# BS in ENVIRONMENTAL SCIENCES ASSESSMENT PLAN AND REPORT 2013-2014

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January 4, 2015

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## I Environmental Sciences Program: History, Status, Achievements, and Challenges

The BS in Environmental Sciences started at Oregon Tech in 1995. It is currently offered on the Klamath Falls campus. Enrollment as of Fall 2013 was 44 students (Figure 1). Enrollment 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 core and advisory faculty, 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 nationwide economic recession. 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 have been required for graduation.

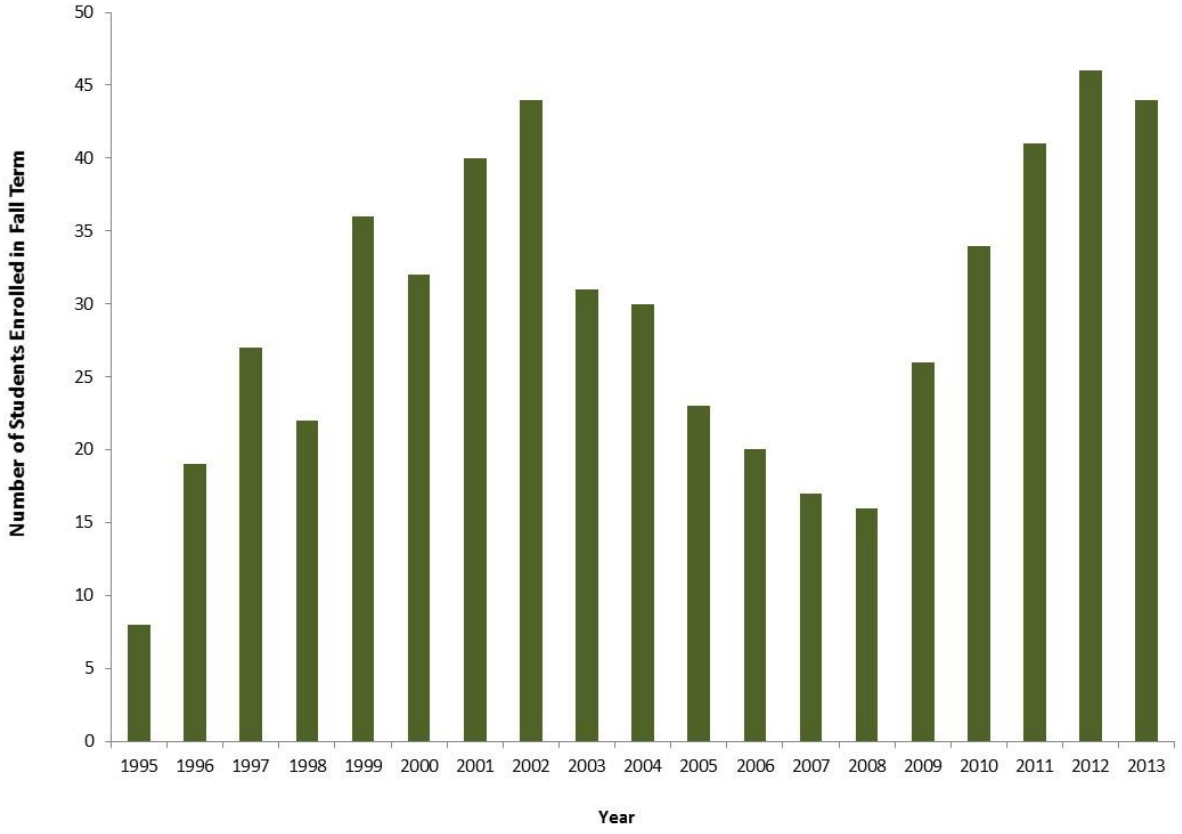


Figure 1. Environmental Sciences Enrollment, Fall Term 1995-2012.

Over the last three academic years (2011-12, 2012-13, and 2013-14) the Environmental Sciences Program has graduated 19 students. Although comprehensive data are not currently available, information from graduates still in touch with Oregon Tech indicates that a great majority of

them find relevant job placement or gain admission to graduate schools within months of graduation. Placement of graduates has occurred in both the public and private sectors. According to publicly available salary figures for typical job grades, graduates entering the job market are being paid at levels that are equal to or higher than graduates of similar fields at other institutions as well as graduates in similar or related fields at Oregon Tech.

Current challenges to the Environmental Sciences Program primarily include implementation of field studies and enrollment limits 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 extended filed trips. The logistical requirements to do so, however, are considerable. They include, but are not limited to, various administrative levels of paperwork for trip approval and documentation; locating, scheduling, and pickup/dropoff of rental vans (sometimes not available at local rental outlets); provision and preparation of food and other camp resources; continuous design and implementation of novel field exercises; 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 core faculty member implemented six field trips, most of which involved overnight travel. The extra work that these trips required to implement these trips is not systematically compensated and sustainability of these efforts has been challenging.

In response to the need to improve delivery of field studies, the Environmental Sciences Program established the Oregon Tech Summer Field Institute (SFI) during the summer of 2012. The SFI has continued during the summers of 2013 and 2014, and expanded plans are being developed for summer 2015. Approximately 50 students have been 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, delivering crucial outcomes that cannot be met during the 9-month school year, instructors unfortunately are not compensated at regular instructional rates, which coupled with the extra work to design novel courses and get students into the field may inhibit program growth and/or achievement of key outcomes. 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 in SFI and they have benefited in special ways. Morevover, SFI allows instructors adequate time (not available during the regular year) to engage students during the times when local soils, plants, animals, etc. are most appropriately available for scientific observation. In short, the SFI has been an integral part of educating environmental sciences students, rather than just an option for faculty looking to make a few extra dollars in the summer. It, however, receives only limited support and virtually no institutional recognition at Oregon Tech. In order to grow and sustain field studies in environmental sciences, faculty need to receive enhanced support for planning and implementing trips and appropriate workload credit for the extra effort required to make field studies successful.

The Environmental Sciences Program is equally challenged by its capacity to support student project requirements. Each student must complete a sophomore and senior project. Nearly two dozen student projects were completed as core requirements or electives in 2012-13. These projects were primarily advised by one faculty member. This situation created an advising

deficiency and despite several high-quality project outcomes, some student projects did not receive adequate advising and were as a result underdeveloped. The addition of 1.5 FTE faculty members to support Environmental Sciences in 2013-2014 the advising workload was better distributed; however, the departmental workload credit was not. With a target enrollment of 60 students and half or more of those students engaged in required project work at any one point in time during the year, an advising deficiency continues to exist even with a total of three core faculty members who have taken on project advising duties. In an effort to stem potential attrition of students who enjoy environmental sciences, but are not prepared or do not wish to complete individually advised research projects as part of their technical training, the Environmental Sciences Program has suspended its requirements for sophomore and senior projects and is currently working to develop a project-based elective track to serve a limited number of students who are prepared to pursue such projects. Other students will achieve project-based learning outcomes as key elements of elective courses, wherein project-based learning is integrated into field and/or geospatial exercises designed to be completed by student teams. Faculty who teach and advise in the program recently have reached a consensus that meeting project-based student learning outcomes in this multi-modal fashion will be more sustainable, more consistent with comparable undergraduate programs, and will allow for expanded program enrollment and development.

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

The Environmental Sciences program faculty and advisory board have reviewed the program purpose, objectives, and learning outcomes during the 2013 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 management of environmental problems. The program focuses on scientific methodology and applied analysis using a combination of traditional and state-of-the-art methodologies, instrumentation, and data analysis. The program is explicitly inter- and multi-disciplinary in its approach to the study of ecosystems and their human and non-human dimensions. The curriculum integrates four disciplinary foundations: natural sciences (geosciences, biology, chemistry, and physics); mathematics (including calculus and statistics); geographic information science (GIS); and integrated social sciences (including economics, geography, sustainability studies).

### Program Educational Objectives

1. Provide knowledge and training in critical thinking, problem solving, and the practical application of the scientific reasoning and methodology utilizing a range of conceptual, analytical, instrumental approaches in environmental sciences
2. Prepare students for contemporary professional employment in environmental sciences and natural resource management.
3. Prepare students for graduate studies in environmental sciences and related fields.
4. Expose students to the types of studies, documents, cultural viewpoints, and resource management and sustainability implications of environmental science.

## Expected Learning Outcomes and courses where they will be assessed

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

1. Apply quantitative skills, including statistical methods, to field and laboratory data related to environmental phenomena (**BIO 112, BIO 434/MATH 362**).
2. Use geographic information systems to solve geospatial problems (**GIS 205, GIS 316**).
3. Develop understanding of the complex relationships between the human and non-human components of ecosystems (**BIO 111, BIO 484**).
4. Design and/or help 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. This (2013-2014) assessment primarily focuses on SLO #3: develop understanding of the complex relationships between the human and non-human components of ecosystems. Materials from two courses, Biology 111 Introduction to Environmental Sciences and Biology 484 Sustainable Human Ecology were assessed.

## IV Summary of 2013-2014 Assessment of Student Learning Outcomes

Table 2 shows assessment results for Biology 111 Introduction to Environmental Sciences. Assessment items included exam questions, a research paper, and a solicited response to a media item concerning the relative contribution of volcanic emissions to the greenhouse effect. The minimum acceptable performance for each of the items was 2/3 of students achieving a score of 75% or greater. In four of the five items assessed the minimum acceptable performance was substantially exceeded. In the one case in which the minimum performance was not met, the nature of the item was. The relatively low score on this item could relate to a lack of exam preparation by students, a lack of emphasis by the instructor on the importance of the particular question to the overall learning objectives of the course, or both. Information concerning the relative likelihood of these scenarios was not provided by the instructor; however, it is noteworthy that the program in 2014-2015 is implementing a curriculum change that requires Geography 105 during the same term as Biology 111. Geography 105 includes substantial material on the earth's climate and atmospheric systems, including the greenhouse effect and related aspects of the earth's heat budget, so it should work to reinforce related aspects of Biology 111 as indicated in this assessment. Although this curriculum adjustment was at the time of its implementation not informed by this assessment, it nonetheless provides further evidence that the adjustment should be beneficial to established student learning outcomes.

Table 3 shows assessment results for Biology 484 Sustainable Human Ecology. Assessment items included quiz scores and research project elements. The minimum acceptable performance for each of the items was 2/3 of students achieving scores reflecting proficiency (rating of 3 out of 4) or high proficiency (rating of 4 out of 4). In two of the three items assessed the minimum acceptable performance was met or exceeded. In the one case in which it was not, like Bio 111, the nature of the item was conceptual and/or factual scientific knowledge. In this case, the scoring was derived from "pop quizzes." Students did not know when they may be tested on their basic understanding of reading materials. While developing such an understanding is not itself sufficient as a learning outcome, this course relied heavily on group discussion and critical thinking. Therefore, coming to class with a basic command of the scientific concepts imbued in the reading material was germane to the pedagogical framework of the class. The relatively low proficiency reflected in this item likely reflects a combination of low student motivation for

reading and "burnout" related to the heavy reading load required in the class. Future iterations of this class would likely benefit from a shorter reading list and a more structured participatory framework for supporting applications of critical thinking.

No indirect assessments were conducted for this SLO. Detailed records of this assessment, along with examples of student work, can be found in the assessment coordinator's files.

## VI Plans for Addressing Student Learning Outcomes 2014-2015

In 2014-15 the Environmental Sciences Program will re-assess SLO #1: Apply quantitative skills, including statistical methods, to field and laboratory data related to environmental phenomena and SLO #4: design and/or help execute a scientific project. SLO #1 will be assessed in ENV 226 Environmental Data Analysis and, if appropriate assignments can be identified, in MATH 361 and/or 362. Assessment of SLO #4 will feature will a new multi-faculty scoring component for student project posters as well as development of new rubric for assessing project-based student learning outcomes. Ideally, this rubric will be applicable to various types of student projects, ranging from individually advised student projects to group projects embedded in elective courses.

Instructional faculty of Bio 111 and 484 will be briefed on this assessment report and they will be asked to develop strategies to improve learning outcomes in these courses, including potential redesign of course elements.

## VII Changes resulting from 2012-2013 Assessments

SLO #2: use geographic information systems to solve geospatial problems

Discussions are in progress with GIS faculty about a potential combination of GIS 103 and 105 into one course, as well as a change in the terms that GME 134 and GIS 205 are offered. These adjustments would streamline the core GIS curriculum for environmental sciences students and repackage it as a one-year series. These changes Use geographic information systems to solve geospatial problems should provide opportunities to improve related student learning outcomes.

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

Table 1. Environmental Sciences Assessment Matrix

| Performance Criteria | Assessment Method | Measurement Scale (0 - 100%; High Proficiency = 90 - 100%, Proficient = 75 - 89%, Limited Proficiency = 60 - 74%, No Proficiency = 0 - 59%) | Minimum Acceptable Performance (67% of students Proficient, > 75%) | # of Students Assessed | Results |
|---|---|---|---|---|---|
| Display ability to research an environmental topic and assess the human/natural interaction | Research Paper Final Score | 0 - 100% raw % | 67% of students at 75% or more | 11 | 100% at 75% or more |
| Construct a rational, supportable statement in response to a stated position regarding the relative contribution of volcano emissions to global species budgets | Solicited Response to Media Item | 0 - 100% raw % | 67% of students at 75% or more | 11 | 82% at 75% or more |
| Describe the Greenhouse effect, list the pertinent gasses, which are increasing with time? | Essay Exam Question | 0 - 100% raw % | 67% of students at 75% or more | 11 | 64% at 75% or more |
| What role does the ozone layer perform for sustaining life on earth? Have human activities caused us to be concerned about the viability of this layer? | Essay Exam Question | 0 - 100% raw % | 67% of students at 75% or more | 11 | 82% at 75% or more |
| Discuss the difference between having an economy that is based on ecological principles verses environmental policies based on a desired economic outcome. Which is sustainable? Why? | Essay Exam Question | 0 - 100% raw % | 67% of students at 75% or more | 11 | 91% at 75% or more |

Table 2. Assessment Matrix for SLO #3, Biology 111

| Performance Criteria | Assessment Method | Measurement Scale (4 = High Proficiency, 3 = Proficient, 2 = Limited Proficiency, 1 = No proficiency) | Minimum Acceptable Performance | # of Students Assessed | Results |
|---|---|---|---|---|---|
| Demonstrate comprehension of essential scientific concepts in assigned reading materials | Cumulative Quiz Scores | 1-4 scale % at 3 or 4 | 67% at 3 or 4 | 16 | 56% at 3 or 4 |
| Select a novel research topic and question reflecting human-environment relations | Scored Project Elements | 1-4 scale % at 3 or 4 | 67% at 3 or 4 | 13 | 92% at 3 or 4 |
| Develop meaningful analysis of data and/or information pertaining to research topic and question | Scored Project Elements | 1-4 scale % at 3 or 4 | 67% at 3 or 4 | 13 | 92% at 3 or 4 |

Table 3. Assessment Matrix for SLO #3, Biology 484