Oregon TECH

2018-19
Environmental Sciences Assessment Report
Prepared by Christy VanRooyen

Contents

Section 1 – Program Mission

The Bachelor of Science program in Environmental Sciences prepares students for immediate employment and graduate studies in the assessment and monitoring of environmental conditions and problems, including research, mitigation and restoration. The BES program focuses on interdisciplinary scientific study of ecology, natural resources, and sustainability with emphases on management, research, and communication. The curriculum is comprised of four integrated core areas in ecology & natural resources; data analysis & statistics; geographic information systems (GIS); and social sciences.

Students within the Environmental Sciences program put their knowledge into practice in the best place possible—the great outdoors. Emphasis is placed on active experiential learning. The program offers numerous and diverse opportunities for students to engage in applied research and resource management projects with the support of faculty and professionals through local and regional partnerships.

Mission Statement: ***Students analyze environmental conditions and problems through applied research and fieldwork, all within the stunning natural setting of the Klamath Basin.***

We believe there is a place in our program for everyone with an interest in natural resources, environmental issues, conservation and sustainability, or just being in the great outdoors! Environmental science and natural resources is a huge field that can accommodate a wide range of individual interests and skills whether it's working with wild animals, plants, people, or computers and technology. Our faculty and partners are here to help build an impressive resume of academic and work experience that will place students in the job or graduate program of their choice.

Graduates can expect to find employment in federal, state, and tribal government agencies, non-governmental organizations (NGOs), and education and research institutions. Students are also well prepared to enter graduate school. Students graduating from our program have taken positions with the U.S. Geological Survey, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. Forest Service, Oregon Department of Forestry, Oregon State Police Wildlife Enforcement, Klamath County Health Department, Klamath Irrigation District, Klamath County Soil and Water Conservation District, the Nature Conservancy, and JELD-WEN Windows and Doors.

The mission, objectives, and student learning outcomes for the BES program are reviewed annually by BES faculty.

Section 2 – Program Educational Objectives

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

- A strong applied foundational knowledge of environmental systems including physical and biogeography, aquatic and terrestrial ecology, and environmental chemistry.
- An understanding of the complex relationships between natural and human systems.
- The application of mathematical and statistical concepts, to field and laboratory data to study natural phenomena.
- Use of GIS to solve geospatial problems.
- Design, execute, and communicate a scientific project. While all graduates will have gone through the scientific process of study design and implementation, they will not be expected to have a complete mastery of this objective. We hope that being exposed to research as an undergrad will better prepare them for graduate school and/or advancement in their careers

Section 3 – Program Description and History

Program History

The BS in Environmental Sciences officially began in 1995 on the Klamath Falls Campus. The Environmental Sciences program has a significant history of partnering with community stakeholders to address current environmental problems. From student involvement in research related to the 2001 water shutoff in the Klamath Irrigation District to a new grant partnership with Klamath County Public Health and the DEQ to monitor the effectiveness of woodstove change outs to improve air quality, BES students utilize their strong data analysis skills to drive positive environmental change in the Klamath Basin. See Table 4 for more information about our many industry relationships (Table 4).

Based on conversations with advisees, we estimate that more than 85% of our graduates gain professional work experience in related fields during their time at Oregon Tech through research projects, internships, and temporary positions. To further substantiate this figure, we have added a question to exit interviews directly inquiring about their professional work experience upon completion of the program. This work experience is a driving force behind our amazing BES graduate success rate which was 100% in 2017-18. In 2018, our graduates accepted positions from the following agencies: Green Savers, Bureau of Land Management, US Forest Service, Klamath Tribes, United States Geological Survey, and ENPLAN according to data collected by Career Services.

Fall enrollment trends from 2014-18 have varied from 51 to 42 students per year in the program. This downward trend was likely due to changes in staffing within the program over the last five years. With the appointment of a new program director and the filling of open positions within Natural Sciences, we are beginning to see an upward tick in enrollment data (Figure 1). It is exciting to report that we graduated our largest class in recent history in the spring of 2016 (14 students) and another relatively large class in 2018 (8 students).

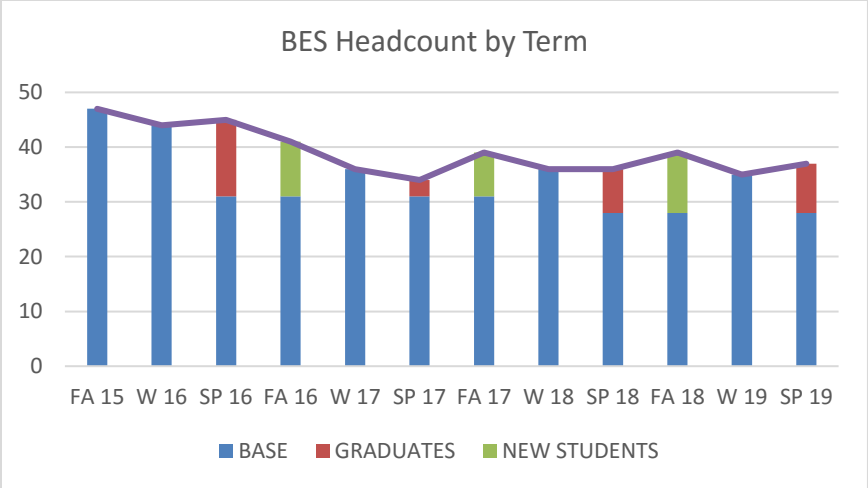


Figure 1: SCARF 4th Week Headcount by term over last four academic years, as given on FAST under the REG_1 Active Student Official Dataset, with a breakdown of students graduated (degrees granted) and new students in spring and fall terms, respectively.

Improved enrollment and retention is one of the primary goals for Environmental Sciences with a target fall enrollment of 60 students within the next 3-5 years. Central to achieving this goal are the strong relationships we are building with and among our students. In Fall 2019 we offered an Environmental Sciences Team Building/Mentorship class where all students enrolled in the program attended a retreat the first weekend of the term. This experimental course included a variety lessons related to environmental sciences as well as presentations on resource management and cave environments given by our partners at the Lava Beds National Park. While at the event, students were paired as mentors and mentees connecting experienced upper classmen with underclassmen or transfer students. These pairs are expected to meet periodically throughout the term to

discuss aspects of the program. We will be accessing the success of these partnerships and the retreat at the end of the term.

One of the limiting factors for increasing enrollment is faculty to teach classes within the program and to support student research. Currently, all BES faculty also teach a variety of general education courses within the Natural Science Department in addition to developing partnerships and designing and implementing research and field studies throughout much of the curriculum. Many of these studies require field trips throughout the Klamath Basin, Southern Oregon, and Northern California. The logistical requirements for field trips are extensive. 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, we offer field trips more frequently than many other programs. For example, each core faculty member in the program generally implements two weekend-long field trips per year, and an additional 3-8 single day field trips each academic year. At 60 students, we recommend adding another full-time faculty member to effectively distribute work load and expand our course offerings into areas indicated both by student interest and industry job opportunity including fisheries, forestry, and fire ecology.

Program Location: Klamath Falls Campus only.

Program Enrollment:

Table 1: BES Enrollment 2014-18

Fall 2014	Fall 2015	Fall 2016	Fall 2017	Fall 2018	5 Year Difference	5 Year % Change
51	48	42	41	42	9	-17.6%

Program Graduates:

Table 2: BES Number of Graduates 2012-18

2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
5	4	5	11	14	3	8

Employment Rates and Salaries:

Employment rate and salary data is based on the 2018 graduates of the BES program, and was collected via exit surveys, career services surveys, and Linkedln. It is important to note that only 6 of our 8 graduates responded to the surveys.

Table 3: BES Graduate Success Rates based on respondents to a Career Services Grad Outcomes Survey.

Employed	Continuing Education	Looking for Work	Not Seeking	Median Salary	Success Rate
5	0	0	0	$40,000	100%

Industry Relationships:

Table 4: Current relationships between BES and local agencies.

Industry Relationships
BES Advisory Board Faculty within the ENV program are actively recruiting members to re-establish the Environmental Science Advisory Board. This board would lend support to strategic planning for the program and better connect our students to industry partners. Klamath County Public Health Students will be monitoring air quality changes in the Klamath Basin related to Woodstove change outs over the next two years. PI Addie Clark US Forest Service Memorandum of understanding with the Forest Service. PI Kerry Farris. Klamath Watershed Partnership We have students working on a project funded through the OR Tech Foundation. PI Jherime Kellermann. Western Native Plants Students are doing restoration work with Western Native Plants in fall of 2018. PI Jherime Kellermann. Bureau of Reclamation – WADRS A large grant from the BOR to fund the collection of hydrologic data in the Klamath Basin for Water Assessment for Drought Resilience & Sustainability (WADRS). PI Erin Cox. US Fish & Wildlife Service Student Worker Internship & Mentoring (SWIM) Program. (2016-2018) PI Erin Cox Department of Environmental Quality OIT recently purchased an air quality monitor to track particulate matter. Data from this monitor will be shared with the DEQ. PI Addie Clark Oregon Bee Atlas Project – Oregon State University, Oregon Department of Agriculture, and Xerces Society. Students are collecting bee specimens for identification and inclusion in the Oregon Bee Atlas project. This initiative aims to identify bee species in Oregon. PI Christy VanRooyen. Western Apicultural Society BES student, Jacob Bennett co-presented with Christy VanRooyen at the Western Apicultural Society Conference in July 2019 on how GIS can be used to research factors that may be impacting colony success rates in the Pacific Northwest. Lake County Resource Initiative Students will be field assistants collecting field data as part of a larger crew examining the effects of alternative silvicultural treatments on ponderosa pine recruitment. PI Kerry Farris

Table 5: Recent BES publications and conference proceedings.

Showcase Learning Experiences
These recent publications/conference proceedings included student researchers. *identifies student name. • O'Leary*, D., J.L. Kellermann, & C. Wayne. 2018. Snowmelt, spring phenology, and extended growing season in Crater Lake National Park. International Journal of Biometeorology. DOI 10.1007/s00484-017-1449-3 • Gunning, A.* & J.L. Kellermann. 2017. Black-backed Woodpecker and Wood-boring Beetle Associations with post-fire burn severity following the National Creek Fire. Northwest Scientific Association Annual Meeting, Ashland, OR. • Kellermann, J.L., J. Lajoie*, S. Mohren, & A. Robatcek*. 2014. Black-backed woodpecker occupancy and Mountain Pine Beetle disturbance at multiple scales: Crater Lake National Park, Oregon. American Ornithologist's Union, Cooper Ornithological Society, Society of Canadian Ornithologists 2014 Joint Meeting, Estes Park, Colorado. • VanRooyen, C. & Bennet, J*. 2019. "Geospatial Analysis of Apis mellifera Colonies". Presented at the Western Apicultural Society Conference. July, 2019.

Table 6: BES Graduate Success Stories 2017-18

Success Stories
Chloe Smith, BES graduate 2018, won the President's Senior Cup for her exceptional academic record as well as her commitment to promoting sustainability at OIT. She is the first ENV graduate to complete the degree as well as three minors: biology, chemistry, and sustainability. Baker McDonald, duel REE and BES graduate 2018, and Ory Foltz won 3rd place in the Catalyze Klamath Competition for their prototype of a 3D printed water flow meter. Their meter was printed at a fraction of the cost of a traditional flow meter.

Section 4 – Program Student Learning Outcomes

Over the last two years, BES faculty have revised our PSLOs to better align with the skills necessary for job success post-graduation. These changes were made in response to updated federal job requirements as listed under current openings on USA jobs as well as conversations with our industry partners about what they are looking for in our graduates.

Upon graduating from the BES program at Oregon Tech, students will have demonstrated an ability to:

1. Attain applicable foundational knowledge, technical skills, information literacy, and experience in several core areas of natural resources & environmental sciences.
2. Constructively work within and among diverse communities and perspectives.
3. Make and advocate for science-based and sustainable solutions to local and global environmental issues.
4. Apply appropriate analytical and statistical techniques to answer data driven scientific questions.
5. Demonstrate geospatial literacy through the utilization of appropriate technology to identify and address environmental problems.
6. Effectively communicate science to a diverse range of community stakeholders.

Section 5 – Curriculum Map

Please note that this section is incomplete. The ENV curriculum has been unstable the last few years with a large curriculum overhaul and faculty turnover leading to changes in scientific expertise. Further, the recent changes in our PSLOs is leading to important conversations about curriculum and how PSLOs are being met. The goal for this year is to develop a revised curriculum that better supports our PSLOs and best utilizes the expertise of our faculty. Given budget constraints and staffing limitations we are also discussing possible cross campus partnerships to meet our student needs. For example, this term many of our students are participating in a science writing class being offered by communications which directly relates to PSLO #6: Communicating Science. We are in discussions with Civil Engineering to determine if some classes could be co-listed so that both BES and CIV students could benefit from the course content.

Table 7 will be populated as we go through the curriculum change process with potential cuts to classes that no longer support the PSLOs or addition of classes which benefit our learning outcomes. The columns that are filled in relate to PSLO 2 for which assessment data is currently being collected and PSLO 5 for which data was collected last year.

Table 7: BES curriculum map and learning objectives. Level of application: F – Foundational P – Practicing C - Capstone

COURSE	PSLO 1	PSLO 2	PSLO 3	PSLO 4	PSLO 5	PSLO 6	ESLO 1	ESLO 2	ESLO 3	ESLO 4	ESLO 5	ESLO 6
BIO 211		F										
ENV 111					F							
GIS 103					F							
GEOG 105		F			P							
WRI 121												
BIO 212		P										
GIS 134					P							
MA 111												
WRI 122												
BIO 213												
GIS 205					P							
MA 112												
ENV 214												
CHE 221												
MA 251												
CHE 221												
ENV 275												

MA 252												
ENV 224												
CHE 223												
SPE 111												
ENV 226												
CHE 331												
PHY 221												
WRI 227												
ENV 365		P			P							
ENV 314		F										
CHE 315		P										
MA 361												
PHY 222												
ECO 201												
BIO 3XX ecology		P			C							
CHE 465		P										
PHY 223												
ENV 434 or MA 362												
SPE 321												
WRI Elec												
ENV 475												
ENV 484		C										
ENV 485		C										
ENV 495					C							

Section 6 – Assessment Cycle

Table 8: BES PSLO and ESLO assessment cycle.

Environmental Science BS PSLO and ESLO Assessment Cycle

Outcome	2018-19	2019-20	2020-21	2021-22	2022-23
PSLO 1 Foundational Knowledge	Assessed annually through completion of course curriculum	Assessed annually through completion of course curriculum	Assessed annually through completion of course curriculum	Assessed annually through completion of course curriculum	Assessed annually through completion of course curriculum
PSLO 2 Constructive Group Work		BIO 212 - Winter BIO 377 - Spring Exit Interview			
PSLO 3 Environmental Advocacy				ENV 475 Exit Interviews	
PSLO 4 Data Analysis			ENV 226-Winter ENV 434 – Spring Exit Interview		
PSLO 5 Geospatial Literacy	GEOG 105 ENV 365 Exit Interview				
PSLO 6 Communicating Science					WRI 345 ENV 495 BIO 386
ESLO 1 Communication					
ESLO 2 Inquiry and Analysis					
ESLO 3 Ethical Reasoning	ENV 111 CHE 315 Exit Interview				
ESLO 4 Teamwork		BIO 212 - Winter BIO 377 - Spring			
ESLO 5 Quantitative Literacy					
ESLO 6 Diverse Perspectives					

Section 7 – Methods for Assessment

PSLO Assessment 2018-19 and 2019-20

Currently, the rubrics for evaluating PSLOs are incomplete, leaving room for inconsistencies in our assessment process. Last year we developed a rubric for the PSLO #5 Geospatial Literacy (Appendix A) and this year we will focus on PSLO #2: Constructive Group Work. With each year and the assessment of a new PSLO, we will eventually have a complete set of rubrics which will greatly standardize the data collected for comparison over time. These rubrics are being designed with the intention that every student should be able to demonstrate a 3 for every skill listed on the rubric prior to graduating.

In addition to assessing one PSLO annually using course work within the program, we hope to add student portfolio component to the program where students will curate examples of their own work which relate to the various PSLOs. These portfolios will include:

- Curricular Vitae
- GIS project work
- Examples of written work where science is effectively communicated.
- Data analysis samples with conclusions.
- Environmental Advocacy Work

The portfolios will serve as both a record of student progress over time and act as evidence of obtaining these specific skills which can be shared by the student with potential employers. As assessment coordinator, I will be researching the portfolio function within Portfolium over the next year and integrating this tool into my ENV 475 Professionalism course in Winter of 2021.

PSLO 5 on Geospatial Literacy was assessed during the 2018-19 academic year. Direct measures were taken in GEOG 105 on two different assignments (Appendix B). Assignment 1 was an orienteering exercise where students created a treasure map using compass bearings and paces which addresses the land navigation skill on the Geospatial Literacy Rubric (Appendix A). Assignment 2 was a laboratory exercise where students interpreted USGS quadrangle maps to answer geospatial questions which relates to the map interpretation skill on the Geospatial Literacy Rubric (Appendix A). As this was the first time using the rubric we decided to only assess in one class with a relatively large class size as a way of calibrating this new tool.

On Assignment 1, the seven groups received an average score of 0.87 of 3 possible on the rubric. 7 of 8 of the groups were able to take and follow bearings in order to successfully navigate to the treasure. 1 group did not provide accurate bearings to their treasure and thus received a score of 0 for land navigation. As written this assignment did not address map interpretation, applying geospatial technology, cartography, or the more advanced skills of land navigation. Given that this is a 100 level physical geography assignment, a score of 1 on the rubric is a completely reasonable expectation for all students to achieve.

The average score on Assignment 2 was 2.6 of 3 possible. This indicates that the 17 students assessed were clearly able to interpret all key characteristics of a map (scale, legend, theme, projection) and that many of them were able to apply this information to answer geospatial questions related to the theme of the map. We were pleased to see the development of this skill so early in their academic career.

We gained some valuable information about the assessment process through our experience last year. In the future we will need assignments which relate to all 4 skills being assessed on the Geospatial Literacy Rubric. This could mean assessing 4 different assignments or assessing fewer assignments which cover more of the skills at once. Assessment should take place in a lower division class (100-200) and an upper division class (300-400) to demonstrate a growing skill set. Ideally, all students will be able to demonstrate a mastery (score of 3) on 4 geospatial literacy skills prior to graduation.

The following courses have been identified as possible sources of data for the Geospatial Literacy PSLO:

ENV 111	ENV 265	ENV 465	ENV 495	
GEOG 105	GIS 134	GIS 316	GIS 426	GIS 425
BIO 367	BIO 377	BIO 386		

In addition to direct measures for Geospatial Literacy we are also using the indirect measure of self-reported efficacy from exit interviews. According to our exit interviews, 100% of our students felt that they are highly proficient at geospatial literacy with 66.7% of these students reporting that their experiences at Oregon Tech

very much contributed to their geospatial literacy. All students who responded suggested that Oregon Tech positively impacted their geospatial literacy.

PSLO 2: Students will constructively work within and among diverse communities and perspectives will be assessed over the 2019-20 academic year. Direct assessment data will be collected by Kerry Ferris in BIO 212 in winter term and Jherime Kellermann in BIO 377 in spring term. All BES faculty will be invited to participate in the creation of the BES Group Work Rubric and scoring of individual examples of student work. In addition, indirect data will be taken via exit interviews.

ESLO Assessment 2018-19 and 2019-20

In 2018-19 we collected data on the Ethical Reasoning ESLO for institutional assessment purposes. This ESLO states, "Oregon Tech students will make and defend reasonable ethical judgments." Direct assessment data was collected in ENV 111 introduction to environmental sciences and CHE 315 chemical fate and transport. The BES assessment coordinator has actively participated in scoring of Ethical Reasoning assignments from across campus. We look forward to seeing how BES students performed on this ESLO when the assessment report comes out.

In 2019-20 we will be assessing ESLO 4 on teamwork which aligns nicely with the assessment of our PSLO 2 on constructively working within a group. The teamwork ESLO states "Oregon Tech students will collaborate effectively in teams or groups". Direct assessment data will be collected in BIO 212 in winter term and BIO 377 in spring term for both the ESLO and PSLO.

Section 8 - Evidence of Improvement in Student Learning

The previous PSLO related to geospatial literacy was focused more directly on the use of GPS and GIS. This was last assessed in 2015-16. While we have expanded the skill set we would like students to graduate with, it is useful to note that historically our students have performed well with geospatial literacy. 86% of students met the criteria during the last assessment cycle (2015). This was up from 67% in 2012.

Previous assessment of geospatial literacy was not evaluated with a rubric so it is difficult to compare the data collected in 2018-19 to the 2015 data. However, our students still appear to be performing well with geospatial literacy. 82% of students scored a 3 of 3 on the Map Interpretation part of the rubric. According to our exit interviews, 100% of our students felt that they are highly proficient at geospatial literacy with 66.7% of these students reporting that their experiences at Oregon Tech **very much** contributed to their geospatial literacy.

Section 9 - Data-driven Action Plans: Changes Resulting from Assessment

With new leadership at the helm and a team of positive and forward-thinking individuals, the faculty are pleased to be making progress on a strategic plan for the BES program. This plan includes refining our curriculum to better support our learning objectives and developing an assessment process which will actually measure the efficacy of our program in meeting our PSLOs.

As a starting point for our strategic planning, we reviewed exit interview data from the last five years. Trends in the data were identified. The following comments showed up multiple times in exit interviews.

Things we do well:

- Providing opportunities to get professional experience.
- The field experiences offered were well received.
- Application of book theory to field work.

Opportunities for Improvement

- Add diversity to our staff and student body

- Better distribute electives throughout the year
- Making science and math requirements more relevant for our students
- Advisors need to be more available and do a better job helping the students achieve their professional goals.
- Update lab equipment.
- Reduce scheduling conflicts.

The BES faculty are making every effort to connect our students to regional scientific research. The many partnerships we have formed (Table 4) provide our students with professional experience and connect them to expertise and tools which we may be unable to provide here on campus given our small program size. Increasing student enrollment is of highest priority for the BES program. As mentioned in Section 3 of this report, we have set a target enrollment of 60 students by fall of 2023. This would be an increase of 42% from the 2018 fall enrollment of 42.

Over the next year, the assessment coordinator will work with institutional research to identify the factors which contribute to BES retention rates. We hope to identify points in our curriculum with high attrition rates and reach out to students who have left the program to discover what drove them to quit school. Based on data already collected it appears that some of the students who leave our program do so for financial and personal reasons which are beyond our control.

Approximately 33% of students reported on the 2018-19 exit surveys that the lower division courses did not provide the foundation necessary for upper division courses. In response to this, we are redistributing course work in a more meaningful way by developing sequences of classes which should be taken in order. The following advising note was sent to BES advisors related to Winter 2020 advising, "If students have NOT yet taken ENV226 – Env Data Analysis, do not put them into ENV434. We are trying to create a logical series for these courses which would be ENV224->ENV226->MATH361->ENV434".

In 2018-2019, 5 of 6 students surveyed indicated that their experiences at Oregon Tech positively impacted their proficiency at Ethical Reasoning and Diverse Perspectives up from 3 of 5 students in 2017-18. This slight increase is likely due to the fact that we have been intentionally pointing out in BES classes when we are dealing with ethical reasoning or diverse perspective issues.

As our curriculum currently includes classes which we can no longer offer due to changes in staffing, course substitutions have to be made to get students to graduation. Students often find this substitution process frustrating. Once the redesigned curriculum is finalized many of the challenges related to advising will be eliminated. The next step in this curriculum redesign process is for program director Jherime Kellermann to create the new curriculum map to be distributed to BES faculty for approval followed by submitting these changes to CPC.

This year we revised our exit surveys to include a question about professional job experience gained as a student including temporary and internship work so that we can specifically track professional development within the program.

We will continue to utilize assessment data to drive decision making within the BES program. We believe that this will lead to a higher recruitment, retention, graduate success rates, and improve learning objective performance. Our use of assessment data will also act as a model for our students about making data driven decisions in the field of educational science which is one of the learning objectives for the program (PSLO 3)!

Appendix A: Geospatial Literacy Rubric

Demonstrate geospatial literacy through the utilization of appropriate technology to identify and address environmental problems.	High Proficiency (3)	Proficiency (2)	Limited Proficiency (1)	(0) No Proficiency OR does not apply to the assignment.
Map Interpretation	Student is clearly able to interpret all key characteristics of a map (scale, legend, theme, projection) and accurately apply this information to answer geospatial questions related to the theme of the map.	Student is clearly able to interpret all key characteristics of a map (scale, legend, theme, projection), but is unable to apply this information to answer geospatial questions related to the theme of the map.	Student is able to interpret some key characteristics of a map (scale, legend, theme, projection) but not all.	Student is unable to interpret the key characteristics of a map (scale, legend, theme, projection).
Land Navigation using a map and compass.	Student effectively coordinates the use of a map and a compass for land navigation. A student at this level should be able to demonstrate the following skills without prompting: • Adjusting for declination • Following a heading taken from a map. • Triangulation	Student coordinates the use of a map and a compass for land navigation. A student at this level should be able to demonstrate some but not all of these skills or may require prompting to complete these tasks: • Adjusting for declination • Following a heading taken from a map. • Triangulation	Student does not coordinate the use of a map and compass together for land navigation. However, the student can take a bearing on an object or follow a heading when supplied one.	Student is unable to use a compass for land navigation.

Demonstrate geospatial literacy through the utilization of appropriate technology to identify and address environmental problems.	High Proficiency (3)	Proficiency (2)	Limited Proficiency (1)	(0) No proficiency or does not apply to the assignment.
Cartography	Student is able to create a map using geospatial technology which includes ALL appropriate elements and is easy to interpret. Appropriate elements include: title, reference information, author, date, compass, scale, key, and projection.	Student is able to create a map using geospatial technology which includes ALL appropriate elements but some aspects of the map make it difficult to interpret.	Student is able to create a map using geospatial technology which includes some of the appropriate elements but not all.	Student is unable to create a map using geospatial technology.
Applying geospatial technology to address an environmental problem.	Student effectively utilizes the most appropriate geospatial technology available to address a specific question related to a broader environmental problem. Student makes an informed evaluation of the data and completely supports their conclusions with appropriate analysis.	Student effectively utilizes geospatial technology to address a specific question related to a broader environmental problem. Student did not choose the best technology available to address the question. and/or Conclusions drawn from their analysis are not completely supported by the data.	Student utilizes geospatial technology to address a specific question related to a broader environmental problem but the data collection is incomplete or any conclusions drawn from their analysis are not supported by the data.	Student demonstrates no ability to use geospatial technology to address a specific question related to a broader environmental problem.

Appendix B: Geospatial Literacy Assignments

Compass Activity

GEOG 105

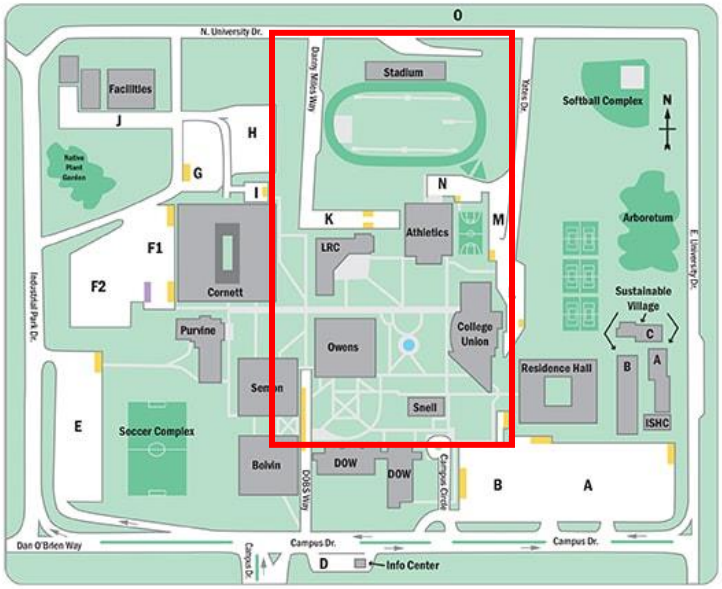
Group Members:

The purpose of this activity is to create a treasure map. Each member of your group will be given a piece of candy which will be placed in the bag to become hidden treasure.

Steps to completing this process:

1. Determine which group member will be in charge of counting paces. Have them determine the length of their pace using a tape measure. Make a note of the pace distance on your paper.
2. Obtain a flag and plant it at a reasonable starting location that can easily be identified. Write a brief description of the starting place on your map.
3. Take a bearing on an object which can clearly be seen from your starting point. Have at least two group members verify the bearing. Note the bearing on your map.
4. Count the number of paces to the object and write this with the bearing on the map.
5. Repeat this process until you have navigated to 5 different objects around campus.
6. At the last object, hide your treasure for another group to find. On the back side of your paper, provide a hint about the location of the treasure in case they have difficulty finding it.
7. Return to the starting location and trade your map with another group to see if you can successfully navigate to their treasure. Any treasure found may now be eaten!

Please note the stipulations below about hiding your treasure.



- Treasure must be hidden outside of buildings within the red boundary designated on this map.
- You should not have to climb on top of anything in order to reach the treasure.
- No destruction of property when hiding the treasure (digging holes, pulling off bark, etc.)

Name:_____ GEOG 105 Score:_____/20

Exercise 7 Drainage Basins and Fluvial Landscapes

1. From the homework video about the Colorado River.
   a. In what ways are humans impacting the Colorado River System (describe at least 3).

   b. Based on what you have learned. Does the current use of the Colorado River seem sustainable into the future? Explain.

The following questions are based on the "Deer Peak, Montana" quadrangle (scale 1:24,000; contour interval 40 feet) which can be accessed on Blackboard.

1. The unimproved dirt road (the gray line) along "Ed's Ridge" roughly follows which natural feature associated with the Eds Creek drainage basin?

2. The stream pattern within the drainage basin of Eds Creek is reproduced at right at a smaller scale. Identify and label the stream order for each stream segment.

   a. How many first order streams are shown? _____

   b. How many second-order streams are shown? _____

   c. Based on what you know about streams, describe at least three characteristics which would differ between the firs order and second order streams.

Using the topographic map on the next page, determine the gradients of the two first-order streams labeled “a” and “b”, the second-order stream labeled “c” on the map above, as well as Eds Creek after it has become a third-order stream. Fill in the table on the next page to help you calculate the gradients.

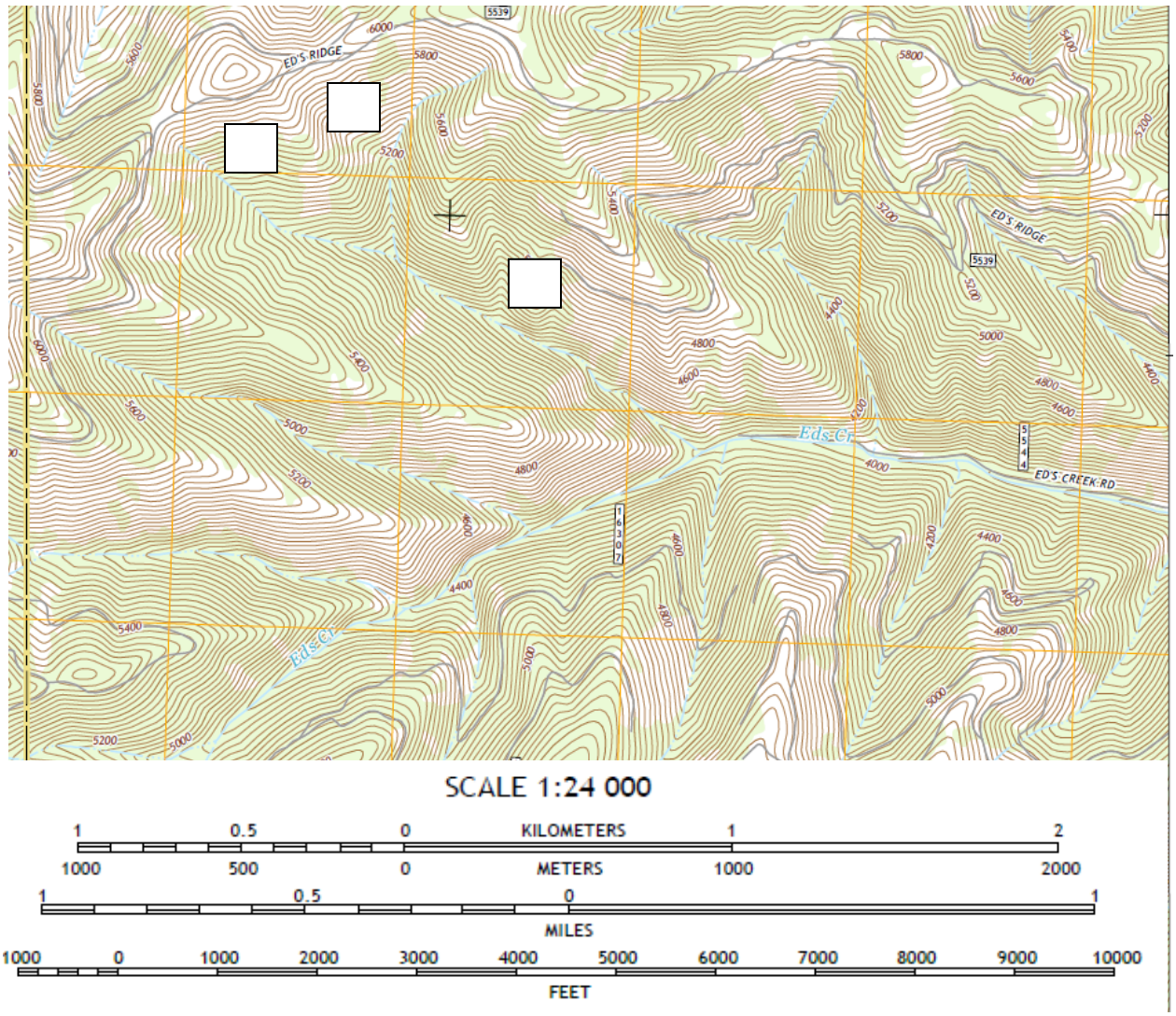


Figure 1: Eds Creek Drainage Basin taken from Deer Peak, Montana quadrangle.

3. The table below gives the gradients of 12 more first-order streams and 4 more second-order streams in the Eds Creek drainage basin. Fill in the gradients of the streams calculated in problem 3 (streams “a” and “b” under first-order; stream “c” under second-order; Eds Creek under third-order).

Stream	Order	Elevation Drop (feet)	Length (miles) (to nearest 0.1mi)	Gradient (feet/mile)
a	1st			
b	1st			
c	2nd			
Eds Creek	3rd			

First-Order Stream Gradients (ft/mi)		Second-Order Stream Gradients (ft/mi)	Third-Order Stream Gradients (ft/mi)
1680	1965	800	
1715	1485	680	
1225	1300	665	
1440	1335	800	
1200	1370		
1210	1355		
a _____ft/mi	b _____ft/mi	c _____ft/mi	_____ft/mi Eds Creek

Using the data from the table above, compute the following:

a. Average gradient of all first-order streams in this basin: _____ ft/mi

b. Average gradient of all second-order streams in this basin: _____ ft/mi

c. What generally happens to the gradients of streams as the stream order increases?

4.

a. Describe the general width and shape (cross section) of the valley floors of first-order streams in the Eds Creek drainage basin.

b. How is the valley floor of Eds Creek different from the valley floors of the first-order streams? (Hint: Look at the difference in valley floor width.)

The following question is based on a section of USGS "Dane Canyon, Arizona" quadrangle below, showing the southern edge of the Mogollon Mesa 134°24'33"N, 111°10'52"W2, formed by a nearly flat-lying layer of resistant rock.

5. If gradient were the only factor controlling the erosive power of these streams, what should happen to the position of the mesa edge with time?

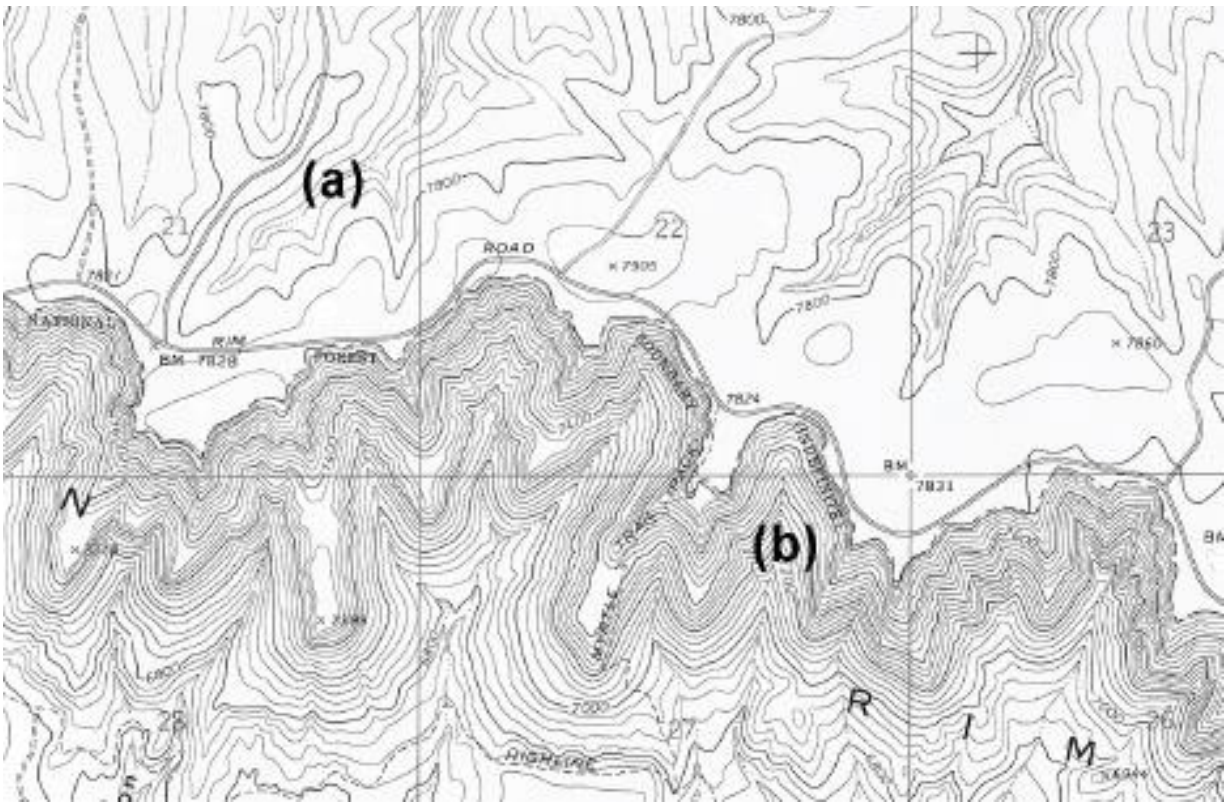


Figure 2: USGS "Dane Canyon, Arizona" quadrangle (scale 1:24,000; contour interval 40 feet).

The following questions are based on the "Voltaire, North Dakota" quadrangle (scale 1:24,000; contour interval 5 feet) which can be accessed via blackboard.

6.

a. In which direction is the Souris River flowing?

From _____ to _____.

b. How can you tell?

7.

a. What is the approximate width of the Souris River Channel? _____ft

b. What is the approximate width of the Souris River Floodplain? _____ft

c. What evidence suggests that the river is widening its valley through lateral erosion?

8.

a. Calculate the sinuosity of the Souris River and classify this value based on your course notes.

Length of present meandering course: 13.5 miles
Length of valley: 4.5

Sinuosity:_____ _____

9. Natural levees can be seen along the Souris River in the center portion of the map (north of Westgaard Cemetery). Approximately how high are the levees?

_____ft

10. Explain the formation of the narrow, triangle-shaped lake just to the east of Westgaard Cemetery (in the NE ¼ of Section 3). You may use a sketch to illustrate your answer.

11. Describe the location of two more lakes, swamps, or topographic depressions along the Souris River that formed in a similar way. (You may refer to Public Land Survey township quarter sections to simplify your location description.)

12.

a. Describe a location where the formation of a new cutoff meander in the Souris River appears imminent.

b. Sketch the current river course near this meander.

c. Sketch what the new river course will look like after the cutoff.

This Lab Exercise was adapted from the Physical Geography Landscape Appreciation Laboratory Manual from Pearson.