications and Reports:

1. Minnick, T.J., and R.D. Alward. 2015. **Plant–soil feedbacks and the partial recovery of soil spatial patterns on abandoned well pads in a sagebrush shrubland**. Ecological Applications 25:3-10.
2. Minnick, T.J., and R.D. Alward. 2012. Soil moisture enhancement techniques aid shrub transplant success in an arid shrubland restoration. Rangeland Ecology and Management 65:232-240.
3. Minnick, T.J., and R.D. Alward. Submitted. Quantitative monitoring for reclamation success: What can it do for you? Environmental Science & Technology.
4. Alward, R.D. and T.J. Minnick. In preparation. Vegetation heterogeneity of abandoned gas well pads in the Piceance Basin of western Colorado.
5. Minnick, T.J., and R. D. Alward. 2011. Heterogeneity of Soil Organic Carbon on Abandoned Natural Gas Well Pads in the Piceance Basin of Western Colorado. Report submitted to ExxonMobil Production Company.
6. Minnick, T.J., R.D. Alward, J.S. Christiansen, K.F. Lambert, and K.H. Burden. 2009. Resource Enhancement Techniques to Aid Shrub Transplant Success in an Arid Shrubland Restoration. Report submitted to the Colorado National Monument.
7. Musselman, R.C., and T.J. Minnick. 2000. Nocturnal stomatal conductance and ambient air quality standards for ozone. Atmospheric Environment 34:719-733
8. Minnick, T.J., and D. P. Coffin. 1999. Geographic patterns of simulated recruitment of two

Bouteloua species: Implications for distributions of dominants and ecotones. Journal of Vegetation Science 10:343-356.

9. Minnick, T.J. 1998. Abiotic Factors Affecting Distribution and Dominance Patterns of Two C_4 Perennial Grass Species. Ph.D. Dissertation. Colorado State University, Fort Collins, Colorado.

RUSSELL D. WALKER, PH.D.

EDUCATION

A.B., Oberlin College, 1977. Mathematics.
Ph.D., Iowa State University, 1986. Analytical Chemistry.

TEACHING EXPERIENCE

Environmental Science and Technology, Mesa State College (Grand Junction, Colorado).
- Professor, 2003-present
- Associate Professor, 1998-2003.
- Assistant Professor, 1993-1998.

Courses Taught (Recent)

Lower Division
- Introduction to Environmental Science
- Science and Technology of Pollution Control (and Lab)

Upper Division
- Environmental Project Management
- Environmental Risk Analysis
- Water Quality (and Lab)
- Applied Atmospheric Science
- Sustainable Building
- Environmental Regulatory Compliance
- Restoration of Aquatic Systems
- Environmental Fate and Transport of Contaminants
- Pollution Investigation and Monitoring (and Lab)
- Capstone in Environmental Science and Technology

ACADEMIC ADMINISTRATIVE EXPERIENCE

Head, Department of Physical and Environmental Sciences, May 2005-present

SCHOLARSHIP

Grants and Contracts

Roaring Fork Conservancy, 2012. $5,000 for "Water Quality in the Crystal River and Coal Creek Basin."

Golder Assocates, Inc., 2011. $6,227 for "Bench-Scale Treatability Study for Ground Water from the Atlas Mill Site."

S&K Aerospace LLC, 2009. $2,897 for "Bench-Scale Study of Ammonia in Ground Water."
Bureau of Reclamation, 2008. $84,610 for "Passive Selenium Bioreactor—Pilot Scale Testing."

Bureau of Reclamation, 2006. $46,783 for "Evaluation of Passive Bioreactors to Reduce Selenium Impacts from Reclamation Projects."
Colorado Energy Research Institute, 2006 and 2007. $75,000 each year for "Energy Workforce Development." (With Rex Cole)

Saccomanno Research Institute, 2006. $11,000 for "Risk Assessment of Human Health Effects from Natural Gas Development in Garfield County, Colorado."

Colorado Department of Natural Resources, Division of Minerals and Geology, 2005. $46,640 for "Uravan Mine Restoration Project." (With Tamera Minnick)

Lathrop Foundation, 2000. $2,400 for "A Study of Agricultural Contributions to Diffuse Water Pollution in Local Watersheds".

Special Incentive Funds from Office of State Colleges in Colorado, 2000. $2,300 for equipment and supplies needed for student participation in restoration projects on the North Fork of the Gunnison River.

Western Alliance to Expand Student Opportunities, 2000. $1,300 to support the work of a minority student on "Pollutant Loadings in the Colorado River from Diffuse Sources in the Grand Valley".

Special Incentive Funds from Office of State Colleges in Colorado, 1998. $800 as partial reimbursement for completing the week-long course *Applied Fluvial Geomorphology* presented by Dave Rosgen of Wildland Hydrology in Pagosa Springs, Colorado.

Mesa State College Techology Enhancement Grant, 1997. $1500 to develop self-paced, computer-based lessons on hazardous waste identification rules for use in Hazardous and Radioactive Waste Management course.

Mesa State College Academic Enrichment Grant, 1996. $900 for equipment and supplies to support work on the Blue Heron Lake Environmental Improvement Project.

Papers, Presentations, Posters, Chapters, and Technical Reports

J.D. Stednick, M.W. Paschke, P.L. Sutherland, R.D. Walker, and T.A. Bauder. Environmental Considerations for Coalbed Natural Gas Development in Colorado. In "Coalbed Natural Gas: Energy and Environment." K.J. Reddy, ed. Nova Science Publishers, 2010.

T. Rutkowski, R. Walker, J. Gusek, and M. Baker. Pilot-Scale Treatment of Selenium in Gravel Pit Seepage Water Using Biochemical Reactor Technology. Annual Meeting of the American Society for Mining and Reclamation, June 2010. Pittsburgh, Pennsylvania.

R. Walker and Golder Associates, Inc. Passive Selenium Bioreactor – Pilot Scale Testing. Final Report to U.S. Bureau of Reclamation Science and Technology Program, Project No. 4414. March 2010.

T. Coons and R. Walker. Community Health Risk Analysis of Oil and Gas Industry Impacts in Garfield County, Colorado. Prepared for Garfield County Commissioners, 2008. http://www.garfield-county.com/environmental-health/human-health-risk-of-oil-gas.aspx

J. Pahler, R. Walker, T.Rutkowski, and J. Gusek. Passive Removal of Selenium from Gravel Pit Seepage Using Selenium Reducing Bioreactors. Annual Meeting of the American

Society for Mining and Reclamation, June 2007, Gillette, Wyoming.
R. Wilson and R. Walker. East Salt Creek Riparian Demonstration Area, 1989-2005 (Poster). Sustaining Colorado Watersheds, October 2006, Breckenridge, Colorado.

R. Walker, R. Wang, and K. Topper. Educating for the Environmental Profession: Innovative Methods in the Mesa State College Environmental Program. 22nd Annual Conference of the National Association of Environmental Professionals, 21 May 1997, Orlando, Florida.

R. Walker, K. Topper, and R. Wang. Environmental Professionals for the 1990's and Beyond: The Mesa State College Environmental Program. 22nd Annual Conference of the National Association of Environmental Professionals, 21 May 1997, Orlando, Florida.

C. Hill and R. Walker. Predicting Maximum Influent Contaminant Concentrations for Groundwater Recovery Wells. 17th Annual Superfund / Hazardous Waste World Conference, 16 October 1996, Washington D.C.

"Regulatory Analysis of Russian Technologies Based on Cobalt Dicarbollide and *iso*-Amyldialkylphosphine Oxide", DOE/ID/12584-215, U.S. Department of Energy Grand Junction Projects Office. April 1995.

Walker, R., Carlson, T., Carpenter, C., Carroll, J., Craiglow, C., Cummins, L., Daub, G., Margolin, J., Rowlands, R., Duray, J. Technology Needs Crosswalk: Proceedings of the ER '93 Environmental Remediation Conference, Department of Energy, pp. 267-269 (1993).

M.L. Ocelli, G.P. Ritz, P.S. Iyer, R.D. Walker and B.C. Gerstein. Quaternary-ammonium cation effects on the crystallization of zeolites of the offretite-erionite family: Part III. Si-29 NMR, Al- 27 NMR and mid-IR characterization. Zeolites 9, 104 (1989).

M. Kuo, J.F. McClelland, S. Luo, P. Chien, R.D. Walker and C. Hse. Applications of infrared photoacoustic spectroscopy for wood samples. Wood and Fiber Sci. 20,132 (1988).

A.E. Elsaid, R.D. Walker, S. Weeks, A.P. D'Silva and V.A. Fassel. Site-selective Shpol'skii spectrometry of sulfur-, oxygen- and nitrogen-containing aromatic compounds in complex samples. Appl. Spectrosc. 42, 731 (1988).

R.D. Walker and B.C. Gerstein. Second-order quadrupolar echo. Phys. Rev. B31, 3167 (1985).

PROFESSIONAL EXPERIENCE

Senior Scientist, Rust Geotech, Inc. (Grand Junction, Colorado)

Project Manager, Technology Needs Assessment, January 1992-August 1993. Coordinated and participated in evaluation of U.S. Department of Energy environmental technology needs and technology development. Responsibilities included technical oversight, cost and schedule control of a $1 million project, and preparation of proposals.

Member, Technical Support Group for U.S. Department of Energy Arid Soils Volatile Organic Compounds Integrated Demonstration at the Hanford Reservation in Washington. January 1992-August 1993.

Assisted in strategic planning, proposals, and presentations for new work from Department of Energy Headquarters. Co-wrote proposals resulting in $2.7 million funding.

Acting Supervisor, Compliance and Regulatory Affairs, September 1991-January 1992. Supported multimedia compliance issues (air, water, and waste) and interpretation of federal, state, and local environmental regulations and DOE orders. Supervised six people.

Project Manager, Commingled Waste Investigation Project, July 1991-September 1991. Provided technical, regulatory, and administrative guidance on assessment and management of hazardous waste commingled with uranium mill tailings.

Senior Scientist, Waste Management, September 1990-July 1991. Managed hazardous, radioactive, and mixed waste generated at U.S. Department of Energy Grand Junction Projects Office.

Florida Department of Environmental Regulation (Tallahassee, Florida)

Supervisor, Hazardous Waste Cleanup, April 1988-September 1990.
Supervised four Superfund project managers and two support personnel.
Responsibilities included technical oversight, contract management, program and financial planning.
Continued project management responsibilities detailed under preceding position.

Project Manager, Hazardous Waste Cleanup, December 1986-April 1988. Managed Superfund and state-funded hazardous waste site cleanups. Responsible for technical aspects of site investigation, risk assessment, feasibility and treatability studies, remedial design, and construction. Responsibilities also included procuring, negotiating, and managing contracts, organizing and presenting public meetings, and providing information to media.

SERVICE (SELECTED EXAMPLES)

Mesa Land Trust, Board of Directors
Member, 2013-present

Stakeholder Advisory Group, Colorado Division of Reclamation, Mining, and Safety, Inactive Mines Program
Member, 2013-present

Colorado Riparian Association, Board of Directors Member, 2013

Advisory Council for the Colorado Canyons National Conservation Area
Appointed by Secretary of Interior to advise BLM on management plan
Coordinator, river corridor working group
Member, 2002-2006

Colorado Riverfront Commission
Local advocacy group promoting riverfront trails and rehabilitation projects
Member, 1998-2001

Environmental Education Advisory Committee
Advocacy group for environmental education in the local school district
Member, 1994-1999

Mesa State College Faculty Senate
President, 1999-2001 and 2003-2004
Secretary, 1998-1999 and 2001-2003

Mesa State College Academy for Educational Excellence
Chair, 1996-1997
Member, 1995-1998

Environmental Science and Technology, Mesa State College
Program Coordinator, 1997-2006

Mesa State College Participation in WERC International Environmental Design Contest
Advisor to student teams, 1993-1996 and 2000-2001

AWARDS

Outstanding Educator of the Year, Grand Junction Chamber of Commerce (2006)
Outstanding Achievement in Service, Mesa State College (2004)

MEMBERSHIPS

Colorado Riparian Association
Colorado Watershed Assembly
American Water Resources Association
American Chemical Society

Appendix 4

Form Used for Course Evaluation by Students

Colorado Mesa University Faculty Evaluation

Western Colorado Community College Faculty Evaluation

CRN
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Instructor Name: _____ Course: _____ (i.e. ENGL 111) Section: _____ (i.e. 001)

NOTE TO STUDENTS: Your responses are anonymous. The results will not be returned to the professor until AFTER grades have been posted. IMPORTANT! This document will be scanned for data entry. Please completely fill in the circle of your selection with pencil or a black or blue pen.

OPTIONAL DATA SECTION: Your responses to the following items are optional.

1. Gender
- CD Male
- CD Female

2. Classification
- CD Freshman
- m Sophomore
- m Junior
- G) Senior
- ® Unclassified
- ® Graduate

3. Type of Course
- CD General Education
- CD Required for Major
- m Elective in Major
- G) Elective Non Major

4. Degree
- ® Certificate
- W AA
- (@ AS
- (@ AAS
- @ BA
- @§) BAS
- @) BBA
- (®) BFA
- ©ID BS
- ®) BSN
- (TI) MA
- @ MBA
- @ MSN
- @ DNP
- @ Undeclared
- @ N/A

5. Department of Major
- ® Art
- (@ Biological Sciences
- Business
- (@ Computer Science, Math, & Statistics
- (® Health Sciences
- ® Kinesiology
- (@ Languages, Literature, & Mass Comm.
- ® Music
- ©ID Physical & Environmental Sciences
- ®) Social & Behavioral Sciences
- (TI) Teacher Education
- (il) Theatre Arts
- @ WCCC
- @ Undeclared

6. Expected grade for this course:
- CD A
- CD B
- m C
- G) D
- ® F
- ® Don't Know

REQUIRED SECTION: Please answer each item as it applies to this class or to this professor, according to the following scale from strongly agree to strongly disagree, and not applicable.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not Applicable
The course assignments are clear.	CD	CD	m	G)	®	®
The grading policies/procedures/criteria for this course are clear.	CD	ill	(I)	G)	®	®
The teaching methods/techniques used by the professor are effective.	CD	CD	(I)	G)	®	®
The exams and assignments of the course are consistent with the course content.	CD	CD	m	G)	®	®
The course is appropriately challenging.	CD	m	m	G)	®	®
The course syllabus accurately reflects the learning outcomes.	CD	CD	m	G)	®	®
The instructor is well prepared for class.	CD	CD	m	G)	®	®
The instructor responds to student questions at an appropriate level.	CD	CD	m	G)	®	®
The instructor uses a variety of teaching methods.	CD	m	m	G)	®	®
The instructor explains how material in the course is useful or relevant.	CD	CD	m	G)	®	®
The instructor is accessible to students during office hours or by appointment.	CD	CD	m	G)	®	®
The instructor promotes respect and civility for all students.	CD	CD	(I)	G)	®	®

Please make comments on the back of this sheet.

Written Comments:

Please take the opportunity to make written comments about this class and the professor on this side of the evaluation sheet. Such comments can be useful in helping the professors evaluate their teaching styles and effectiveness .

A. What were the most effective aspects of this course?

8. What changes would you recommend for this course?

C. Are the classroom/laboratory facilities conducive to learning? - If not, please explain.

D. Other Comments:

Appendix 5

Survey of Environmental Science Alumni

Summary of Alumni Survey Results

(Full results follow the summary)

Program strengths:

- The most notable result from the alumni survey results was that **76%** (of 17 respondents) of Environmental Science graduates were "very satisfied" with their undergraduate education, as compared to **57%** of all graduates from CMU (referred to as "all alumni" hereafter).
- **94%** of Environmental Science graduates rated the overall quality of their education as "very high" or "high" as compared to **85%** of all alumni.
- No Environmental Science graduates were "ambivalent" or "dissatisfied" with their undergraduate education, compared to 7% of all alumni who were.
- More Environmental Science graduates (**77%**) would encourage a current high school senior to attend CMU than would all alumni (**63%**).

Environmental Science majors mentioned the following as the "greatest strengths of the program":

- 64% of answers mentioned the experience/expertise of the faculty.
- 35% field labs and hands on experience
- 24% small class size
- A variety of courses were mentioned that proved to be most useful to students in their current environmental work, however ENVS331 Water Quality was mentioned the most frequently.

Quality of instruction

The following areas had the most positive results (number in parentheses is the sum of "very strong" and "strong" responses):

- Quality of lab and field instruction and activities (100%)
- Quality of classroom instruction and activities (94%)
- Availability of faculty for help (88%)
- Commitment of faculty to teaching (94%)
- Diversity of faculty expertise (82%)
- Advising on CMU courses and requirements (77%)

The following areas could be viewed as relative weaknesses, since they are the only points that recorded student responses in the "weak" category, even if it was only one response (number in parentheses is the sum of "adequate" and "weak" responses). No ENVS student answered "very weak" for any of the questions.

- Advising on graduate school opportunities (47%)
- Preparation for "real world" (41%)
- Variety of courses available in program (35%)
- Advising on careers and job search (29%)
- Quality of environmental science equipment and facilities (29%)
- Only 24% of Environmental Science graduates reported having a conversation with faculty weekly, as compared to 46% of all alumni.

General Education

Environmental Science graduates answered that they were "very well" prepared to perform the following general education skills at a ***higher*** rate than all alumni (number in parentheses is the difference between Environmental Science graduates and all alumni):

- Have knowledge of the natural world (39%)
- Possess the knowledge necessary to achieve a healthy lifestyle (13%)
- Appreciate the aesthetic spirit of humanity through the arts (13%)
- Appreciate the contributions of literature to our perception of the world (7%)
- Understand the structure and discipline of mathematical thought in problem solving (7%)
- Communicate effectively in the English language (4%)
- Be aware of the great philosophical issues which have endured through the ages (4%)
- Have an understanding of the multicultural nature of our world (3%)
- Think critically (3%)

Environmental Science graduates answered that they were "very well" prepared to perform the following general education skills at a ***lower*** rate than all alumni (number in parentheses is the difference between Environmental Science graduates and all alumni):

- Have an understanding of the complexities of social systems (-7%)
- Acquire knowledge on your own (-3%)
- Be an effective leader (-1%)

Careers after graduation

More Environmental Science graduates are working full-time (88%) than all alumni (71%). 75% of Environmental Science graduates had work positions related to their major, about the same as all alumni (74%). 29% of Environmental Science graduates have enrolled in a graduate or professional degree program since graduating, slightly lower than all alumni (40%).

Results of Survey of Environmental Science Alumni

(Survey implemented and complied by CMU Institutional Research)

Alumni Survey Results for Environmental Sciences Graduates - 2014

Undergraduate Degree Questions Audience size of 66 - 17 completed survey

Overall, how satisfied are you with your undergraduate education?

	#	%
Very Satisfied	13	76.5%
Generally satisfied	4	23.5%
Ambivalent	0	0.0%
Generally Dissatisfied	0	0.0%
Very Dissatisfied	0	0.0%

Based on what you know now, how well do you think your undergraduate experience prepared you to:

	Very Well		More than Adequately		Adequately		Less Than Adequately		Very Poorly	
	#	%	#	%	#	%	#	%	#	%
Communicate effectively inthe English Language	9	52.9%	8	47.1%	0	0.0%	0	0.0%	0	0.0%
Understand the structure and discipline of mathematical thought in problem solving	7	41.2%	7	41.2%	3	17.6%	0	0.0%	0	0.0%
Be aware of the great philosophical issues which have endured through the ages	4	23.5%	7	41.2%	5	29.4%	1	5.9%	0	0.0%
Have an understanding of the multicultral nature of our world	5	29.4%	10	58.8%	2	11.8%	0	0.0%	0	0.0%
Think critically	11	64.7%	5	29.4%	1	5.9%	0	0.0%	0	0.0%
Have an understanding of the complexities of social systems	6	37.5%	6	37.5%	4	25.0%	0	0.0%	0	0.0%
Have knowledge of thenatural world	12	70.6%	4	23.5%	1	5.9%	0	0.0%	0	0.0%
Appreciate the contributions of literature to our perception of the world	7	41.2%	4	23.5%	6	35.3%	0	0.0%	0	0.0%
Appreciate the aesthetic spirit of humanity through the arts	6	35.3%	2	11.8%	7	41.2%	2	11.8%	0	0.0%
Posses the knowledge necessary to achieve a healthy lifestyle	7	41.2%	7	41.2%	2	11.8%	1	5.9%	0	0.0%
Acquire knowledge on your own	10	58.8%	6	35.3%	1	5.9%	0	0.0%	0	0.0%
Be an effective leader	8	47.1%	7	41.2%	2	11.8%	0	0.0%	0	0.0%

While an undergraduate, about how often did you have conversations with faculty outside of class?

	#	%
Never	0	0.0%
Rarely (1-2 times persemester)	3	17.6%
Occasionally (3-5 times per semest	5	29.4%
Often (once every two weeks)	5	29.4%
Very Often (at least once a week)	4	23.5%

Would you encourage a current high school senior to attend CMU?

	#	%
Definitely Would	13	76.5%
Probably Would	3	17.6%
Maybe	1	5.9%
Probably Would Not	0	0.0%
Definitely Would Not	0	0.0%

Undergraduate Degree Questions (continued)

What was your undergraduate major?

	#	%
ENVS BS	17	#REF!

In what year did you graduate from the major/certificate you chose above?

	#	%
2013	2	12.5%
2012	2	12.5%
2011	5	31.3%
2010	4	25.0%
2009	1	6.3%
2008	0	0.0%
Other	2	12.5%

How would you rate the overall quality of your education within that degree/certificate program?

	#	%
Very High	8	47.1%
High	8	47.1%
Average	1	5.9%
Low	0	0.0%
Very Low	0	0.0%

Indicate below the strengths and weaknesses that you perceive in the environmental science program at CMU by clicking the number using the following scale:

1= Very Weak 2 = Weak 3 = Adequate 4 = Strong 5 = Very Strong

	Very Strong		Strong		Adequate		Weak		Very Weak	
	#	%	#	%	#	%	#	%	#	%
Quality of classroom instruction and activities	10	58.8%	7	41.2%	0	0.0%	0	0.0%	0	0.0%
Quality of lab and field instruction and activities	12	70.6%	4	23.5%	1	5.9%	0	0.0%	0	0.0%
Availability of faculty for help	9	52.9%	6	35.3%	2	11.8%	0	0.0%	0	0.0%
Commitment of faculty to teaching	11	64.7%	5	29.4%	1	5.9%	0	0.0%	0	0.0%
Diversity of faculty expertise	10	58.8%	4	23.5%	3	17.6%	0	0.0%	0	0.0%
Variety of courses available in program	7	41.2%	4	23.5%	5	29.4%	1	5.9%	0	0.0%
Preparation for "real world"	4	23.5%	6	35.3%	6	35.3%	1	5.9%	0	0.0%
Advising on CMU courses and requirements	8	47.1%	5	29.4%	4	23.5%	0	0.0%	0	0.0%
Advising on careers and job search	7	41.2%	5	29.4%	3	17.6%	2	11.8%	0	0.0%
Advising on graduate school opportunities	6	35.3%	3	17.6%	2	11.8%	6	35.3%	0	0.0%
Quality of environmental science equipment and facilities	7	41.2%	5	29.4%	4	23.5%	1	5.9%	0	0.0%

Answer these two questions if you currently hold (or held in the past) a job in the environmental profession or a related profession.

What environmental science courses have proven to be most useful to you in your environmental work?

- Soil science and water quality have proven to be the most useful.
- Pollution control, environmental law, environmental regs, project management, water quality, groundwater, independent study for selenium bioreactor project
- Environmental chemistry, college algebra, air quality, Statistics for experimental design
- My concentration was the secondary science education. My air, water, soil classes gave me a solid basis to be a better teacher. The best course I had was the independent study with Russia that had me looking at different lesson plans provided by different organizations and decide how I would en corporate them into my classroom.
- The introduction to environmental science and technology course, water quality,
- Water Quality, Grassland and Shrubland Management, Soils, Statistics, Stream Restoration, Botany
- The course that I could to be one of the most useful to me in my career so far was Russ Walkers project management course. I could that it really is applicable in my day to day work.
- environmental politics, water quality, air quality
- Soil Chemistry, Environmental Chemistry
- pollution control
- Aquatic Restoration, Water Quality, Grasslands, Restoration
- Water Quality, River Dynamics, Air Quality, Chemistry
- Probability & Statistics, Fire Management, Soil Science & Sustainability, Atmosphere, Ecosystem Management
- Soils Science & Sustainability, Mined Land Reclamation, Water Quality, GIS
- water quality, GIS courses

What specific topics from environmental courses have proven to be most useful to you in your environmental work?

- Soil physical and chemical properties as well as surface and groundwater interactions with plants and soil.
- Everything to do with RCRA and everything to do with watersheds and sampling surface and groundwater. Also, reading scientific papers critically to identify the strengths and weakness of the science and analysis
- chemistry, air quality regarding greenhouse gases, algebra calculations
- The general approach of soil, air, water was good. I would have benefited more had there been greater overlap between my env. Sci classes and education classes.
- Water quality scientific equipment & meter usage & understanding how the parameters relate to quality
- Plant identification, soil identification, identifying wetland criteria, statistics for data analysis
- Even though during school, understand regulations was not my most favorite thing, it really has helped me to be able to understand and use regulations that are applicable to my career.
- natural resource management
- Lab procedures, pollutant pathways, and regulatory procedures
- sampling techniques
- Wetlands, 404 permitting, NEPA, ESA, SHPO
- Water quality issues, measurement techniques and water analysis, chemistry courses
- Forest ecology principles, wetland deliniation practices, weather characteristics, tree species identification, use of various tools such as Diameter Tapes, map and compass, etc.
- GIS, land reclamation, water and soil sampling.
- the watershed science courses

What courses in other programs have been most helpful to you?

- Some of the watershed science courses like Hydrology were helpful.
- All math classes and chemistry. But not statistics - stats teacher was terrible
- college algebra
- My secondary Sci methodology class, weather & climate, ecosystem bio.
- River Dynamics & Hydrology
- Botany, Statistics, Technical Writing
- For my current career path, Oil and Gas regulations and policy course would have been very helpful.
- Definitely GIS. It has been so beneficial that I really believe GIS should even be a required course for the Environmental Science program.
- chemistry
- English
- History courses
- Probability & Statistics, Weather & Climate, Health & Wellness
- GIS, statistics, calculus, biology, chemistry
- statistics

In general, the environmental science courses I took at CMU were:

Too easy; I was not prepared for my job or graduate school	1
About right	15
Too hard; they went over my head	0

What do you think is the greatest strength of the CMU environmental science program?

- The range of topics and expertise of the staff would be the greatest strength for the program.
- The experience of the professors, and the dedication to providing students with both knowledge and critical thinking skills
- Small class size and excellent teachers
- Open door policy
- Its dedicated staff that really bring the subjects to life.
- The greatest strengths of the CMU environmental science program are the faculty and the class sizes.
- The professors were the greatest strength. The were always willing to help and all had a lot to offer.
- I really enjoyed the small class sizes, 3 hours labs, and actual field experience. The Saturday field trips were great for hands on learning.
- the field work was engaging, comprehensive, and effective
- the professors
- The diverse courses taught
- The field experience, the knowledge and background of the faculty, the small class size.
- The professors
- The availability of the professors, and their willingness to help and guide the students. Also the amount of hands on field activities and variety of local projects available.
- The quality of the program professors cannot be beaten!
- Field trips
- the laboratory experience

If you could change one thing about the CMU environmental science program, what would it be?
The frequency of class offerings could be a little higher. Given the size of the staff it is somewhat limited on being able to improve significantly, but one thing that was hard was having some classes only be offered during one semester every other year.
More sustainable/green courses, because environmental science and sustainability are both based on broad knowledge of various disciplines and how systems are integrated
labs take up a large amount of time and only qualify as one credit
Bring back the secondary Sci concentration
Include more ecology courses & include more waste management courses. These are primary subjects needed for this area.
More diversity in the class selection and better prepared to write technical documents.
Lab classes be worth mor credit hours.
I think GIS should be a required course rather than an elective. It's an extremely valuable skill to have for any environmental science related career, in my opinion. I work for the BLM now and it's been such a valuable tool in all the projects I work on.
better laboratory supplies
asbestos!!!!
I think there needs to be more course on NEPA and maybe even secondary soils courses.
Offer more courses related to water quality and water issues in the West.
More hands on experience and more career guidance
Offering more courses related to forestry, or even developing some type of forestry study program (minor/major).
Adding a graduate program would be great!

If you would like to expand on any of the above topics, or have comments on other topics, feel free to provide those here. We will appreciate any comments that help us improve our program.
Some of the teaching techniques could be varied a little bit. Some classes had just a powerpoint lecture that wasn't as interactive as other lectures and some classes had limited class work that didn't help solidfy topics covered in class and left grades to mostly exams.
My only regret is that I had to take general education classes, because I could have taken a lot more environmental science topics instead. I completely disagree with the gen ed requirements for a degree.
I had many teachers at CMU and most were excellent and extremely knowledgeable.
There needs to be more direct involvement with the industries we work in so that students have a better grasp of what the work environment will be like. We train to be environmental scientists but the reality is our first jobs are probably going to be environmental technicians. I also think a greater focus on how to go about getting into a graduate program would be very helpful. And lastly CMU needs an ecology or environmental science masters degree program because a Bachelors just doesn't cut i
I would have loved to had some range classes (specifically named range for federal employment), I would also have liked to have been taught more about the NEPA process and writing NEPA documents. This knowledge would have given me a better edge in the job market after graduation.
Looking back I am thankful for all I gained from the environmental program at CMU

Job and Career Questions

Are you working for pay right now?

	#	%
Yes, work full-time	15	88.2%
Yes, work part-time	1	5.9%
No	1	5.9%

In what type of organization is your principal employment? Mark the one best answer.

Self-employed in own business or professional non-group practice	1
Private for profit corporation/company/group/group-practice	9
Higher education (public or private)	0
Elementary or secondary education (public or private)	2
International organization in the US	0
International organization outside of the US	0
US Military	0
Federal Government (except military)	4
State and local government, institution, or agency (except education)	0
Private non-profit organization (except education and international organizations)	0
Other -	0

Which of the following best describes your current position?

	#	%
Entry Level	5	31.3%
Mid-Level	7	43.8%
Senior Level	4	25.0%
Executive Level (except for chief executive)	0	0.0%
Chief Executive (CEO, COO, CFO, GM or principal in a business of other organization)	0	0.0%

How many years have you been in your current job type?

	#	%
Less than 3 years	8	50.0%
3-5 years	5	31.3%
6-9 years	3	18.8%
10 or more years	0	0.0%

Is your current position related to your undergraduate field(s) of study?

	#	%
Yes, related to major(s)	12	75.0%
No, not related	4	25.0%

Job and Career Questions (continued)

How well did CMU prepare you for your current career?

	#	%
Very Well	5	29.4%
More than Adequately	6	35.3%
Adequately	6	35.3%
Less Than Adequately	0	0.0%
Very Poorly	0	0.0%
NA	0	0.0%

What is your approximate annual gross income (before taxes)?

	#	%
Under $20,000	1	7.1%
$20,000 - $29,999	1	7.1%
$30,000 - $39,999	5	35.7%
$40,000 - $49,999	2	14.3%
$50,000 - $59,999	1	7.1%
$60,000 - $74,999	2	14.3%
$75,000 - $99,999	2	14.3%
$100,000 - $149,999	0	0.0%
$150,000 - $249,999	0	0.0%
$250,000 - $499,999	0	0.0%
Over $500,000	0	0.0%

Comments about you work experience that will help improve CMU:

- Working for the USDA, work experience has included many aspects of agriculture that would be a beneficial program for CMU to add to the curriculum.
- Work experience requires a good (or advance)working knowledge of MS Excel and the ability to write well. I would suggest a CMU course that teaches everyone advanced Excel, Word, and Powerpoint
- My CMU adviser helped put me in contact with my current employer
- I'm currently a school Librarian. Would love to take some classes toward being a school Librarian.
- I work as an environmental field technician and to move beyond that level these days you really need to have a masters degree. Most work is in oil and gas related industries and there is very little available beyond that. An emphasis on management would greatly strengthen the chance for students to get better paying positions. I have never received a raise in two years of employment and the opportunity for advancement is not present in my workplace. Focus on waste remediation and spill response are important here as well as inspections and audits on waste facilities in my line of work. I encourage people to seek graduate school and employment in another place besides the western slope. CMU is a great start but only a start.
- The faculty cared and worked hard to give us the best experience possible. I felt prepared in my past employment in the field and a lot of times had more knowledge than senior employees with a higher education. I hope to get back into environmental science within a few years. I am currently managing a veterinary hospital and hope to combine my management skills and my environmental science knowledge to find a higher position if the field. Thank you.

Why are you not currently working for pay? (Please mark all that apply)

	# of times checked
I chose not to enter the workforce at this time.	0
It has been difficult to find a position in my field.	0
It has been difficult to find a position paying an appropriate salary.	0
I am raising afamily.	1
I am currently astudent.	0
I am doing volunteerwork.	0
I am retired.	0
Other	0

Education since College

Have you enrolled in a graduate, professional, or other degree/certificate program since graduating from CMU?

	#	%
Yes	5	29.4%
No	8	47.1%
No, but I plan to enroll in the next two years.	4	23.5%

Are you enrolled in this program now?

	#	%
Yes, I am a full-time student	1	20.0%
Yes, I am a part-time student	1	20.0%
No	3	60.0%

How long after you graduated from the degree/certificate program this survey pertains to did you start this program?

	#	%
Immediately (following fall or sprin	3	60.0%
1 Year later	0	0.0%
2-3 years later	2	40.0%
4-6 years later	0	0.0%
7-10 years later	0	0.0%
11 or more years later	0	0.0%

Altogether, how many years have/did you attend(ed) further schooling? Mark the best answer.

	#	%
None	0	0.0%
1 to 2 years	3	60.0%
3 to 4 years	2	40.0%
5 to 6 years	0	0.0%
7 to 10 years	0	0.0%
11 or more years	0	0.0%

How well did CMU prepare you for this educational program?

	#	%
Very Well	2	40.0%
More than Adequately	3	60.0%
Adequately	0	0.0%
Less Than Adequately	0	0.0%
Very Poorly	0	0.0%
NA	0	0.0%

What level of education are/were you pursing?

	#	%
Certificate	0	0.0%
Associate	0	0.0%
Baccalaureate	0	0.0%
Post-Bacc Certificate	1	20.0%
Master's	4	80.0%
J.D.	0	0.0%
Doctoral	0	0.0%
Other	0	0.0%

In which field and program are/were you studying?

Environmental Policy and Management	NEPA
Natural Resource Management	Hydrology
Education	

What is the name of the College/University where you attend(ed)?

Denver University
Denver University
USU
Framingham State University
Colorado School of Mines

Did you complete this program?

	#	%
Yes	3	60.0%
No	1	20.0%
In the process of finishing	1	20.0%

Other comments about furthering your education:

- I thought the environmental course offered at Mesa were much more useful than the courses I took to complete my Master's Degree at DU. I also felt like I got more for my money at Mesa.
- M.A. in Education

Suggestions for improving the degree/certifcate program:

- Continue to expand the range of expertise and topics.
- Maybe some more studies on lab analysis and how to properly manage analytical data
- None
- More ecology, management and specialized courses on plant ID. More emphasis on waste remediation and inspection of facilities. More phase one training. And for god sakes add some graduate level classes if not an entire program.
- See above comments.

Additional Comments:

- None
- Thanks to the staff of the environmental science department for a quality education and good foundation.
- I really enjoyed the Environmental Science program and the professors were awesome!

Demographic Questions

What is your gender?

	#	%
Male	6	35.3%
Female	11	64.7%
Prefer not to respond	0	0.0%

What is your ethnicity?

	#	%
American Indian or Alaskan Native	0	0.0%
Asian	0	0.0%
Black or African American	0	0.0%
Hispanic of any race	1	5.9%
Native Hawaiian or Pacific Islander	0	0.0%
White	16	94.1%
Two or more races	0	0.0%
Race and ethnicity unknown	0	0.0%
Non-Resident Alien (of any race or ethnicity)	0	0.0%
Prefer not to respond	0	0.0%

What is your current age?

	#	%
Under 21	0	0.0%
21-24	2	11.8%
25-34	11	64.7%
35-44	4	23.5%
45-54	0	0.0%
55 or older	0	0.0%
Prefer not to respond	0	0.0%

Do you live in the state of Colorado?

	#	%
Yes	13	81.3%
No	3	18.8%

If yes, do you live in Western Colorado?

	#	%
Yes	11	68.8%
No	5	31.3%

Appendix 6

Evaluation of Library Resources

Library Program Assessment
John U. Tomlinson Library
Colorado Mesa University

Date of Assessment: September 21, 2015

Purpose of Assessment: Program Evaluation

Program under review: Environmental Science & Technology

Program Level/s: Bachelor

Liaison Signature: Jamie Walker

1. Collection Assessment

   This assessment was prepared with reference to Library of Congress Subject Headings. Subject headings were chosen to reflect environmental science courses listed in the Colorado Mesa University 2014-2015 Catalog. An initial keyword search of the library's online catalog using the term "environmental science" indicated that over 4,500 items of all types are available within CMU's collections.

   a. Reference Support: There are 11 reference books listed in the library's online catalog with a keyword search of "environmental sciences". Online dictionaries in ecology, environment, renewable energy and sustainability, and geological sciences are also available through the library's Oxford Reference subscription.

   b. Monographic Sources (print and online): The library's online catalog (CMU) was searched for locally available books including e-books. Searches were first done for all print monographic materials and then limited to those published from 2004 to current. Government documents, which were not included in the "print" searches, were searched separately. The Prospector catalog was also searched to determine what might be readily available from other libraries without regard to date. Specific searches using subject keywords are presented here:

Subject Heading	CMU All Print	CMU 2004-Print	CMU Gov. Docs	CMU E-Books	Prospector
Environmental Sciences	67	21	138	311	3,506
Sustainability	146	66	377	516	719
Ecosystem Management	44	15	379	47	2,700
Pollution	419	33	4,776	314	434,945
Permaculture	1	0	0	0	93
Soil Science	28	3	4	34	770
Sustainability	146	66	377	516	719
Tailings (Metallurgy) – Environmental	0	0	18	0	151
Environmental Risk Assessment	37	10	196	58	1,818
Water Quality	113	10	4,152	46	20,750
Geographic Information Systems	75	16	225	181	3,193
Atmosphere	97	27	827	142	3,726
Shrubland Ecology	0	0	17	0	109
Grassland Ecology	12	3	90	3	714
Fire Ecology	19	5	78	3	1,016
Fire Management	10	6	222	3	1,134
Renewable Energy Sources	29	16	527	81	4,490
Sustainable Buildings	12	12	79	32	741
Sewage Disposal	12	2	243	7	3,728
Aquatic Ecology	1	1	58	16	975
Restoration Ecology	39	20	198	25	1,267
Statistics	690	133	8,159	1,171	124,449
Soil Science	28	3	4	34	770
Sustainability	146	66	377	516	719
Tailings (Metallurgy) – Environmental	0	0	18	0	151
Environmental Risk Assessment	37	10	196	58	1,818
Water Quality	113	10	4,152	46	20,750
Geographic Information Systems	75	16	225	181	3,193
Atmosphere	97	27	827	142	3,726
Shrubland Ecology	0	0	17	0	109
Grassland Ecology	12	3	90	3	714
Fire Ecology	19	5	78	3	1,016

c. Electronic Resources: The library subscribes to a number of electronic resources suitable for those researching environmental topics. E-books grow in number each year, and the above table under Monographic Sources shows we have a significant number. Given that e-books are relatively new on the market, most of them have been published within the last 10 years. The library also subscribes to a number of article databases suitable for environmental research as noted in the next section. Through the library's 88 databases university researchers have indexing to over 70,000 journal titles, over 30,000 of which are full text. Although not specifically counted here, there are links in the online catalog to thousands of online government documents.

d. Periodicals (print and online): The library subscribes to about a half dozen environmental science journals. Most of these have been switched to online access with a couple remaining in print format. The Greenfile database was first searched for environmental topics. Greenfile covers all aspects of human impact to the environment and indexes and abstracts more than 600,000 records; with open access

full-text links to more than 9,000 records. GeoRef was also searched which provides indexing to 3.4 million articles going back to 1669. The Academic Search Complete database (ASC) was then searched for environmental science articles. ASC indexes nearly 14,000 journals with 9,000 in full-text. ASC has partial full-text coverage from current back as far as 1887, but coverage is primarily from the late 1980s onward. Finally, the EBSCO Discovery Services database (EDS) was searched to uncover resources beyond ASC. EDS searches across several of CMU's databases including ASC. Results of individual searches are shown in the table below. These search results suggest there is a significant amount of material available in periodical resources, much with online full text. Journal literature not available through Colorado Mesa University can be provided by the Interlibrary Loan Department. Article requests are provided through 2 programs, RapidILL and OCLC Resource Sharing. RapidILL gives access to 245 academic library journal collections. The average amount of time it takes to fill an article request is 11 hours. Most requests are filled through this program. Beyond that, OCLC Resource Sharing gives access to 72,000 library collections worldwide. Both of these programs also provide book chapters as scanned documents.

Subject Heading	Greenfile	GeoRef	Academic Search Complete	EDS
Environmental Sciences	5,643	37	8,708	372,406
Sustainability	2,811	88	6,468	28,117
Ecosystem Management	3,681	22	5,099	11,062
Pollution	75,904	160,704	92,668	687,502
Permaculture	142	0	252	1,503
Soil Science	838	189	2,049	323,498
Sustainability	2,811	88	6,468	218,530
Tailings (Metallurgy) -- Environmental aspects	12	5,414	56	246
Environmental Risk Assessment	2,183	1	2,664	19,081
Water Quality	10,568	55,937	18,701	60,372
Geographic Information Systems	2,341	24,727	10,937	24,028
Atmosphere	3,874	25,774	19,940	82,087
Shrubland Ecology	55	0	124	927
Grassland Ecology	432	0	883	9,309
Fire Ecology	295	0	486	6,833
Fire Management	351	2	845	10,194
Renewable Energy Sources	14,040	97	18,840	70,900
Sustainable Buildings	3,095	0	2,568	20,903
Sewage Disposal	3,589	5	7,893	37,419
Aquatic Ecology	1,186	1	2,907	27,877
Restoration Ecology	2,235	0	3,898	14,107
Statistics	8,540	1,461	330,390	799,707

2. Evaluation of the total collection

   a. Strengths: All topics studied for this report had at least some materials; there were no areas that were entirely lacking resources. Journals are a strength for environmental science information. CMU has access to over two million articles of possible relevance for just the subjects listed above. Articles not otherwise available

may be requested though interlibrary loan. Also available are many monographs in both print and electronic formats relevant to the program. Many not available locally can be quickly obtained though Prospector. Government Documents also make a strong showing in support of this subject area.

b. Weaknesses: A few monographic areas are weak, such as "permaculture", "shrubland ecology" or the rehabilitation of mined land etc.

3. Recommendations: Attention should be given to areas that appear weak and supportive materials should be obtained where appropriate. Existing funds should be adequate to purchase new materials.

Library Director:

Sylvia L. Rael Date: 9/21/15

Appendix 7

2015 Assessment Report

Colorado Mesa University Program Outcome and Assessment Plan Template
Program Name: Environmental Science and Technology

Date: January 2015

Program Outcomes	Courses/Educational Strategies Indicate if outcome is Beginning(B), Developing(D) or Advanced(A)	Assessment Method(s)	Time of Data Collection/Person Responsible	Results of Assessment	Actions Taken
Outcome #1 Construct an organized argument (oral and written) supported by current research on a technical issue in environmental science appropriate for a specialized audience. (Communication skills)	ENVS492 Capstone in Environmental Science (A)	**What:** Students complete a semester- long project for a real client on a local environmental need. They develop a 15-40 pp. written report and a 20 minute presentation of their completed project for their client. **How:** Written reports and presentations are assessed by the ENVS492 instructor, other ENVS faculty, and the local client using a common evaluation form.	**Who:** The professor teaching ENVS492 Capstone **When:** Each spring during ENVS492	**Results:** Results presented for 2014 Capstone projects only (5 projects total). All scores are based on a 1-5 scale. (note: only one faculty member and one project sponsor rated 2 of the 5 capstone projects) **Capstone presentation evaluation** (5 of 5 projects): • Overall mean = 4.1 • ENVS faculty(3) = 3.9 • Project sponsor(1) = 4.8 • Individual projects ranged from 3.4 to 4.3 **Capstone report evaluation** Scores are means and ranges of ENVS faculty (3) & sponsor (1) ratings. • written report quality (I) = 3.9 (2-5) • lit review quality(F) = 3.1 (1-5) **Key Findings:** • Presentations rated higher than written reports. • Sponsors rated projects higher than faculty.	**Action:** Since the literature review received the lowest score, more emphasis will be placed on this in ENVS492. For example, students will be required to generate outlines of knowledge gained in prior courses and new knowledge needed for their capstone project. This assignment will be started the second week of the semester rather than mid-semester to allow more time for feedback and revision. Additional evaluation is underway as a part of our program review process. **Re-evaluation Date:** May 2016

				• Lit review rated lowest of all criteria evaluated. • Variability among groups high **Conclusions:** Students generally do a better job of oral communication than written communication. This may be a reflection that they have to do oral presentations in some upper division courses, but fewer research papers. Project sponsors tended to be satisfied with our students work.	
Outcome #2 Demonstrate the ability to design a study, collect and analyze quantitative environmental data, effectively translate results into graphs or tables, and interpret these results. (Quantitative skills, critical thinking skills)	ENVS492 (A)	**What:** Students complete a semester- long project for a real client on a local environmental need. As a part of this project, students design the study, and collect, analyze, translate and interpret quantitative data. **How:** Study design and data analysis in the final reports will be assessed by the ENVS492 instructor, other ENVS faculty, and the local client using a common evaluation form.	**Who:** The professor teaching ENVS492 Capstone **When:** Each spring during ENVS492	**Results:** Results presented for 2014 Capstone projects only. All scores are based on a 1-5 scale. **Capstone report evaluation** Scores are means and ranges of ENVS faculty (3) & sponsor (1) ratings. • Data interpret. (G) = 4.0 (2.5-5) • Work Plan (D) = 3.4 (2-5) • Detail and quality (E) = 3.7 (1-5) **Key Findings:** • Completeness and detail of work plans rated lowest of the categories • Data interpretation rated the highest • Highest variation among groups in project detail and quality **Conclusions:** Developing a detailed and complete work plan is one of our students' weaker skills. This is likely because this requires more critical thinking than the other skills	**Action:** More emphasis will be placed on Work Plan development in ENVS492. Level of detail required in the Technical Approach section will be increased. We will also try to find better examples of professional work plans for students to use as examples. Additional evaluation is underway as a part of our program review process. **Re-evaluation Date:** May 2016

				assessed here. Also, students don't get practice developing work plans in any required classes, but they do get practice interpreting and displaying data in many of our classes starting at the 200-level.	
Outcome #3 Demonstrate the ability to use tools, technology, and methods appropriate for measuring and analyzing environmental data (e.g., field and laboratory instrumentation and equipment, computer software for processing scientific data). (Technology skills)	ENVS492 (A)	**What:** Students complete a semester- long project for a real client on a local environmental need. As a part of this project, students use tools appropriate to their problem to measure and analyze environmental data. **How:** Method and data analysis in the final reports will be assessed by the ENVS492 instructor, other ENVS faculty, and the local client using a common evaluation form.	**Who:** The professor teaching ENVS492 Capstone **When:** Each spring during ENVS492	**Results:** Results presented for 2014 Capstone projects only. All scores are based on a 1-5 scale. **Capstone report evaluation** Scores are means and ranges of ENVS faculty (3) & sponsor (1) ratings. • Project methods (C) = 3.3 (1-5) **Key Findings:** This criteria had the second lowest average of all the criteria evaluated and had the highest range possible. **Conclusions:** Developing appropriate methods for a capstone project is a thought process that occurs during the development of the Capstone work plans. We have already identified work plans as a weak point of our students (see Outcome #2). Again, this may be because students don't get practice developing work plans in any required classes.	**Action:** More emphasis will be placed on Work Plan development in ENVS492. Level of detail required in the Technical Approach section will be increased. We will also try to find better examples of professional work plans for students to use as examples. Additional evaluation is underway as a part of our program review process. **Re-evaluation Date:** May 2016
Outcome #4 Demonstrate an understanding of terminology, concepts, theories, and practices in environmental science. (Specialized knowledge)	ENVS104 (B) ENVS492 (A)	**What:** Comparing pre- and post-test scores on a general knowledge quiz (50 MC questions). **How:** Students take a pretest in their ENVS104 and the same their senior year in ENVS492	**Who:** The professors teaching ENVS104 and ENVS492 Capstone. **When:** Every semester during ENVS104 and each spring during ENVS492	**Results:** **Pre-test and Post-test comparison** (mean and range) • Pre-test = **58%** (55-65%) 2009-14, 12 classes, 303 students • Post-test = **79%** (76-86%) 2009-14, 6 classes, 94 students	**Action:** No action needed. **Re-evaluation Date:** N/A

		What: Exit exams (developed internally) in four core subject areas. **How:** Students take 4 exit exams in four different subjects during their senior year in Capstone (ENVS492)	**Who:** The professor teaching ENVS492 **When:** Each spring during Capstone (ENVS492)	**Exit exams** • **81%** of exit exams were passed on the first attempt • 13%, 3.5%, 1.7% and 0.3% passed on the 2nd, 3rd 4th, and 5th attempts, respectively. **Key Findings:** • Post-test scores were 21% higher than pre-test scores. • Range of scores between classes were small (10%) and similar between pre- and post-tests • 94% of seniors passed their exit exams on the first or second tries. **Conclusions:** Students are learning and retaining basic knowledge in this program.	
Outcome #5 Complete a field-based project that evaluates and proposes a solution for a local problem or need by effectively synthesizing applicable concepts from environmental science and related disciplines. (Applied learning)	**ENVS492**	**What:** Students complete a semester- long field based project for a real client on a local environmental need. **How:** Written reports and presentations are assessed by the ENVS492 instructor, other ENVS faculty, and the local client using a common evaluation form.	**Who:** The professor teaching ENVS492 **When:** Each spring during Capstone (ENVS492)	**Results:** **Capstone report evaluation** Scores are means and ranges of ENVS faculty (3) & sponsor (1) ratings. • Basic science (A) = 3.8 (2.5-5) • Parts to system (B) = 3.8 (2.5-5) • Alternate explanations(H)=3.6 (2-5) • Client interaction (J) = 4.6 (3-5) **Capstone presentation evaluation:** Project quality = 4.1 **Key Findings:** • These criteria (A, B, H, J) were among the highest rated of capstone project reports. • Still, presentation quality scored higher than the report quality criteria used for this outcome.	**Action:** Additional evaluation is underway as a part of our program review process. No action needed until new data are collected. **Re-evaluation Date:** N/A

				Conclusions: As stated in Outcome #1, ENVS students generally do a better job of oral communication than written communication. This may be a reflection that they are required to do oral presentations in some upper division courses, but fewer written research papers. Capstone projects scored higher in these applied aspects of their Capstone projects than other criteria. This may be a reflection of the strong applied nature of the ENVS program-students do and see a lot of applied projects in the many lab courses required for our major. Project sponsors tended to be satisfied with our students during these capstone projects. The ENVS instructor gives them a handout on professional communication which may help with this.	

Evaluation Report: Environmental Science Program, Department of Physical and Environmental Sciences

Prepared by Dr. Shirley Vincent, National Council for Science and the Environment

February 2016

Executive Summary

This evaluation is based on my site visit on March 31st -February 1st 2016. Prior to the visit, I was provided the BS in Environmental Science and Technology (ENVS) program's self-study and other supporting documents. During the visit I met with Tim Foster, President of Colorado Mesa University (CMU); Carol Futhey, Provost and Vice President of Academic Affairs; Steve Werman, Assistant Vice President for Academic Affairs; Kurt Haas, Assistant Vice President for Academic Affairs and Director of Graduate Studies; Russ Walker, Head of the Department of Physical and Environmental Sciences; Deborah Kennard and Tamara Minnick, ENVS faculty; key administrators from the library, IT, distance education and assessment offices; seven ENVS seniors and five alumni. I toured the department, library and other university facilities. Through the interviews and experiences, I constructed a strong understanding of the ENVS program. The time and effort of all those involved in planning and participating in the site visit was greatly appreciated—especially since some came in to meet with me in spite of the weather closure of the campus.

The purpose of this report is to: (1) compare the Department of Physical and Environmental Sciences (DPES) program in Environmental Science and Technology (ENVS) to peer programs nationally based on National Council for Science and the Environment (NCSE) research, and (2) make recommendations on improving the programs relative to peer programs nationally and feedback from program constituents—faculty, students, and alumni. The ENVS major is the only interdisciplinary environmental and sustainability (IES) program offered at Colorado Mesa University (CMU).[1]

CMU recently underwent a strategic assessment and reorganization process that defined its vision for the future: "Colorado Mesa University in 2020 will be respected as a learning community that embraces diversity of students, faculty, staff, ideas, and degree levels, while maintaining a quality educational environment that focuses on serving its many constituents. As it assumes an expanded leadership role, CMU will expand its public engagement of the region's stakeholders by serving as the primary intellectual and cultural center and promoting the exchange of ideas that are of regional, national, and international importance." A university often is a significant partner in regional economic development. Environmental and sustainability education programs are critically important for regional development and are in high demand for the workforce of the future. The ENVS program strengthens CMU's role as an important contributor to economic development and providing service to society.

[1] IES programs include all degree programs with environment/al or sustainability in the degree name as well as other degree programs that focus on the environment or sustainability using an interdisciplinary approach, such as natural resources and watershed management.

Program Review Element	Check the appropriate selection				Provide explanation if not agree with element and/or why unable to evaluate
	Agree	Not Agree	Unable to Evaluate	Not Applicable	
The program's self-study is a realistic and accurate appraisal of the program.	X				
The program's mission and its contributions are consistent with the institution's role and mission and its strategic goals.	X				
The program's goals are being met.		X			Most of the programs goals are being met – additional faculty lines are needed for the program to be able to achieve its goals.
The curriculum is appropriate to the breadth, depth, and level of the discipline.		X			The current curriculum is strong but doesn't include sufficient focus on the sociopolitical aspects of environmental issues.
The curriculum is current, follows best practices, and/or adheres to the professional standards of the discipline.		X			The curriculum doesn't include systems approaches to environmental problem solving which is a critically important core skill.
Student demand/enrollment is at an expected level in the context of the institution and program's role and mission.	X				
The program's teaching-learning environment fosters success of the program's students.	X				
Program faculty members are appropriately credentialed.	X				
Program faculty members actively contribute to scholarship, service and advising.	X				
Campus facilities meet the program's needs.	X				
Equipment meets the program's needs.		X			Adequate budget for maintaining and updating key equipment is an ongoing concern.
Instructional technology meets the program's needs.	X				
Current library resources meet the program's needs.	X				

Student learning outcomes are appropriate to the discipline, clearly stated, measurable, and assessed.		X			The assessment plan in place is very good but incomplete. An important learning goal has not been assessed yet.
Program faculty members are involved in on-going assessment efforts.	X				
Program faculty members analyze student learning outcome data and program effectiveness to foster continuous improvement.	X				The new process put in place is working well but is incomplete at this point.
The program's articulation of its strengths and challenges is accurate/ appropriate and integral to its future planning.		X			The program needs to work with an advisory board to better align its curriculum with workforce needs and current trends.

Colorado Mesa University Carnegie Classification

- *Basic Carnegie Class/Control:* Baccalaureate Colleges: Diverse Fields, public control
- *Size and Setting:* Medium four-year, primarily nonresidential (FTE enrollment of at least 10,000 degree-seeking students, fewer than 25% of degree-seeking undergraduates live on campus and/or fewer than 50% percent attend full time)
- *Enrollment and Undergraduate Profile:* Very high undergraduate, four-year, full-time, inclusive, higher transfer-in
- *Instructional Programs:* Undergraduate balanced arts and sciences/professions some graduate coexistence, Graduate post baccalaureate other-dominant, with other professional programs
- *Community Engagement:* not designated

The Carnegie Classification of Higher Education Institutions has been the leading framework for recognizing and describing institutional diversity in U.S. higher education since 1970. The Carnegie Classification framework is been widely used in the study of higher education, both as a way to represent and control for institutional differences, and also in the design of research studies to ensure adequate representation of sampled institutions, students, or faculty. The attributes listed here for Colorado Mesa University (2015 profile) are used to tailor this report.

Department of Physical and Environmental Sciences

The Department of Physical and Environmental Sciences (DPES) administers a number of degrees organized into five programs: Environmental Science and Technology, Chemistry, Engineering, Geosciences, and Physics.

Environmental Science and Technology

- BS in Environmental Science and Technology (concentration in Environmental Science with options in Pollution Monitoring and Control and Ecosystems Restoration)
- Minor in Environmental Science and Technology
- Technical Certificate in Sustainability Practices

Chemistry program

- BS Chemistry (concentration in biochemistry)
- Minor in Chemistry

Engineering Program

- AAS/BS in Mechanical Engineering Technology

BS in Mechanical Engineers in partnership with CU-Boulder Geosciences Program

- AS in Liberal Arts (Geology emphasis)
- BS in Geosciences (concentrations in Geology and Secondary Education, option in Environmental Geology for Geology concentrators)
- Minors in Geology, Watershed Science, and Geographic Information Systems and Technology

Physics Program

- AS in Liberal Arts (Physics Emphasis)
- BS in Physics
- Minor in Physics

The website for the Environmental Science and Technology major provides this description: Environmental Science is the study of the relationships among humans, other organisms, and the non-living physical environment, with an *emphasis on the impacts of human activities*. Technology, when used wisely, contributes to the solution of current environmental problems and the prevention of new ones.

The webpage also includes answers to two questions "Why major in environmental science?" and "Why study Environmental Science as CMU?" as follows: Although the modern era of environmental protection and restoration is 30 years old, we continue to face an array of complex, challenging problems. These problems range from the local scale, such as a polluted mine site, to the global scale, such as resource use that affects our land, air, water and ecosystems. If we are to maintain and improve the quality of life for current and future generations, we must respond to these problems with timely and effective solutions. Our program in Environmental Science and Technology will prepare you to be part of the solution to these environmental challenges. Students who enjoy doing science, particularly in an outdoor setting, and solving challenging problems will find this work to be deeply satisfying.

In the Colorado Mesa University program, we emphasize understanding, protecting and restoring land, air and water resources. A large portion of the program is devoted to field work. The opportunities to do this fieldwork are abundant in the Grand Junction area, with its surrounding private and public lands, and water resources. In addition, our faculty have a variety of specialties, enabling our students to gain experience in a wide variety of areas. Class sizes are small, leading to quality interactions with the instructors.

Administrative Location of the Environmental Science and Technology Program

The Environmental Science and Technology program is one of five programs located within the Department of Physical and Environmental Sciences. Each program has its own designated faculty and the programs operate to a large extent independently. The ENVS program has its own designated laboratories and classroom space and its own core faculty.

This structure is unusual. At baccalaureate colleges most (57%) IES administrative units are programs that span multiple departments, another 23% are housed within their own department (such as a Department of Environmental Studies and Sciences), and 20% are IES degree programs housed in other departments (such as Biological Sciences). The ENVS program at CMU is a hybrid—it's housed in a department that serves as the umbrella for five programs—one interdisciplary (ENVS), three disciplinary (chemistry, geoscience and physics) and one professional (engineering). In one sense it's an IES program in a primarily discipline-based department but it also has its own core faculty and dedicated space so in that sense it's located in its own department.

Faculty and Facilities

The environmental science and technology program has three core tenured faculty members, who trained as an analytical chemist, an ecologist and a botanist. All are well-qualified and actively engaged in research and community service. All three receive strong praise from the students and alumni on the quality of their teaching as well as their availability and role as advisors.

The campus facilities are exceptional as are the instructional resources and the library facilities, services, and holdings. The program has dedicated laboratory facilities that include a multipurpose instructional lab, student and faculty research lab space, and storage space for equipment and materials.

The program has some challenges in maintaining current equipment in working order and updating equipment to keep pace with new ENVS technology. The students noted that they thought the technology (equipment) used in the program was somewhat out-of-date based on their internship and work experiences.

Attributes of the Environmental Science and Technology Degree

Tables 1-4 illustrate how the ENVS BS program compares to peer programs at peer institutions. The average number of majors for the ENVS program are much higher than those for peer programs but the number of graduates indicates a potential problem with retention to graduation (Table 1).

Table 1. Degree program enrollment/graduates*

	Majors Average 2009-12		Graduates Average 2009-12		ENVS Average 2009-current	
	Mean	Max	Mean	Max	Majors	Graduates
Environmental Science(s) BS *n*=19	26	75	9	40	124	17

*Degree programs at baccalaureate colleges that participated in 2012 NCSE survey.

The program requirements for the ENVS degree are similar to peer programs in many respects but not all (Tables 2-3). The number of credit hours required for the degree, major and core are only slightly higher than average, but the number of credit hours developed specifically for the degree is much higher than average 50 versus 15. The ENVS degree requirements are similar to peer programs in requiring a capstone/synthesis course and requiring participation in team research (the majority of programs either require or have as an option for requirements). The ENVS requirements differ from peer programs in not requiring individual research and a senior thesis or equivalent (most peer programs require), and in requiring a field course and participation in an applied project (only a third of peer programs require). Half of peer programs also include an honors option and support for undergraduate research publications.

Table 2. Degree requirements for CMU ENVS majors

Credit hours for degree	Credit hours for major		Credit hours for core		Credit hours designed for major
120 (<25% distance)	67		37		50
Coursework in a traditional discipline or professional field	Dual degree/major required	Minor or equivalent required	Dual major required for some degree options	Minor or equivalent required for some degree options	Minor or equivalent encouraged but not required
					√
Other requirements	Required	Required for some degree options	An option to meet a requirement	Encouraged but not required	Not offered
Advanced synthesis/capstone course	√				
Field research course or equivalent	√				
Senior thesis or equivalent					√
External internship (credit earned for degree)				√	
Participation in a team research project	√				
Participation in an individual research project			√		
Participation in an applied project (campus, community, demonstration)	√				
Study abroad (credit earned for degree)			√		
Professional development	Honors option	Encourage UG publication	Encourage conference presentation	Require or encourage careers exploration	Require or encourage formal internship matching

Table 3. Degree requirements for Environmental Science(s) BS programs*

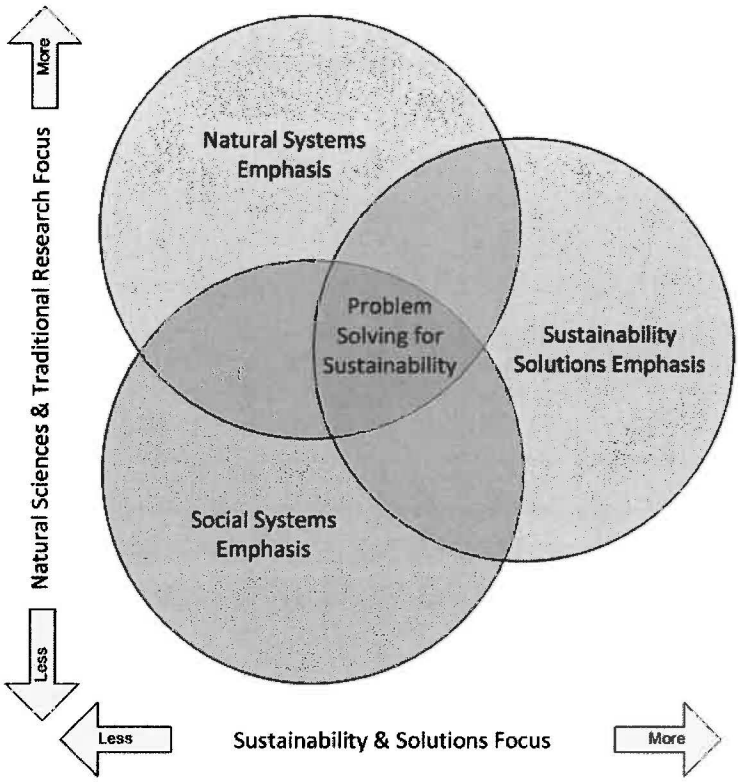
(*n*=22)

Mean credit hours for degree	Mean credit hours for major		Mean credit hours for core		Mean credit hours designed for major
118 (<25% distance)	58		34		15
Coursework in a traditional discipline or professional field	Dual degree/major required	Minor or equivalent required	Dual major required for some degree options	Minor or equivalent required for some degree options	Minor or equivalent encouraged but not required
	14%	29%	-	14%	43%
Other requirements	Required	Required for some degree options	An option to meet a requirement	Encouraged but not required	Not offered
Advanced synthesis/capstone course	89%	-	-	6%	5%
Field research course or equivalent	32%	-	21%	32%	15%
Senior thesis or equivalent	58%	5%	16%	16%	5%
External internship (credit earned for degree)	11%	5%	5%	58%	-
Participation in a team research project	44%	6%	17%	11%	22%
Participation in an individual research project	58%	-	10%	32%	-
Participation in an applied project (campus, community, demonstration)	32%	5%	5%	58%	-
Study abroad (credit earned for degree)	-	5%	5%	79%	11%
Professional development	Honors option	Encourage UG publication	Encourage conference presentation	Require or encourage careers exploration	Require or encourage formal internship matching
	53%	50%	-	18%	23%

*Degrees at baccalaureate colleges that participated in 2012 NCSE survey.

Curriculum

NCSE research has revealed three broad approaches to undergraduate IES education as described in the report on curriculum design.[2] The ENVS program aligns with the *Natural Systems Emphasis* cluster.[3]



The *Natural Systems Emphasis* model prepares scientists who, through their combination of breadth of understanding of sustainability and interdisciplinary processes and disciplinary depth in an area of the natural sciences or in a thematic area such as pollution control or ecosystem restoration can effectively participate in applied research to inform decision-making. Programs aligned with this model are most often named environmental science(s) and often have the primary goal of preparing students for graduate study. The also most often require participation in field and applied research courses. These attributes, with the exception of a primary goal of preparing students for graduate study, are consistent with the ENVS program.

The *Social Systems Emphasis* model prepares policy and administration professionals to serve as critical policy actors within transdisciplinary processes as well as translators working at the policy-science and policy-management interfaces. Programs aligned with this model are most often named environmental studies and often focus on a strong liberal arts education rather than pre-professional education.

Professionals prepared in programs embracing the *Sustainability Solutions Emphasis* models serve as the "meta-experts" and decision process managers who understand the relevance of various expertise and knowledge claims in interdisciplinary and transdisciplinary processes and therefore can construct, facilitate, and manage these processes. These programs have the most variety in their names and have the strongest focus on preparing environmental and sustainability professionals. This approach is consistent with a transdisciplinary approach to problem solving as well as evolving IES workforce needs as defined by the federal government, employers and IES professionals.

[2] Vincent, Bunn and Sloane (2013). *Interdisciplinary Environmental and Sustainability Education: Curriculum Design*. National Council for Science and the Environment, Washington: DC.
[3] Data for the analysis provided by Dr. Walker.

Assessment

The ENVS program recently developed a set of Student Learning Outcomes for the ENVS students. The current assessment plan includes six of the seven learning outcomes. One of the most important learning outcomes—identify and evaluate the assumptions, hypotheses, alternative views on environmental problems, then articulate implications and form conclusions—is not currently addressed by the assessment plan. CMU programs have six years to implement evaluation plans and the ENVS program is on track to do so, with only one learning outcome assessment plan pending. Suzanne Lay, the Co-Director of Assessment at CMU believes the ENVS program assessment process is going well.

The process of implementing the assessment plan is ongoing with data collected and analyzed for 2014. Conclusions and actions for improvement are well thought out and appropriate. The program should include a plan for evaluating the seventh learning outcome in its next iteration of planning.

The Environmental Science Workforce

Job opportunities for graduates of environmental science programs are especially strong. Demand for all STEM (Science, Technology, Engineering and Mathematics) graduates is growing. A recent study reports that demand is intensifying for STEM graduates in not only traditional STEM occupations but also in other occupations that value STEM graduates' core competencies.[4]

Job opportunities for STEM graduates in the environmental sector are especially strong. The United States Department of Labor predicts an 11% increase in the number of environmental scientist and specialist positions between 2014 and 2024, higher than the average for physical scientists (7%), and higher than the average for all occupations (7%).[5] Jobs are concentrated in two areas: professional, scientific and technical services (40%), and government, especially state and local government (41%). A 2013 study revealed that college graduates in environmental fields (natural resources and environmental sciences) have some of the lowest unemployment rates compared with other majors, and environmental science graduates have a lower unemployment rate than majors in other physical and life sciences.[6]

Job growth for environmental scientists and specialists is expected to be strongest in private sector consulting firms; demand is also expected to be strong in local and state governments in environmental health areas. More businesses are expected to consult with environmental scientists in the future to help them minimize the impact their operations have on the environment, and environmental scientists are expected to be needed to help planners develop and construct buildings, utilities, and transportation systems.

The 2008 *Jobs and Environment Initiative* study analyzed the environmental job market nationally and in nine states (Arizona, California, Connecticut, Florida, Michigan, Minnesota, North Carolina, Ohio and

[4] Carnevale, A. P., Smith N. and M. Melton (2011). STEM. Georgetown University Center on Education and the Workforce.
[5] Bureau of Labor Statistics. US Department of Labor *Occupational Outlook Handbook 2016-17 Edition: Environmental Scientists and Specialists.* http://www.bls.gov/ooh/life-physical-and-social-science/environmental-scientists-and-specialists.htm
[6] Carnevale and Cheah, (2013) *Hard Times: College Majors, Unemployment and Earnings.* Washington, DC: Georgetown University Center on Education and the Workforce

Wisconsin).[7] It identified the size of the environmental protection industry as $341 billion/year and growing (projected to reach $496 billion in 2020; larger than most industrial sectors and the top Fortune 500) and estimated the industry was responsible for the creation of 5.3 million jobs in 2005 distributed across all employment sectors. The study also found that the environmental sector is more resilient or "recession-proof" in economic downturns.

The size of the environmental industry in the nine states comprised from 2.6% to 3.9% of state GDP, corresponding to 2.9% to 4.9% of total state jobs. The size of the environmental protection sector is fairly consistent across the states included in the study; therefore likely to comprise a similar proportion of state GDP and total state jobs in Colorado.

Emerging opportunities for IES program graduates include planning-oriented jobs in public administration (environmental policy and planning, urban development), land use planning, sustainability (private and public sector sustainability management, sustainable community development, international sustainable development), and environmental management (private and public sector environmental management systems, water management, energy management, greenhouse gas accounting and management, materials and waste management). Environmental protection expertise and sustainability knowledge are increasingly applicable across a wide spectrum of jobs, creating demand for IES degree programs as well as minors, certificates, and professional continuing education programs.

A recent national study investigated the economic worth of different undergraduate majors and where bachelor's degree holders work by occupation and industry.[8] The report included information on undergraduate environmental science degrees and other related degrees (Table 4). Each major has a distinct profile in terms of the graduates' professions, the sectors they work in, and the number that earn graduate degrees (and the impact a graduate degree has on earnings). This report indicates that only about a third of environmental science degree holders have earned graduate degrees; but recent NCSE surveys of IES program graduates indicate that the majority (>80%) plan to earn master's degrees. The study also reveals that management is the top occupational category for environmental science graduates.

The five program alumni I spoke with had diverse positions: 1) owner/manager of his own company that specializes in asbestos removal and abatement (2006 graduate), 2) consulting company database manager and analyst (2007 graduate), 3) consulting company permitting and compliance related primarily to wetlands for oil and gas extraction and transportation projects (2012 graduate), 4) consulting company third party verification for greenhouse gas cap and trade agreements and mitigation, and 5) consulting company energy market analyst (2015 graduate. Four of the seniors aspire to jobs in federal government agencies, one is attending professional school in environmental law, and two hope to work in the education/non-profit sector.

[7] Bezdek, R. H., R. M. Wendling, and P. DiPerna. (2008). Environmental Protection, the economy, and jobs: National and regional analyses. *Journal of Environmental Management* 86: 63-79.

[8] Carnevale, A. P., J. Strohl, and M. Melton. (2011). What's it Worth: The Economic Value of College Majors. Georgetown University Center on Education and the Work Force.

Table 4. Economic characteristics for selected majors

Major	Top three occupational categories	Top three industry categories	Median earnings	Proportion with graduate degree/earnings boost with degree
Environmental Science	Management, Life Science, Sales	Professional Services, Public Administration, Retail Trade	$51K	29%/40%
Ecology	Management, Life Science, Sales	Professional Services, Health Services, Public Administration	$44K	36%/74%
Chemistry	Life Science, Management, Education	Manufacturing (non- durable), Professional Services, Education Services	$58K	60%/93%
Natural Resources Management	Management, Life Science, Sales	Public Administration, Professional Services, Education Services	$50K	28%/45%

ENVS Program Strengths

The ENVS environmental programs' strengths include:

- Strong science foundation and many specific ENVS courses
- Capstone course/applied project experience
- Core tenured environmental science faculty
- Facilities including dedicated laboratories and storage space
- High student demand and satisfaction
- Excellent student/faculty relationships

The ENVS program has a number of strengths including: 1) the curricula with its strong science emphasis, high number of courses developed specifically for the major, and the applied research capstone which provides student with real-world experience and career opportunities, 2) the high quality facilities, 3) the core ENVS faculty tenured within the DPES, and 4) high student demand and satisfaction and positive relationships with the students and alumni. Many environmental science programs at baccalaureate colleges do not have their own core faculty.[9]

The capstone course is a particular strength of the program. The students demonstrate application of the knowledge and skills they've acquired in the curricula by working closely with local/regional agencies and organizations on real-world problems. Several students and alumni mentioned that the capstone was instrumental in providing experience beneficial for seeking employment after graduation.

Two other notable strengths are high student demand—the number of majors is much higher than peer programs and has had steady growth since 2008—and exceptional student satisfaction as evidenced by the alumni survey results. The current students and alumni emphasized the quality of the ENVS courses and their advising relationships with the program faculty.

[9] Vincent, Sutton, Santos and Sloane 2015. *Interdisciplinary Environmental and Sustainability Education and Research: Leadership and Administrative Structures.* National Council for Science and the Environment. Washington DC.

ENVS Program Challenges

The ENVS program has several challenges, including:

- High number of majors to faculty ratio
- Student retention
- Equipment maintenance and updated technology
- Curriculum is not well aligned with current environmental science curricula and national employment opportunities
- Lack of an advisory board
- Lack of meaningful engagement with the CMU Redifer Institute research and policy centers

The program growth necessitates the need for at least one additional faculty member. Class sizes are larger thus requiring more faculty time which limits their ability to participate in program development and research activities. Increases in the number of majors also necessitates additional course sections which are taught by part-time faculty. Instruction for the ENVS Soil Science and Sustainability course is problematic. An individual with soils science expertise is needed to regularly cover this core environmental science course.

Student retention is an issue as discussed in the self-review. The calculus requirement appears to be an impediment for some students; removing this requirement may improve retention. The current students believe an advanced statistics course would be of more benefit than calculus. They recommend requiring ENVS 475 Experimental Design and Statistical Analysis in Environmental Science instead of calculus for the major. The alumni also agreed an advanced statistics course would be beneficial; only one used calculus in his career.

Funding to maintain and update key core equipment is sometimes a challenge for the program. An advisory board may be able to assist with funding or donation of services/equipment.

The current students and alumni also felt that more social science content should be included in the major (requirements or restricted electives), particularly environmental policy, philosophy of science and ethics, environmental politics, and working with stakeholders in environmental decision-making. They also thought there should be more focus on professional skills such as GIS and environmental assessment (NEPA). Linking science, policy and management is an important element of environmental science; this linkage has been identified as one of the critical unmet needs of society and highlights the need for environmental professionals trained to work at the policy-science and management-science interfaces to help bridge science and policy.

The most significant weakness in the ENVS program is that it hasn't kept up with current trends in environmental science curriculum design, specifically a lack of preparation in understanding and applying systems approaches that focus on the interfaces and interactions of coupled human-nature systems. The ENVS program is described this way on its website: "Environmental Science is the study of the relationships among humans, other organisms, and the non-living physical environment, with an *emphasis on the impacts of human activities*." This description is not well aligned with the characteristics of the

current consensus view on the identity of the field or with the approach of the federal government (representative of the national view).

- Focus of study: the interfaces and interactions between coupled human-nature systems.
- Educational approach: an integrated, holistic approach that focused on interdisciplinary knowledge and insights gained from systems approaches and diverse epistemological viewpoints.
- Key learning outcomes: disciplinary synthesis and systems-thinking skills; knowledge of the sociopolitical and natural aspects of environmental problems, understanding the limits of technology and science, and the importance of dealing with uncertainty.

An interdisciplinary systems approach is the core of environmental science today. The federal government formally shifted its environmental focus to sustainability in the 2007 national *Sustainability Research Strategy* which states: "The focus on sustainability research recognizes the changing nature of environmental challenges that society faces today. In the past the United States Environmental Protection Agency (USEPA) focused its actions more directly on specific pollutants, their sources and their causes. More recently, and into the future, the Agency must provide information that will address a broader set of environmental issues involving population and economic growth, energy use, agriculture and industrial development. Capably addressing these questions and the tradeoffs they will entail requires ***new systems-based focus on science and analysis***."[10] USEPA programs and research are now grouped into four key areas: 1) safe and sustainable communities, 2) sustainable water, 3) air, climate and energy, and 4) safer products for a sustainable world and are focused on pollution prevention and design for sustainability. The structure of the ENVS Pollution Monitoring and Control option is more aligned with the previous USEPA structure focused on pollution monitoring and control in air, water and soils.

The 2015 National Science Foundation Advisory Committee on Environmental Research and Education (NSF AC-ERE) report titled *America's Future: Environmental Research and Education for a Thriving Century* also emphasizes the need for the "science of integration" and "systems science" that integrates the behavioral sciences, life sciences, earth and atmospheric sciences, social sciences, mathematics, physical sciences, engineering and information sciences.[11]

Environmental professionals point to the relevance of sustainability-oriented integrative processes in their work, particularly the need for professional skills related to context-specific problem solving that engages a variety of public and private entities. They emphasize that professional competence is linked to problem solving in specific contexts—working with environmental issues in the interplay of companies, consultants, regulatory authorities, local communities and non-governmental organizations.

[10] United States Environmental Protection Agency Office of Research and Development. 2007. *Sustainability Research Strategy*. http://www.epa.gov/Sustainability/pdfs/EPA-12057_SRS_R4-1.pdf.

[11] National Science Foundation AC-ERE. 2015. *America's Future: Environmental Research and Education for a Thriving Century*. National Science Foundation. Washington, DC.

Recommendations

Effectively addressing the challenges faced by the ENVS programs require an open-minded consideration of the current curriculum, additional faculty lines, and mechanisms to support engagement with the Redifer Institute Centers.

Assigning priority to the recommendations is somewhat difficult since they are interrelated. A new faculty line would be highest priority (recommendation 3), but the criteria for the position should be carefully considered in regard to recommendations 1, 2 and 6. Curriculum change is second priority closely related to all the recommendations. Some changes can be done immediately, such as changing the calculus requirement to the advanced statistic courses. Other changes should be make in consultation with an advisory board, the input of a new faculty hire with environmental science training and expertise in systems approaches to problem-solving, and engagement with the Redifer Centers. Recommendation 6 requires the other recommendations be implemented and therefore is the lowest current priority.

1) ***Consider curriculum changes to increase retention and better align the curriculum with current trends and job opportunities.*** The calculus requirement is a barrier for some students and isn't a core course required for most environmental science professionals. Advanced statistics is more relevant for environmental scientists. I recommend replacing the current calculus requirement with an advanced statistics course: ENVS 475 Experimental Design and Statistical Analysis in Environmental Science.

   I also recommend the ENVS program develop an advisory board or work with the advisory boards associated with the Redifer Institute Centers to determine which social science and professional course electives could be added to the restricted electives list to best prepare students for the Western Slope and Colorado region workforce. Management and organizational development, courses related to understanding the sociopolitical aspects of environmental problems (e.g. environmental policy, environmental politics, philosophy and ethics) and working with stakeholders (e.g. sociology, conflict resolution) are good options.

   Ideally, environmental science curricula should provide: (1) an overview of the fundamentals of environmental science and studies including current issues and an introduction to core concepts of sustainability (ENVS 104); (2) core concepts in the natural sciences relevant to understanding natural systems and anthropogenic perturbations—including understanding of the scientific method, the limitations of science, and uncertainty (several ENVS courses); (3) a course or courses that integrate core concepts in the social sciences and humanities relevant to understanding the interrelationships between social and natural systems—including economic systems, historical perspectives, ethics, and values; and (4) a course or courses that introduces systems approaches for developing new understanding and knowledge to facilitate policy development and management decisions—including a discussion of differing epistemological and methodological perspectives on environmental issues as well as an introduction to stakeholder involvement and conflict resolution. The current capstone course would be the ideal course for the students to gain practice in using a systems thinking/problem solving approach.

2) ***Consider changing the pollution monitoring and control option to one better aligned with current environmental/sustainability themes.*** The United States Environmental Protection Agency identifies four key areas of environmental protection—sustainable water resources, sustainable communities (including health and planning), energy and climate (including adaptation, mitigation and communication) and sustainable materials and processes design. The DPES and CMU have broad expertise in water indicating a water-focused concentration may be an option; water conservation and management may be an option that fits well with the current program strengths.

   Historically, many graduates of the ENVS program have found jobs related to pollution monitoring and control, especially consulting work involved with permitting and compliance related to the natural resource extraction industries. These industries are experiencing a sharp downturn in the Western Slope that is unlikely to rebound soon. The industries employing the most people in the Western Slope are government, accommodation and food services, retail trade, health care and social assistance and construction.[12] The ENVS program should focus on preparing students for the emerging jobs in the changing economy of the region and for broader regional and national opportunities for environmental scientists/professionals.

3) ***Consider hiring two new full-time faculty positions for environmental science: one now and one later to develop capacity for a master's program.*** The ENVS faculty to major ratio is 1:48 compared with 1:10 for the chemistry and physics programs and 1:16 for the geosciences program. Credit hour ratios are slightly lower at 1:671 for environmental science and technology compared with 1:693 (physics), 1:718 (geosciences) and 1:733 (chemistry). This ratio could be higher if the ENVS faculty were expanded and thus able to offer more general education classes. Demand for environmental and sustainability education is high—the Princeton Review's annual incoming freshman survey finds 60% of students and parents consider college's commitment to environmental issues (including course offerings) as an important factor in their decision on where to attend.[13] The ENVS program also has room to grow—the average number of majors in environmental undergraduate programs increased by 49% from 2008-2012.[14]

   The program's continued rapid growth requires additional faculty to continue to provide a quality program that allows students to have access to the courses they need to graduate on time. A new hire also provides an opportunity to not only support the current strong program, but also provides an opportunity to modernize the current program and position the program for future opportunities. I recommend an immediate new faculty line right away to stabilize the program and bring in needed expertise in interdisciplinary systems approaches to environmental problem solving and another faculty line later to support a redesigned concentration focused on water and allow the development of a professional environmental master's program. For both positions I recommend the program consider candidates with training in environmental science, with needed expertise in both soils and

[12] Fox 2014. *Western Slope Economy*. Colorado Business Review 80(4). Leeds School of Business, University of Colorado Boulder.

[13] The Princeton Review. 2015. *College Hopes and Worries Survey Report*. https://az589735.vo.msecnd.net/pdf/cohowosurvrpt_mar182015.pdf

[14] Vincent, Bunn and Sloane. 2013. Interdisciplinary Environmental and Sustainability Education on the Nation's Campuses 2012: Curriculum Design. National Council for Science and the Environment. Washington DC.

systems approaches to problem-solving for the first position and watershed conversation and management for the second. There are over 150 environmental science doctoral programs at research universities across the United States; a number of these have emphases in geosciences or water/watershed management.

4) ***Consider how the ENVS program can be more engaged with the Redifer Institute Centers.*** The ENVS program would benefit from involvement in the stakeholder and community engagement activities of the Centers. Practical methods/mechanisms to support closer ties between the centers and the ENVS programs should be considered by CMU.

5) ***Consider establishing an advisory board or working with the advisory boards of the Redifer Institute Centers.*** An advisory board is an important source for information about the qualifications employers are seeking in environmental science graduates, and changing workforce needs in the Western Slope and Colorado region. They also serve an important function in experiential learning opportunities (internships and capstone projects), graduate careers placement, and potentially program support (donations, equipment and equipment servicing needs).

6) ***Consider developing a new graduate degree for environmental science majors.*** The ENVS programs do not provide an opportunity for students to seamlessly continue their education at CMU. Nationally, the majority of environmental science program undergraduates plan to continue their education through the master's level—immediately following graduation or later in their careers. A new graduate program in environmental science should be considered. Professional Science Master's which combine studies in science and business may be a good option.[15] Another option is an accelerated 5-year BS/Professional Master's program. A project-based (rather than thesis-based) 3+2 BS/Master's option would be a good fit for the ENVS program. Demand is strong for a master's program in environmental science—all the seniors I spoke with said they would immediately continue if a 3+2 BS/Master's option was offered. All but one of the alumni either had already earned or planned to earn a master's degree.

   The Master in Environmental Management program at Western State Colorado University provides an illustrative model of a program that has 70 students enrolled during its first two years of operation. The program provides a limited residency online option that is attractive to students. In addition to the MEM program, Western State Colorado University also hosts the Center for Environment and Sustainability that coordinates faculty and student community research and the Institute for Applied Sustainability that provides continuing education options for working professionals. Continuing education options can bring in revenue and enhance external partnerships.

   An increasing number of programs are also offering dual majors—these options are attracting increasing numbers of students, providing evidence of students' interest in programs that fuse environment/sustainability and other disciplines/professions. A dual environmental science degree combined with a business management degree would likely be competitive. Other dual options, such as dual programs in environmental science and public health should also be considered.

[15] See http://www.sciencemasters.com for more information.