BS in ENVIRONMENTAL SCIENCES ASSESSMENT PLAN AND REPORT 2007-2008

Prepared by: Dr. Maureen Sevigny, Professor and Program Director
May 30, 2008

Table of Contents

I Environmental Sciences Program: Introduction and History 3

II Environmental Sciences Program Purpose, Objectives, and Student Learning Outcomes
Environmental Sciences Program Purpose 4
Program Educational Objectives 4
Expected Learning Outcomes and courses where they will be assessed 4

III Environmental Sciences Program Assessment Matrix 5
Three-Year Plan for Assessing each of the Student Learning Outcomes 5

IV Plans for Measuring Student Learning Outcomes during 2007-08 6

V Results of Assessment Activities during 2007-08 9

Appendix A: Survey for BIO 225 11

Appendix B: Survey for BIO 497 13

I Environmental Sciences Program: Introduction and History

The BS in Environmental Sciences program started in 1995. It is offered only on the Klamath Falls campus of Oregon Institute of Technology.

Enrollment has ranged from a low of eight in 1995 to a high of 44 in 2002. The trend has been declining over the past five years. This decline is related to the growth of the AAS degree Natural Resources at Klamath Community College (KCC) and OIT's new BS in Biology degree (that began accepting students in 2006). Some KCC graduates have transfer into the OIT's Environmental Sciences and Biology programs and it is anticipated there will be an increase in this over the next few years.

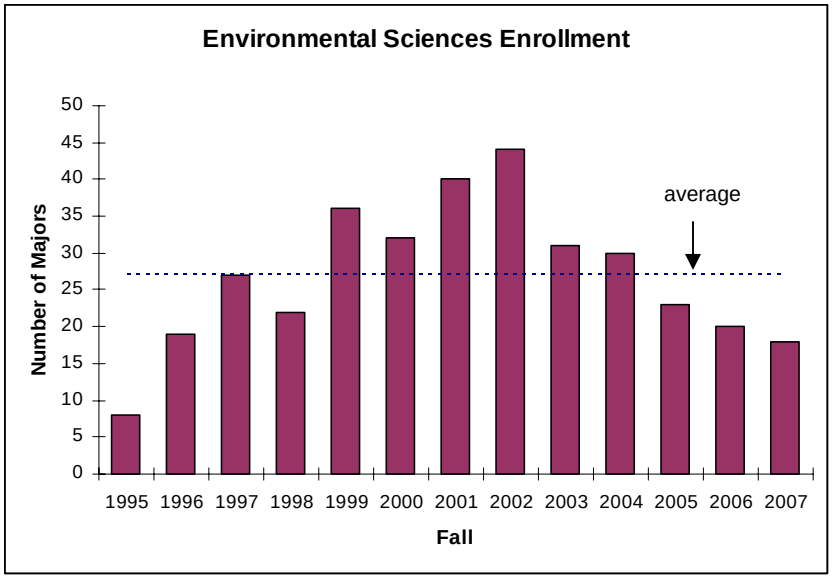

Figure 1. Environmental sciences enrollment, fall term, 1995-2007

Retention rates in the major have been highly variable. Between 1999 and 2007, first year freshmen 1-year retention rates in the major have ranged between 0 and 100%, averaging 45%. The 1-year retention rates for first year freshmen who continue at OIT in a different major averaged 46%, however, making an average overall first-year freshman retention rate of 91%, far above the institutional average. Transfer student 1-year retention rates have averaged 85% over the past five years. Given the traditionally high attrition rates for students starting their college careers as science or engineering majors, these retention rates are quite strong. It should be noted that the three years in which there was a 0% retention rate of environmental sciences freshmen in their major there were retention rates of 67%, 100%, and 100% for these students in new majors at OIT.

Given the relatively small enrollment, it is not surprising that the number of graduates has averaged just under five per year for the last seven years. This number is likely to decline over the next two years given the recent decline in the number of majors.

The average salary of environmental sciences graduates as reported in 2006 was $46,667. This was 96% of the average of all OIT graduates in the survey, and was comparable to the average salaries of civil engineering ($47,990) and clinical laboratory sciences ($47,192).

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

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 law
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

1. Ability to specify, calibrate and use appropriate scientific instruments to collect biological, chemical, and physical data to address a scientific question and understand the limitations of the instrumentation (**CHE 232, BIO 496**).
2. Ability to apply mathematical concepts, including statistical methods, to field and laboratory data to study scientific phenomena (**BIO 112, BIO 497**).
3. Ability to use GIS to solve environmentally related geospatial problems (**GIS 205, GIS 326**).
4. Ability to apply biological, chemical and physical principles and methods to determine the functional condition of natural systems (**BIO 225, BIO 337**).
5. Understand the complex relationships between natural and human systems (**BIO 111, BIO 485**).
6. Design and execute an independent scientific study, including the ability to develop and test a scientific hypothesis, conduct effective literature searches, critically evaluate the results in scientific journals, and articulate the results and implications of the study in both written and oral presentations (**BIO 262, BIO 498**).

III Environmental Sciences Program Assessment Matrix

Table 1 shows the planned three-year assessment cycle on a term-by-term basis

Year	Fall	Winter	Spring
One	BIO 225: Riparian Assessment Methods BIO 497: Senior Project Data Analysis	BIO 112: Introduction to Data Analysis	BIO 337: Aquatic Ecology
Two		GIS 205: GIS Data Integration BIO 498: Senior Project Presentation	GIS 326: Geospatial Vector Analysis II BIO 262: Sophomore Project
Three	BIO 111: Introduction to Environmental Science	BIO 485: Klamath Bioregional Studies	BIO 496: Senior Project Data Collection CHE 232: Streamwater Sampling

Table 1. Three-year assessment cycle

Table 2 shows the planned three-year rotation for assessing each of the six student learning outcomes beginning in Fall 2007. In this plan:

- Year one assesses Outcomes 2 and 4 (mathematical competence and functional condition determination)
- Year two assesses Outcomes 3 and 6 (GIS skills and independent scientific investigation)
- Year three assesses Outcomes 1 and 5 (scientific data collection and understanding natural/human systems)

Year	Term	Learning Outcomes	Courses Evaluated
2007	Fall	(4) Determining functional condition (2) Mathematical competence	BIO 225: Riparian Assessment Methods BIO 497: Senior Project Data Analysis
	Winter	(2) Mathematical competence	BIO 112: Introduction to Data Analysis
	Spring	(4) Determining functional condition	BIO 337: Aquatic Ecology
2008	Fall		
	Winter	(3) GIS skills (6) Scientific investigation	GIS 205: GIS Data Integration BIO 498: Senior Project Presentation
	Spring	(3) GIS skills (6) Scientific investigation	GIS 326: Geospatial Vector Analysis II BIO 262: Sophomore Project
2009	Fall	(5) Natural/human systems	BIO 111: Introduction to Environmental Sciences
	Winter	(5) Natural/human systems	BIO 485: Klamath Bioregional Studies
	Spring	(1) Scientific data collection (1) Scientific data collection	BIO 496: Senior Project Data Collection CHE 232: Streamwater Sampling

Table 2. Three-year rotation for assessing student learning outcomes

IV Plans for Measuring Student Learning Outcomes during 2007-08

The two outcomes to be assessed during 2007-08 are: (SLO 4) ability to apply biological, chemical and physical principles and methods to determine the functional condition of natural systems; and (SLO 2) ability to apply mathematical concepts, including statistical methods, to field and laboratory data to study scientific phenomena. Direct and indirect measures for each outcome, as well as planned assessment activities for each outcome will be addressed in this section.

Outcome: Determine functional condition of a natural system

Courses to be evaluated: BIO 225: Riparian Assessment Methods and BIO 337: Aquatic Ecology
Direct measures: observation of students participating in field exercises; field reports

Performance Criteria	Assessment Method	Weak	Acceptable	Exceptional
Understands how specific biological or physical parameters are used as indicators of riparian health and functionality	Observation by instructor of student discussion during field exercises	Can identify some key parameters in the field but does not understand how they relate to ecological function	Can identify key parameters in the field and perceives some relationships to ecological function	Can identify key parameters in the field and understands how they relate to ecological function
Measures or calculates key parameters used to determine functionality including streamflow, discharge, and a family biotic index	Field report and observation by instructor of students during field exercises	Poor technique in collecting field data. Little or no ability to perform appropriate calculations from the data.	Can collect and record field data but unsure how to perform appropriate calculations	Can collect and record field data and perform appropriate calculations
Classifies a stream reach using the Rosgen Level II classification system	Field report	Does not relate observed parameters to Rosgen classification categories	Correctly relates most of the observed parameters to Rosgen classification categories	Correctly relates observed parameters to Rosgen classification categories
Understands how landform influences the potential of an ecological community	Field report	Cannot identify significant landform characteristics that determine the site's potential	Identifies some characteristics; may or may not show how they determine the site's potential	Identifies key characteristics and describes how they determine the site's potential
Understands how human activity influences the capability of an ecological community	Field report	Cannot identify significant human activities that limit the site's potential	Identifies some characteristics; may or may not show how they limit the site's potential	Identifies key characteristics and describes how they limit the site's potential
Uses the BLM's Proper Functioning Condition (PFC) checklist to determine the functional class of a stream reach	Field report	Cannot relate the items in the PFC checklist to the site characteristics	Relates most of the items in the PFC checklist to the site characteristics	Relates the items in the PFC checklist to the site characteristics and correctly determines functional class

Table 3. Rubric for assessing understanding of how to determine the functional condition of a natural system

In future years, this student learning outcome will also be measured indirectly through a survey questionnaire students will fill out at the completion of the BIO 225 field trip. See Appendix A for a copy of this survey instrument.

Outcome: Apply mathematical concepts, including statistical methods, to field and laboratory data to study scientific phenomena

Courses to be evaluated: BIO 112: Introduction to Data Analysis and BIO 497: Senior Project Data Analysis

The evaluation will focus on a freshman level course (BIO 112) where basic concepts are taught or reviewed using spreadsheets and databases and a senior level course (BIO 497) where intermediate-level statistical methods are used to test hypotheses from field or laboratory data.

BIO 112: Introduction to Data Analysis
Direct measures: student homework consisting of applications of Excel or Access to perform calculations and discuss the implication of their results. Three of the five homework assignments will be evaluated for mathematical understanding.

Performance Criteria	Assessment Method	Weak	Acceptable	Exceptional
Calculates descriptive statistics (mean, median, range), weighted averages and expected values	Spreadsheet submitted as homework	Performs < 75% of the calculations correctly	At least 75% of the calculations are correct	All calculations correct
Interprets descriptive statistics and indices correctly	Spreadsheet submitted as homework	Explains < 75% of the statistics or calculated values correctly	At least 75% of the explanations are correct	All explanations are correct
Creates appropriate contingency tables and histograms	Spreadsheet submitted as homework	Creates tables and histograms but data not grouped appropriately	Creates tables and histograms; at least 75% group the data appropriately	Creates tables and histograms; all data grouped appropriately
Interprets contingency tables and histograms correctly	Spreadsheet submitted as homework	Answers < 75% of the questions correctly	Answers at least 75% of the questions correctly	Answers all questions correctly
Creates appropriate charts	Spreadsheet submitted as homework	Chart shows correct data but does not reflect the key relationships in the data; labeling incorrect or missing	Chart shows correct data and reflects the key relationships. Labeling generally correct and informative	Clearly labeled chart shows correct data and reflects key relationships in the data; correct labeling including units
Interprets charts correctly	Spreadsheet submitted as homework	Answers < 75% of the questions correctly	Answers at least 75% of the questions correctly	Answers all questions correctly

Table 4. Rubric for assessing basic data analysis skills

Indirect measure: IDEA Center diagnostic form data will be used to determine if students felt they had attained a level of competence with the mathematics as well as the software.

BIO 497: Senior Project Data Analysis
Direct measure: Students write up the "data analysis" section of their senior project report during this course. This section will be evaluated to determine how well students performed on each of the following criteria:

Performance Criteria	Assessment Method	Weak	Acceptable	Exceptional
Research question and an appropriate testable hypothesis stated	Data analysis report	Question not stated and/or hypothesis not testable as stated	Question and testable hypothesis stated	Question and testable hypothesis stated; appropriate mathematical notation included
Field or laboratory data clearly organized to enable hypothesis testing	Data analysis report	Spreadsheet or database incomplete or data not documented completely	Spreadsheet or database complete and data mostly documented	Spreadsheet or database complete and all data clearly documented
Appropriate statistical software used to test the hypothesis; choice of statistical test explained	Data analysis report	Hypothesis not tested, incorrect test used, or test not used correctly	Hypothesis tested correctly with limited explanation regarding the choice of the test	Hypothesis tested correctly; choice of statistical test explained correctly
Results of the statistical test presented	Data analysis report	Results not presented in clearly labeled tables and/or charts	Results presented in tables and/or charts	Results presented in tables and/or charts with appropriate labels and significant digits
Results of the statistical test discussed	Data analysis report	Results not discussed in correct statistical terminology	Results discussed in mostly correct statistical terminology	Results discussed in correct statistical terminology
Appropriate conclusion reached about the research question (based on the statistical test)	Data analysis report	Conclusion not clearly stated and defended or incorrect conclusion stated	Correct conclusion clearly stated; reasoning mostly correct	Correct conclusion clearly stated and defended

Table 5. Rubric for assessing advanced statistical analysis skills

Indirect measure: A modified version of the IDEA Center diagnostic form data will be used to determine if students felt they had attained a level of competence with the statistical methods as well as the software. The reason this will be a modified version of the IDEA Center form is that the senior project course is a seminar course and is typically not evaluated as part of the "Student Numerical Evaluation" process. I will create my own end-of-term questionnaire for students to fill out regarding their perceptions of their own understanding of statistical testing and analysis of results. This survey will be used in the follow-up course, BIO 498, where students prepare their final project report and deliver an oral presentation. Where students lack confidence in their own understanding, there will be time to review principles and methods in BIO 498 to help them complete their own learning in this area. When students deliver their final project presentations, it is painfully obvious when they really do not understand the statistical tests they performed or how the statistical results should inform their conclusions. See Appendix B for a copy of this survey questionnaire.

V Results to date from measuring Student Learning Outcomes during 2007-08

Outcome: Determine functional condition of a natural system
Course evaluated: BIO 225: Riparian Assessment Methods
Number of students: 6

Performance Criteria	Weak (=1)	Acceptable (=3)	Exceptional (=5)	Weighted Total
Understands how specific biological or physical parameters are used as indicators of riparian health and functionality	1	4	1	18
Measures or calculates key parameters used to determine functionality including streamflow, discharge, and a family biotic index	1	2	3	22
Classifies a stream reach using the Rosgen Level II classification system	1	3	2	20
Understands how landform influences the potential of an ecological community	1	1	4	24
Understands how human activity influences the capability of an ecological community	1	0	5	26
Uses the BLM's Proper Functioning Condition (PFC) checklist to determine the functional class of a stream reach	1	4	1	18
Average	1 (=17%)	2.3 (=38%)	2.7 (=45%)	21.4

Table 6. Assessment scores for BIO 225: Riparian Assessment Methods, Fall 2007

Discussion:
This is a very small sample; results are not necessarily representative of the average student who enrolls in this course. One student was consistently weak, not only in the field exercises and subsequent written report (which form the basis of this assessment) but he also demonstrated a consistent misunderstanding of the concepts and applications in the course quizzes. The other five students quickly grasped the field techniques and calculations, both in theory in the quizzes and in practice in the field exercises and report writing.

This course throws a lot of material, terminology, and applications at the students in a very short amount of time. The expectation is the students will deepen their knowledge and skills in subsequent courses including possibly their sophomore and senior projects. As such, it is not surprising that many of the new concepts and techniques were demonstrated at an "acceptable" level but did not indicate mastery. Observing and understanding landform and human effects on the riparian system is as much related to past life experiences as it is to new information presented in this course; it is not surprising that students showed higher levels of mastery in these categories.

Future changes:
This course may be too "content-rich" for a 1-credit course. It may be worth dropping the section on benthic macroinvertebrates (which is part of the EPA's Rapid Bioassessment Protocol but not part of the Proper Functioning Condition methodology that underpins this course) to allow for more in-depth study of stream channel morphology. Macroinvertebrates and biotic indices are now included in BIO 111 (Introduction to Environmental Sciences) which is taken by all environmental sciences majors. It is also part of the curriculum of BIO 337 (Aquatic Ecology) which is a popular elective taken by most majors.

Outcome: Apply mathematical concepts, including statistical methods, to field and laboratory data to study scientific phenomena

Course evaluated: BIO 112: Introduction to Data Analysis
Number of students: 3

Course evaluated: BIO 497: Senior Project Data Analysis
Number of students: 1

Neither course will be evaluated this year because of the excessively small sample sizes. Data will be collected and aggregated with subsequent classes to attain a more robust sample.

Appendix A

Self-Assessment Survey of Learning for BIO 225: Riparian Assessment Methods

The survey on the following page is designed to assess students' own perception of:

- their understanding of key concepts of riparian assessment methods
- their ability to perform key tasks related to collecting and interpreting field data used in riparian assessment

Oregon Institute of Technology
Department of Natural Sciences
BIO 225 – Riparian Assessment Methods

Please circle the answer that best describes your experience in BIO 225 this term using the following key:

1 = Strongly agree
2 = Generally Agree
3 = Not Sure
4 = Generally Disagree
5 = Strongly Disagree

I I understand:

1. what a riparian area is. 1 2 3 4 5
2. the role a floodplain plays in dissipating energy. 1 2 3 4 5
3. how to use the Rosgen stream channel classification 1 2 3 4 5
4. how to use benthic macroinvertebrates to assess water quality. 1 2 3 4 5
5. the role greenline vegetation plays in streambank stability. 1 2 3 4 5
6. the role of the PFC checklist in determining riparian condition. 1 2 3 4 5
7. how to interpret each item in the PFC checklist. 1 2 3 4 5
8. the concept of dynamic equilibrium 1 2 3 4 5
9. the difference between the capability and potential of a riparian area. 1 2 3 4 5

II I am confident I:

1. can name at least three important functions of a riparian area 1 2 3 4 5
2. could distinguish an E-channel from a D-channel in the field 1 2 3 4 5
3. can use a flowmeter to measure stream flow in the field 1 2 3 4 5
4. can measure a stream's discharge in cubic feet/second in the field. 1 2 3 4 5
5. can calculate the width/depth ratio of a stream reach. 1 2 3 4 5
6. can collect macroinvertebrates and use them to calculate a biotic index . . .1 2 3 4 5
7. can use the PFC checklist to assess a stream's functional condition. 1 2 3 4 5
8. could prepare a field sketch that would be a good depiction of the site. 1 2 3 4 5
9. could recognize upland activities that could harm a riparian area 1 2 3 4 5

Appendix B
Self-Assessment Survey of Learning for BIO 497: Senior Project Data Analysis

The survey on the following page is designed to assess students' own perception of:

- their understanding of the principles of statistical analysis appropriate to their senior project data and research question
- their ability to perform statistical tests and apply the results to their research question and testable hypothesis

Oregon Institute of Technology
Department of Natural Sciences
BIO 497 – Senior Project Data Analysis

Please circle the answer that best describes your experience in BIO 225 this term using the following key:

1 = Strongly agree
2 = Generally Agree
3 = Not Sure
4 = Generally Disagree
5 = Strongly Disagree

I I understand:

1. the difference between a research question and a testable hypothesis. . . . 1 2 3 4 5
2. the difference between independent and dependent variables. 1 2 3 4 5
3. the use of a control variable in analyzing cause and effect 1 2 3 4 5
4. how to interpret the statistical significance of a t-statistic. 1 2 3 4 5
5. how to interpret the statistical significance of an F-statistic. 1 2 3 4 5
6. how to interpret the statistical significance of a p-value 1 2 3 4 5
7. the difference between correlation and causation 1 2 3 4 5

II I am confident I:

1. can enter data into Excel in a way that allows for statistical testing. 1 2 3 4 5
2. can use Excel to calculate descriptive statistics 1 2 3 4 5
3. can use Excel to perform a simple or multiple linear regression 1 2 3 4 5
4. can use Excel to perform a t-test of sample means 1 2 3 4 5
5. can use Excel to perform an analysis of variance 1 2 3 4 5
6. can use Excel to perform a chi-square test 1 2 3 4 5
7. can interpret and explain the results of a linear regression 1 2 3 4 5
8. can interpret and explain the results of a t-test of sample means 1 2 3 4 5
9. can interpret and explain the results of an analysis of variance 1 2 3 4 5
10. can interpret and explain the results of a chi-square test 1 2 3 4 5