BS in ENVIRONMENTAL SCIENCES ASSESSMENT PLAN AND REPORT 2012-2013

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I Overview of the Environmental Sciences Program: History, Status, and Challenges

The BS in Environmental Sciences started at Oregon Tech in 1995. It is currently offered only on the Klamath Falls campus. Enrollment as of Fall 2012 was 46 students (Figure 1). It has ranged from a low of eight in 1995 to a high of 46 in 2012. The decline between 2002 and 2008 is believed to be related the growth of the AAS degree Natural Resources at Klamath Community College (KCC) and the establishment in 2006 of Oregon Tech's BS in Biology. Since 2008, however, the BS in Environmental Sciences has experienced a steady increase in enrollment, which may be explained by a combination of the following factors: new faculty (instruction and advising), new dual-major programs in Civil and Renewable Energy Engineering, expanded recruiting efforts, suspension of the BS in Biology by the Natural Sciences Department, and a poor economy. The current enrollment goal for the program is approximately 60 students. Enrollment is functionally limited by the capacity of faculty to advise student research projects, which are required for graduation.

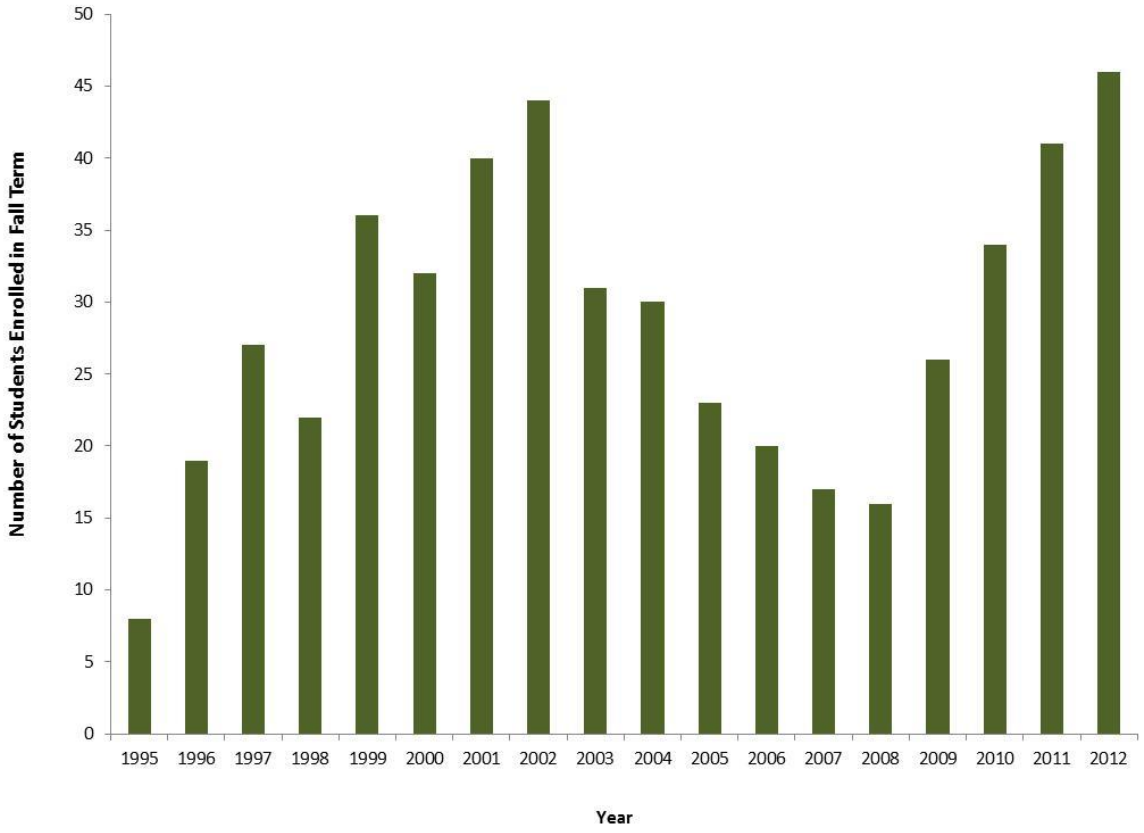

Figure 1. Environmental Sciences Enrollment, Fall Term 1995-2012

Over the last two academic years (2011-12 and 2012-13) the Environmental Sciences Program has graduated twelve students. According to currently available information, only one of these students is not currently employed in the environmental sciences field. Placement of graduates has occurred in both the public and private sectors. Although salary figures are not available,

anecdotal evidence suggests that graduates are placing and being paid at levels that are equal to or higher than graduates of similar fields at other institutions and graduates in similar or related fields at Oregon Tech.

Current challenges to the Environmental Sciences Program include implementation of field studies and functional limits on enrollment imposed by student research project requirements. In order to teach environmental sciences in the hands-on way that Oregon Tech advocates, faculty must design and implement field studies throughout much of the curriculum. Many of these studies require or are otherwise aided by overnight travel. The logistical requirements to do so, however, are great. They include, but are not limited to, various administrative levels of paperwork for trip approval and documentation; locating, scheduling, and retrieval of rental vans (sometimes not available at local rental outlets); provision and preparation of food and other camp resources; nearly continual design and implementation of novel field applications; and regulation of student conduct in field settings. While many of these requirements are not unique to the Environmental Sciences Program, the frequency with which they must be met is. During the 2011-12 school year, for example, one faculty member implemented six field trips, most of which involved overnight stays. The extra work that these trips required went fully or partially uncompensated and occurred in substantial part because of the personal initiative and resources of the instructor. This circumstance could be not sustained. Fewer field studies occurred during the 2012-2013 school year, which may have been an appropriate adjustment; however, student learning opportunities were undoubtedly fewer than the year before.

In response the need to better support field studies, the Environmental Sciences Program established the Oregon Tech Summer Field Institute (SFI) during the summer of 2012. The SFI continued during the summer of 2013. Approximately 50 students were enrolled each summer in an average of five courses. Some students attended from other schools or participated as professionals seeking continuing education. While the SFI has been successful, instructors are not compensated at regular instructional rates, despite the extra work involved in designing novel courses and getting students into the field. In addition, the special modes of learning that take place do not undergo assessment or student review. While summer field studies are not required to graduate with a BS in Environmental Sciences, most of the students in the program have opted to take advantage of the opportunities offered and many have benefited in special ways. Moreover, summer field studies allow instructors adequate time (not available during the regular year) to engage students during the times when soils, plants, and animals are most available for scientific observation. In short, the SFI is an integral part of educating environmental sciences students, not just an option for faculty looking to make a few extra dollars. It, however, receives little support or recognition at Oregon Tech and instructors appear to receive no appropriate credit or the opportunity for institutionally supported student review. The demands of a hands-on education in environmental sciences need to have better recognition and better incentives for the Environmental Sciences Program to continue to flourish at Oregon Tech.

The Environmental Sciences Program is also challenged by the functional limits imposed by student project requirements. While these projects are often of excellent quality, they are done at great expense to both faculty and student. Each student must complete a sophomore and senior project. Sixteen required student projects are underway and several others are in place as electives or course substitutions in 2012-13. All have been primarily advised by one faculty

member. The addition of 1.5 FTE faculty members to support Environmental Sciences in 2013-2014 will help to distribute the project advising load; however, with a target enrollment of 60 students and half or more of those students engaged in project work at any one point in time during the year, an advising deficiency will continue to exist. More importantly, the program experiences some attrition of students who enjoy environmental sciences, but are not prepared or do not wish to complete research projects. A crucial question for the program as it moves forward is, "Should all students have to complete a rigorous undergraduate research project of their own design or should such a project be an option?" The program may be able to support more students if not all of them had to complete research projects. This question is important for many reasons, including a new university policy that links program enrollment to compensation such as director stipends and release time. As it stands, a minimum of 50 students in a program is required for a department to receive any compensation in the form of stipend or release time. The Environmental Sciences Program has never had this number of students, despite its special needs and accomplishments, and it may never have this number given its rigor and the relatively low level of support it has received to conduct its special curriculum. Therefore, the program proceeds only at great expense to its faculty and through extremely generous support of outside advisors who donate their professional time to help teach our students. Moving forward, special support will be needed in order to retain the level of rigor while evolving the curriculum according to the Oregon Tech tradition of hands-on learning.

II Environmental Sciences Program Purpose, Objectives, and Student Learning Outcomes

The Environmental Sciences program faculty and advisory board reviewed the program purpose, objectives, and learning outcomes during the 2012 fall term and elected to initiate no immediate changes. The program purpose, objectives, and learning outcomes are detailed below.

Environmental Sciences Program Purpose

The Environmental Sciences program prepares students for immediate employment and graduate studies in the analysis and mitigation of environmental problems. The program focuses on science methodology and applied analysis, applying state-of-the-art field methods, instrumentation, and data analysis to the study of the natural and human environment from an interdisciplinary systems perspective. The curriculum builds on four cores: natural sciences (biology, chemistry, and physics); mathematics (including calculus and statistics); geographic information science (GIS); and integrated social sciences (including economics, geography, and bioregional studies).

Program Educational Objectives

1. Provide knowledge and training in the practical application of the scientific method utilizing appropriate analytical approaches and instrumentation-based methodologies.
2. Prepare students for roles in resource management that require critical thinking and problem solving skills.
3. Prepare students for graduate studies in environmental sciences, natural resource management, environmental education, geography, geographic information science, and regulation.

4. Provide students with technical and analytical skills that enable them to find employment in federal and state resource agencies, consulting firms, community-based education, and industrial firms tasked with environmental compliance.

Expected Learning Outcomes and courses where they will be assessed

Upon completion of the program, students will have demonstrated the following abilities:

1. Apply mathematical concepts, including statistical methods, to field and laboratory data to study scientific phenomena (**BIO 112, BIO 434/MATH 362**).
2. Use GIS to solve geospatial problems (**GIS 205, GIS 316**).
3. Understand the complex relationships between natural and human systems (**BIO 111, BIO 484**).
4. Design and execute a scientific project. (**Project course series: BIO 261, 262, BIO 471, 472, 473, 474**).

III Environmental Sciences Program Assessment Matrix

Table 1 (attached) shows the planned three-year assessment rotation cycle on a term-by-term basis for each of the four student learning outcomes. The 2012-2013 assessment primarily focuses on SLO #2: GIS Skills.

IV 2012-2013 Assessment of Student Learning Outcome 2: GIS Skills

This outcome was assessed in GIS 205 GIS Data Integration and GIS 316 Geospatial Vector Analysis I in the winter of 2013. This outcome was last assessed in winter term of 2009. The instructor made direct measurements of student proficiency using a scale of 1-4, which was designed in conjunction with the assessment coordinator. In both courses, student projects provided the primary basis for assessment. Only in GIS 205 were test questions also used as a supplement to the project work. Assessment results are shown in Tables 2 and 3.

The project assessed in GIS 205 required use of a GPS unit to map the location of two point, line, and polygon features and to record the data in a GIS format. Students were also required to develop metadata. The results for GIS 205 indicate various levels of proficiency across performance criteria (Table 2). Students appear to have a lack of proficiency understanding the fundamentals of GPS (Global Positioning System) operation. This is a particularly puzzling result since GPS technology is now a part of mainstream culture and students have a course that is in part focused on GPS operation (GIS 105) during an earlier part of the curriculum. Students show a satisfactory level of proficiency in use of GPS to record location and attribute information and a high level of proficiency communicating geospatial data via a web map. These results are derived from a small sample (two students) and may not be representative of overall student performance in this course during the four years between assessments. Moreover, different criteria were used for this assessment than for the 2009 assessment. Despite, these factors, however, proficiency appears to be a falling in the area of GIS 205. This drop could be related to a lack of knowledge gained or retained from previous coursework.

The project assessed in GIS 316 involved production of a map, either in terms of a simple cartographic representation or as a result of researching a geospatial topic. Results indicate that students are sufficiently proficient in three of the four performance criteria (Table 3). The only less than proficient criterion was the design of an appropriate database. Only 50% of the six students scored at the proficient or highly proficient level. Overall, proficiency levels decreased from 2009 to 2013, despite a lowering of the minimum acceptable performance. Most of the decrease is related to the performance of two of the six students assessed, who were struggling with academic performance in all of their coursework. Thus, these results may speak more to the quality of students in this particular class than to the overall quality of instruction and learning in the class as a whole and as designed by the instructor.

V Plans for Addressing Student Learning Outcomes 2013-2014

The program director (also assessment coordinator) will meet with the GIS instructor to review assessment results and explore the possibility of adjusting coursework in such a way as to improve student proficiency. Possible adjustments may include redesign of individual lectures or exercises or the redesign of whole courses. This exploration is timely as the Environmental Sciences Program is preparing a comprehensive curriculum planning proposal.

VI Changes Resulting from 2011-2012 Assessments

Institutional Learning Outcomes assessed in by the Environmental Sciences Program in 2011-12 included courses related to math (Bio 112 and MATH 362) and student research projects (Bio 261, 262, 471, 472, 473, and 474). For the math-related courses, Bio 112 was offered as an expanded pilot course, ENV 107 Environmental Data Analysis. Its one credit hour was changed to three credits and an expanded treatment of the types and analysis of datasets commonly encountered in environmental sciences was introduced. Anecdotal evidence indicates that the course was a success and plans are underway to permanently add it to the curriculum. For Math 362, the instructor has begun to employ a more practical approach to the course, using a novel software program and organizing the course around problems commonly encountered in the real world. Informal student feedback about these changes has been positive. No students were enrolled last year in this course, so there are no results to compare. New performance criteria for each of these courses will be developed for the next math-related assessment.

For the project-related courses, proficiency was generally high across the board in 2011-2012. For 2012-13, a new instructor advised the project course series. While no obvious adjustments seem necessary, questions related to the sustainability of the project course series that were outlined in the first section of this document appear to demand new attention by program faculty. Whereas the projects appear to be one of the best aspects of the program, they are also labor intensive and may sap resources from other parts of the curriculum given their demands and current staffing levels. Changing the curriculum to make the projects optional (but perhaps for honors credit) may be a way to preserve the special opportunities they afford to highly motivated students without losing students who may not desire or do not need such training to achieve their career goals. Such an adjustment was likely not contemplated during previous years because the number of students in the program was relatively low; however, with enrollment at or near record levels, the demands on faculty have increased. Thus, the outcomes of the projects (as

traditionally assessed) are not so much at issue, rather the underlying assumptions that they are necessary for the program to succeed is at question. This issue will be engaged during the 2012-2013 school year and addressed appropriately given feedback from key program faculty, both new and veteran.

Year		Fall	Winter	Spring
One **2011-2012**	#4 Scientific Projects Revisit Ethics ISLO Revisit Career Planning & Lifelong Learning ISLO Revisit Written Communication #1 Mathematical Competence & Mathematics ISLO	BIO 471: Senior Project Proposal Research BIO 474: Senior Project Data Analysis and Presentation BIO 484: Sustainable Human Ecology BIO 474: Senior Project Data Analysis and Presentation BIO 474: Senior Project Data Analysis and Presentation	BIO 261: Sophomore Project Proposal BIO 472: Senior Project Proposal BIO 112: Introduction to Data Analysis MATH 362: Statistical Methods II	BIO 262: Sophomore Project BIO 473: Senior Project Data Collection
Two **2012-2013**	#2 GIS Skills		GIS 205: GIS Data Integration GIS 316: Geospatial Vector Analysis I	
Three **2013-2014**	#3 Natural/Human Systems	BIO 111: Introduction to Environmental Science BIO 484: Sustainable Human Ecology		

Table 1. Evironmental Sciences Assessment Matrix

Performance Criteria	Assessment Method	Measurement Scale (4 = High Proficiency, 3 = Proficient, 2 = Limited Proficiency, 1 = No proficiency)	Minimum Acceptable Performance (Half are Proficient)	# of Students Assessed	Results
Understand fundamentals of GPS operation	Scored Projects	1-4 scale % at 3 or 4	50% at 3 or 4	2	0% at 3 or 4
Use of GPS to record location and attribute information	Scored Projects	1-4 scale % at 3 or 4	50% at 3 or 4	2	50% at 3 or 4
Communicate geospatial data via a web map	Scored Projects	1-4 scale % at 3 or 4	50% at 3 or 4	2	100% at 4

Table 2. Assessment results for SLO #2: Ability to use GIS to solve geospatial problems in GIS 205 (Winter 2013). Measurement scale: 1: No proficiency, 2: Limited proficiency, 3: Proficient, 4: High proficiency.

Performance Criteria	Assessment Method	Measurement Scale (4 = High Proficiency, 3 = Proficient, 2 = Limited Proficiency, 1 = No proficiency)	Minimum Acceptable Performance (Most are Proficient)	# of Students Assessed	Results
Create a topologically appealing representation	Scored Projects	1-4 scale % at 3 or 4	67% at 3 or 4	6	67% at 3 or 4
Design a cartographically appealing representation	Scored Projects	1-4 scale % at 3 or 4	67% at 3 or 4	6	67% at 3 or 4
Design an appropriate database	Scored Projects	1-4 scale % at 3 or 4	67% at 3 or 4	6	50% at 3 or 4
Apply appropriate geospatial analysis	Scored Projects	1-4 scale % at 3 or 4	67% at 3 or 4	6	67% at 3 or 4

Table 3. Assessment results for SLO #2: Ability to use GIS to solve geospatial problems in GIS 316 (Winter 2013). Measurement scale: 1: No proficiency, 2: Limited proficiency, 3: Proficient, 4: High proficiency.