Department of Environmental Sciences Undergraduate Program Assessment
Emory College of Arts and Sciences

Assessment Period: September 1, 2021-August 31, 2022

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Introduction

The Department of Environmental Sciences offers students an opportunity to engage in an interdisciplinary curriculum, combining coursework in both natural and social sciences and the humanities. The ENVS curriculum emphasizes systems thinking and integrative learning. On average, around 45-50 Emory students complete either the major (BA or BS) or one of the two minors (Environmental Science and Sustainability Sciences) each year, with a graduation rate similar to that of Emory College.

The variety of faculty disciplines in the department allows for meaningful collaboration in areas of ecology, conservation, disease ecology, environmental policy, resource management, sustainability and development, earth and atmospheric sciences, and geography and spatial sciences. Students are prepared for a work in a variety of settings:

- Environmental Services/ Renewables & Environment
- Non-profit, Education, Government Administration
- Hospital & Healthcare (MD, Nursing, PT and Hospital Administration)
- Law Practice
- Research

The breadth of faculty research and its relevance to some of the most pressing issues of our time – anthropogenic changes that place people and wildlife at increased risk of pathogen exchange, impacts of combustion emissions on air quality and health, food and water security, climate change and sustainability -- all make for a vibrant learning experience for ENVS students. Students are encouraged to discover and pursue their passions in environmental science through internships, study abroad, and participation in environmentally focused student organizations.

ENVS Mission statement: *Through interdisciplinary perspectives, and by integrating research, teaching, and service, our goal is to advance knowledge and prepare the next generation of scholars, researchers, practitioners, and citizens. We strive to exert a significant positive impact on environmental facets of human health, ecosystem management, sustainable development, and biodiversity conservation, at local, regional, and global scales.*

This report provides a one-year assessment of the undergraduate program within the Department of Environmental Sciences (ENVS) that covers the period from September 2021-August 2022 to build on our two-year report submitted in Fall 2021. This assessment was done by members of the ENVS Undergraduate Curriculum Committee, consisting of Dr. Shaunna Donaher (Chair), Leah Thomas, Dr. Gonzalo Vazquez-Prokopec, Professor Michael Page, and Dr. Debjani Sihi, in consultation with the remaining faculty and staff in the department. Shaunna Donaher and Leah Thomas authored this report.

Our previous assessment began to report results on our updated major curriculum, which was implemented in Fall 2020. We still have a small (but growing) sample of students graduating under the new requirements, and are now in a position to begin to evaluate longitudinal trends through this assessment.

The assessment and supporting analyses are described in six sections. Section 1 provides an overview of our Student Learning Outcomes and Goals. Section 2 details the methods and data from the assessment efforts by the curriculum committee. This includes data collected from case studies, statistical data on progress through the major, and student capstone portfolios. Section 3 provides a comprehensive review of results, analyses, and conclusions related to the methods discussed in the preceding section, with Section 4 offering recommendations for the use of these data to improve programmatic learning outcomes. Finally, Section 5 and Section 6 discuss faculty involvement in departmental assessment and outline plans for the next assessment cycle (Fall 2022 – Fall 2024), respectively. We begin with a description of student learning outcomes and goals.

1. ENVS STUDENT LEARNING OUTCOMES/GOALS

The 7 desired learning outcomes for ENVS undergraduate majors are shown in Table 1. Environmental science is comprised of many traditional disciplines, including earth (geology and soil science), atmospheric sciences, ecology, and ecosystem sciences, as well as social sciences (political science, anthropology, and geography), so the curriculum is inherently interdisciplinary. As such, the curriculum consists of both discipline-specific and interdisciplinary aspects. Students are required to take foundational courses that provide grounding in the theories, concepts, and methods of traditional environmental science disciplines. Much of the curriculum, however, requires courses integrate across disciplines, allowing students to understand how the disciplinary fields are interrelated. The track-based curriculum allows for students to focus on particular groupings of environmental science disciplines, while building depth in specific content areas. Common methodologies that develop quantitative skills in statistics, modelling and spatial data analyses are also required across the curriculum. We also see independent and experiential courses as part of the integrative curriculum. We want students to gain experience in using the skills, knowledge and abilities gained from our undergraduate program to help prepare them for their careers.

Table 1. List of ENVS undergraduate Learning Outcomes. Outcomes 1, 2, 4, 6, and 7 (starred *) are assessed this report.

Learning Outcome 1	*Remember knowledge of foundational environmental science content
Learning Outcome 2	*Demonstrate understanding of intersection between interdisciplinary environmental fields
Learning Outcome 3	Analyze environmental data
Learning Outcome 4	*Participate in experiential learning
Learning Outcome 5	Lead independent work in an environmental project
Learning Outcome 6	*Display scaffolding of learning throughout the program
Learning Outcome 7	*Evaluate individual learning in courses

2. ASSESSMENT METHODS

We assessed Learning Outcomes 1, 2, 4, 6, and 7 (Table 1) using three tools: 1) Case Studies, 2) Capstone Portfolios, and 3) Measures of Scaffolding, as shown in Table 2. This multifaceted approach allowed for a combination of quantitative and qualitative analyses in order to broadly evaluate student growth throughout the program, student exposure to experiential learning, student metacognition of their own learning, and scaffolding of learning throughout the program. The three assessment tools are described below.

Table 2. Learning Outcomes and Goals assessed in this report, matched with their respective analysis tools.

Learning Outcome	Goal	Assessment tool(s) used to evaluate objective
1	Remember knowledge of foundational environmental science content	Case Study
2	Demonstrate understanding of intersection between interdisciplinary environmental fields	2a) Case Study 2b) Capstone portfolios
4	Participate in experiential learning	Calculate what % of classes graduating seniors took that are considered >50% experiential by faculty
6	Display scaffolding of learning throughout the program	6a) Calculate % of students through 131, and 131 and methods courses by end of sophomore year 6b) Calculate % 2/3 done with ECO/EAS/SSP intermediate breadth requirements by end of 1st semester junior year 6c) Capstone portfolios
7	Evaluate individual learning in courses	Capstone portfolios

Tool #1: Case Study

A case study prompt (Table 3) was given to students at the start of their introductory lecture class (ENVS 120, ENVS 130, or ENVS 140), typically one of the first classes they have the option of taking in the department. This same case study was also given to students at the start of the required department capstone class (ENVS 490), which they take in their final semester. Our long-term goal for this assessment tool is to match student responses for majors that filled out the case study in both classes to address growth throughout the program, but during our assessment last year we recognized that we needed to improve our case study prompt. The prompt used in the case study was purposefully designed to be broad, but appeared to not provide sufficient prompting to encourage students to demonstrate their knowledge in all assessment objectives. In Spring 2022 we updated the prompt to better address the concepts in our rubrics (Tables 5, 6, and 7). This updated prompt was given in ENVS 120, ENVS 140, and ENVS 490 in Spring 2022, and ENVS 490 in Fall 2022, but we do not have any students that completed both the introductory and final case study to compare for this assessment report. Instead, 4 members of the ENVS faculty evaluated four random, blinded case study responses from graduating seniors in ENVS 490 in Spring 2022 to assess competence. In future years we will be able to use this tool compare the same students from the start of the program to the end of the program and assess growth as well.

Table 3. Case Study Prompt given to students at the start of ENVS 120, ENVS 130, ENVS 140, and ENVS 490. This prompt is given as a for-credit Canvas survey.

Instructions: You have up to 20 minutes to discuss the topics related to this problem in the spaces below. Please do not use any outside sources. There are not any wrong answers, we just want to see the knowledge and thought processes that you have coming into this class. You must type some characters for each question in order to get full credit for the survey. **Assume that you just moved to a location where water usually comes from a large local river that flows into a lake. This location has had severe water scarcity issues in the past several years that have prompted concern among many members of the community.**	
Question 1	How might this scarcity of water have become a problem in the first place? What specific causes and/or interactions might have contributed?
Question 2	What kind of data would you need to collect to fully understand the problem? What approaches would you use to analyze it? Do you think other environmental scientists might take a different approach?
Question 3	In what ways would this problem impact the environment and society? How would you communicate these challenges with members of the community?
Question 4	Is there anything you didn't share above that you would like to add? (if not, type 'no')
Question 5	Which of your past ENVS classes were most helpful in developing your answers to this case study and why?

Tool #2: Capstone Portfolios

The changes to our major in Fall 2020 added a required capstone course (ENVS 490) in the final semester for both BA and BS students. This course has students compile and reflect on examples of learning throughout the major in a portfolio (Table 4). We had 20 students complete this requirement since our last assessment report. For this report, student portfolios were evaluated qualitatively by the faculty members of curriculum committee for examples of interdisciplinarity, scaffolding of learning, and metacognition.

Table 4. Capstone Portfolio Requirements for ENVS 490 in Spring 2022

Component B	Write a reflection on your initial interests in environmental science and how your experience in the intro series (ENVS 120/130/140/131/AP) shaped/changed those interests. Suggested inclusions: What content/experiences from the intro series were most meaningful to you? Did the intro series help you decide on a BA or BS track?
Component C	Submit any one sample assignment from an ENVS class you took before this semester. Write a reflection on why you chose this sample and identify strengths/weaknesses in your knowledge and skills. Suggestion: Do you have any ideas for how to make the assignment more valuable in the future?
Component D	Write a reflection on how the 4 intermediate breadth classes you chose connected (or didn't) with your other classes in the department. Suggestion: Did you build on the intermediate content in other classes? Did you purposefully choose advanced electives based on intermediate breadths?
Component E	Create a concept map showing linkages across content in your chosen advanced electives, along with a reflection of common themes and complementary traits of your elective choices. Details: A concept map should contain 4-7 bubbles of key ideas (or assignments) in each elective class with links between the bubbles shown and explained.
Component F	Write a reflection on how your 2 lab/field courses influenced your understanding of environmental science. Suggestions: What was valuable about these experiences beyond the lecture-only classes? Did these classes specifically help prepare you to address an environmental problem?

Component G	Write a reflection about how your independent study experience integrated prior course knowledge and helped build new knowledge and/or skills. Suggestion: Did the independent study help you narrow down your career path or build specific skills/knowledge/networks for your post-graduation goals?
Component H	For BS students only: Write a reflection of what external BS courses you chose and why, and how they enhanced your understanding of environmental science (or didn't).
Component I	Write a letter to an incoming ENVS student. Reflect on your initial goals upon declaring the major, and how those changed (or didn't) during your academic experience.

Tool #3: Scaffolding Tool

One of our main goals of restructuring the major requirements was to create levels of knowledge, from an introductory series (lecture plus ENVS 131); to four intermediate breadth categories (Methods, Ecology and Conservation (ECO), Earth and Atmospheric Sciences (EAS), Social Science and Policy (SSP)); to advanced electives; to independent work (independent study, capstone portfolio). These levels are meant to help guide students in scaffolding their learning by requiring foundational knowledge and skills be developed early, so advanced work can come later. The department already has ENVS 131 as a prerequisite on many upper-level classes, but few advanced courses require any additional hierarchy in terms of when students take courses beyond the foundational and intermediate levels. For this analysis tool, we looked at data on student progress through the major to see what % of students are meeting benchmark goals of taking foundational/intermediate breadth classes, and what % of students are taking classes designated as 'experiential' by the course instructor.

2a) Assessment of Learning Outcome 1

Learning Outcome 1 asks students to remember knowledge of foundational environmental science content. We used the case studies to evaluate this by scoring responses from students about to graduate using the rubric shown in Table 5. This allowed us to break down three levels of student knowledge. Objective 1a looks at identification and application of foundational ideas across 3 main concept areas in environmental science (Earth/Atmospheric Science (1a-1), Ecology/Conservation (1a-2), and Social Science/Policy(1a-3)), as well as concepts that bridge all 3 areas. A list of relevant topics in each concept area is shown in Table 6. This list was developed from suggestions provided by 8 faculty and 1 staff member in the department. Objective 1b looks at knowledge of environmental science methods. Objective 1c looks at knowledge of systems thinking (the understanding of interconnectivity and feedbacks within environmental systems). Case studies were blinded and scored by all 4 faculty members of the ENVS curriculum committee. Results are presented in Section 3a.

Table 5. Scoring rubric for Learning Outcome 1. (+ indicates that bridging topics also count)

	Excellent (4)	Proficient (3)	Developing (2)	Beginning (1)	Missing (0)
Objective 1a: Remember Foundation Environmental Science Content					
1a-1: Foundation content in earth/atmospheric science (EAS)	Identifies and correctly applies more than one EAS concept+ relevant to case study.	Identifies and correctly applies one EAS concept+ relevant to case study.	Identifies more than one EAS concept+ relevant to case study.	Identifies one EAS concept+ relevant to case study.	No mention of EAS concepts
1a-2: Foundation content in ecology and conservation (E&C)	Identifies and correctly applies more than one E&C concept+ relevant to case study.	Identifies and correctly applies one E&C concept+ relevant to case study.	Identifies more than one E&C concept+ relevant to case study.	Identifies one E&C concept+ relevant to case study.	No mention of E&C concepts
1a-3: Foundation content in social science and policy (SSP)	Identifies and correctly applies more than one SSP concept+ relevant to case study.	Identifies and correctly applies one SSP concept+ relevant to case study.	Identifies more than one SSP concept+ relevant to case study.	Identifies one SSP concept+ relevant to case study.	No mention of SSP concepts
Objective 1b: Remember Environmental Science Methods					
	Illustrates advanced understanding of methods with sophisticated explanation of application for one or more examples	Identifies one or more methods with appropriate application	Identifies one or more methods + provides superficial application	Mentions but does not apply one method	No mention of methods
Objective 1c: Use Systems Thinking					
	Illustrates advanced understanding of interconnectivity with sophisticated explanation of application for one or more examples	Identifies one or more concepts with appropriate application	Identifies one or more concepts + provides superficial application	Acknowledges at least one systems thinking concept, but does not apply	No mention of systems thinking

Table 6. Lists of relevant knowledge in three main ENVS content areas, plus bridging concepts across areas. This list is used to score Objective 1a in the rubric in Table 5.

Bridging Concepts Pollution Resilience Tipping points Environmental justice Biogeochemical Anthropogenic influences Watersheds Systems thinking Resource management		
Ecology/Conservation Topics	**Earth/Atmospheric Topics**	**Social Science/ Policy Topics**
Ecosystem services Disturbance regimes Habitats	Hydrologic cycle Climate change influence Drought/ flooding Streamflow Land use changes/ impervious surfaces Water storage/ dams Ground material/ sediments	Tragedy of the Commons Externalities (negative or positive) Design priniciples/Ostrom Regulations/cap and trade Changes in population/ water use Community-based management Collaboration/stakeholders

2b) Assessment of Learning Outcome 2

Learning Outcome 2 asks students to demonstrate understanding of intersection between interdisciplinary environmental fields. We evaluated this in 2 ways: Objective 2a used the case studies as described above along with the rubric in Table 7 to quantitatively assess understanding of interdisciplinarity related to the case study. Objective 2b used student submissions in their capstone portfolios to qualitatively show examples of interdisciplinarity in their classes, class projects, and independent studies. Results from the case study are presented in Section 3a, with results from the portfolios presented in Section 3b.

Table 7. Rubric for evaluating Learning Outcome 2a.

Objective 2a: Demonstrate Understanding of Intrsection between Interdisciplinary Environmental Fields	**Excellent (4)**	**Proficient (3)**	**Developing (2)**	**Beginning (1)**	**Missing (0)**
2a-1: Sees (makes) connections across disciplines	Synthesizes or draws conclusions using concepts or theories from more than one field of study or perspective.	Synthesizes or draws conclusions from examples or facts from more than one field of study or perspective.	Connects concepts or theories from more than one field of study or perspective.	Connects examples or facts from more than one field of study or perspective.	No integration demonstrated.
2a-2: Framing of problem invites intergrative apporach.	Purpose clearly calls for integrative approach and provides clear rationale for this approach.	Purpose clearly calls for integrative approach but no or weak rationale is offered	Purpose implies integrative approach, but no rationale offered.	Purpose is ambiguous	No integration demonstrated.
2a-3: Disciplinary perspectives and insights are balanced	Disciplinary insights are delicately balanced to maximize the effectiveness of the paper in light of the purpose of the work. The integration is elegant and coherent and there are no distractions in the building of the argument	Disciplinary insights in the paper are generally balanced on substantive grounds in light of the purpose of the work. However, one or more aspects of the argument may be weakly addressed.	The student attempts to balance perspectives but builds this on artificial or algorithmic grounds rather than substantive ones. (e.g., giving equal weight to each disciplinary perspective studied irrespective of its substantive relevance to the problem at hand).	Case analysis shows an imbalance in the way particular disciplinary perspectives are presented in light of the purpose of the work. (e.g., particular disciplinary perspectives are given disproportionate weight for no obvious reason).	No integration demonstrated
2a-4: Shows awareness of the limitations and benefits of the contributing disciplines or how the disciplines intertwine.	The benefits and/or limitations of the differing contributing disciplines or fields are discussed clearly, insightfully, and in relationship to one another	The benefits and/or limitations of the differing contributing disciplines or fields are sufficiently and clearly discussed. Some of the points made may be general or obvious.	There is awareness of more than one discipline but there is only brief discussion of the limitations and/or benefits of the disciplinary contributions.	There is awareness of more than one discipline but there is no discussion of the limitations and/or benefits of the disciplinary contributions.	No integration demonstrated

2c) Assessment of Learning Outcome 4

Learning Outcome 4 requires students to participate in experiential learning to gain exposure to methods and real-world content of environmental science. Although all majors are already required to take at least two courses designated as lab/field classes, this outcome assesses a broader scope of exposure, including classes not designated as such within the major. To assess this, we calculated what percent of classes graduating seniors took that are considered 50% or more ‘experiential content’ by the faculty teaching those classes. This ‘experiential’ learning could either be what

faculty called “hands-on learning”, or “out-of-classroom learning” and is based on survey information filled out for all classes in the department in 2018. The list of classes meeting these thresholds is shown in Table 8. Results of this calculation are shown in section 3c.

Table 8. List of classes reported by faculty (in 2018) to spend 50%+ of class focusing on experiential components either in or out of the classroom

Course Number	**Course Level**	**50%+ Hands-on experience**	**50%+ Out-of-classroom experience**
ENVS 131	100	N	Y
ENVS 232	200	Y	N
ENVS 240L	200	Y	N
ENVS 241+242	200	Y	Y
ENVS 247L	200	Y	Y
ENVS 328	300	Y	N
ENVS 341	300	Y	**Y**
ENVS 366	300	Y	N
ENVS 371 & 372	300	Y	Y
ENVS 380	300	Y	Y
ENVS 426	400	Y	Y
ENVS 442	400	Y	N
ENVS 446	400	Y	N
ENVS 460	400	Y	N
ENVS 483	400	Y	N
ENVS 491	400	N	Y
ENVS 497	400	N	Y

2d) Assessment of Learning Outcome 6

Learning Outcome 6 requires students to scaffold their learning throughout the program, so they can learn foundational knowledge and skills early and build on this with more advanced material with successive progress in the major. Part of the scaffolding effort is built into major requirements by requiring foundational and intermediate breadth classes, though we do not specify when students need to take these classes beyond having ENVS 131 as a prerequisite for many upper-level classes. Students have a choice in their advanced elective classes, and to meet this learning goal we would ideally like to see evidence of them making class choices that advance their environmental science knowledge in depth and not just breadth. Results are presented in Section 3d.

Objective 6a: To evaluate early exposure to foundational content and methods, we used statistical data from our current majors to calculate the percent of students that have completed ENVS 131 by end of sophomore year, and the percent of students that have completed both ENVS 131 and their methods intermediate breadth course by end of sophomore year.

Objective 6b: To evaluate early exposure to intermediate breadth content classes, we used statistical data from our current majors to calculate the percent of students that have completed at least 2 out of 3 ECO/EAS/SSP intermediate breadth requirements by the end of 1st semester junior year.

Objective 6c: Objective 6c used student submissions in their capstone portfolios to qualitatively show examples of scaffolding of learning in their classes, class projects, and independent studies. Scaffolding examples could be intentional choices made by the student, or organic occurrences due to the nature of the major requirements.

2e) Assessment of Learning Outcome 7

Objective 7 used submissions from student capstone portfolios to qualitatively show examples of student awareness of their own learning experience from their classes, class projects, and independent studies. These examples could include how they chose specific elective courses, skills they acquired, or awareness of gaps in their knowledge. Results are presented in Section 3e.

3. ANALYSIS OF ASSESSMENT RESULTS

3a) Learning Outcomes 1 and 2a Results

As described in Section 2, the curriculum committee assessed the case studies conducted by students at the start of ENVS 490, the capstone portfolio class that students take in their final semester. In our Fall 2021 report, we found that seniors were scoring low on many aspects of the rubric (shown in Table 9), which we hypothesized was due more to an ineffective prompt than them not meeting the associated learning goals. We redesigned the case prompts (Table 3) and had students complete the new case study beginning in Spring 2022. For this assessment we do not have same-student pairings to compare between their intro lecture class and senior year, so we cannot assess growth. However, we chose a random sample of 4 students (out of 20) that completed the case study in Spring 2022 to assess (1) meeting of learning goals, and (2) the effectiveness of the updated prompt.

Each case study was assessed by four faculty members using the rubric in Table 5, with Table 10 showing the total count of scores in three main accomplishment levels. A score of 0 means that the student did not show any knowledge to meet that objective. A score of 1 or 2 represents beginning (1) or developing (2) knowledge. A score of 3 or 4 shows mastery, either at the proficient (3), or excellent (4) level. There is still a spread in inter-rater reliability, but consistency intra-rater (not shown) allows us to compare total counts at each level.

The results of this improved assessment tool show that by the time students get to ENVS 490 in their final semester, all are showing awareness of interdisciplinary nature of the environmental science field, with most showing mastery of foundational environmental science content. We suspect that the improvement between Tables 9 and 10 is due to a more effective case study prompt rather than an actually difference in knowledge between student samples. The lowest performances are still in objective 2a-4, and this is a trend we will follow to see if it continues in future assessments. Future assessments will also allow us to compare responses by the same student between their intro course and graduation to evaluate growth.

Table 9. Total count of rater scores of '0', '1 or 2', and '3 or 4' from case study evaluations in Spring 2021 under the old case study prompt. (n=15 (5 students with 3 raters per student)). These results were presented in the Fall 2021 assessment report.

Objective	# of cases receiving '0' scores in 490	# of cases receiving '1' or '2' scores in 490	# of cases receiving '3' or '4' scores in 490
1a-1: Foundation content in earth/atmospheric science	0	6	9
1a-2: Foundation content in ecology and conservation	2	5	8
1a-3: Foundation content in social science and policy	1	5	9
1b: Remember Environmental Science Methods	9	4	2
1c: Use Systems Thinking	1	9	5
2a-1: Sees (makes) connections across disciplines	0	12	3
2a-2: Framing of problem invites integrative approach.	0	11	4
2a-3: Disciplinary perspectives and insights are balanced	1	8	6
2a-4: Shows awareness of the limitations and benefits of the contributing disciplines or how the disciplines intertwine	5	10	2

Table 10. Total count of rater scores of '0', '1 or 2', and '3 or 4' from case study evaluations in Spring 2022, under the updated case study prompt. (n=16 (4 students with 4 raters per student))

Objective	# of cases receiving '0' scores in 490	# of cases receiving '1' or '2' scores in 490	# of cases receiving '3' or '4' scores in 490
1a-1: Foundation content in earth/atmospheric science	0	3	13
1a-2: Foundation content in ecology and conservation	0	4	12
1a-3: Foundation content in social science and policy	0	2	14
1b: Remember Environmental Science Methods	0	3	13
1c: Use Systems Thinking	0	4	12

2a-1: Sees (makes) connections across disciplines	0	4	12
2a-2: Framing of problem invites integrative approach.	0	4	12
2a-3: Disciplinary perspectives and insights are balanced	0	4	12
2a-4: Shows awareness of the limitations and benefits of the contributing disciplines or how the disciplines intertwine	0	10	4

3b) Learning Outcome 2b Results

Objective 2b: The capstone portfolios in ENVS 490 had many examples of interdisciplinary experiences in the department, and especially highlighted systems thinking. Selected examples are presented below.

Example from introductory lecture class (ENVS 120)- "*ENVS 120 taught me to think in an interdisciplinary way and connect with broad fields of study. Unlike any other science course I took before, ENVS 120 taught me to think more extensively than a cell or molecule scale. To address overarching topics in environmental science, I learned interdisciplinary thinking relies on broad understandings of refined parameters involved in systems."*

Example from intermediate breadth classes- *"229, 240, and 260 all pushed me to think about systems in the environment (atmospheric, ecological, and viral) through a calculated lens. Each connected to my other classes in similar ways of citing sources properly, understanding environmental events through a scientific and social lens, and creating stimulating visuals to represent system dynamics."*

Example from advanced electives- *"Many of the major concepts from my upper-level elective courses fit with each other to develop a robust and deep understanding of environmental topics from several perspectives. For example, the topic of resilience was one that recurred in several courses. We discussed resilience from an ecosystem perspective in ecology courses. We also discussed resilience from an institutional and design perspective in Institutions and the Environment and Biophilic/Green Design."*

Example from ENVS 222_OX – *"The most important takeaway from the course was about the interdisciplinary nature of earth and environmental sciences. Without geology it is impossible to understand theories of abiogenesis, paleontology, and evolution. Without chemistry we cannot understand geology, and without physics there is no chemistry. Everything is elementary, but elementary knowledge is too fine a tool to paint an accurate picture of the global scale systems that impact living beings. This interconnectedness lies at the heart of Ecology and environmental health that I would go on to study at length in future courses."*

Example from an approved substitute for 390 that showed **lack** of interdisciplinary consideration*: "The course [350] did not focus much on the interdisciplinary nature of environmental science. Since the only environmental topics the book covered much were ecological, the other disciplines of environmental science were mostly ignored."*

Students also submitted concept maps showing linking concepts across advances electives, shown in Figures 1-3.

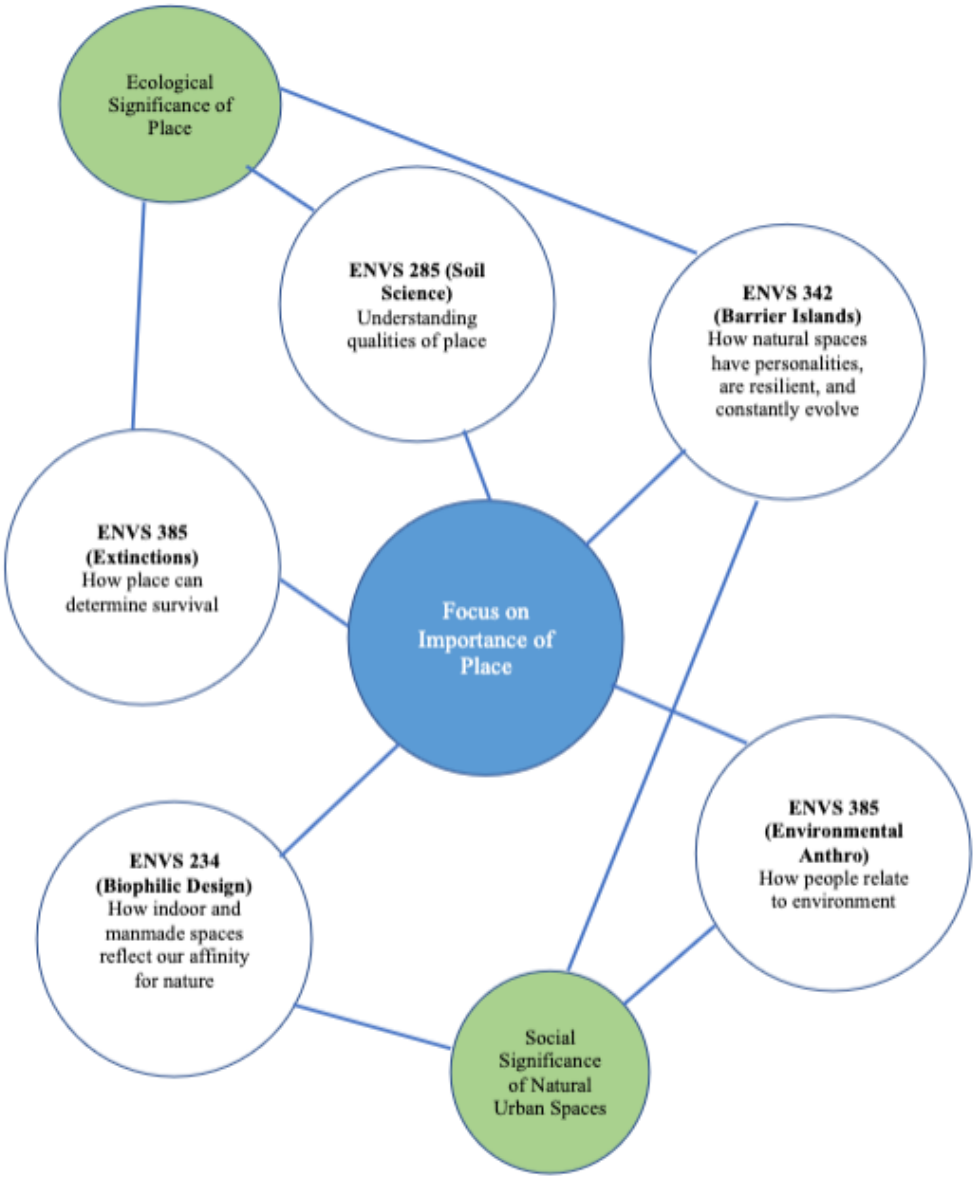

Figure 1. Sample concept map 1 showing connection in advanced elective classes.

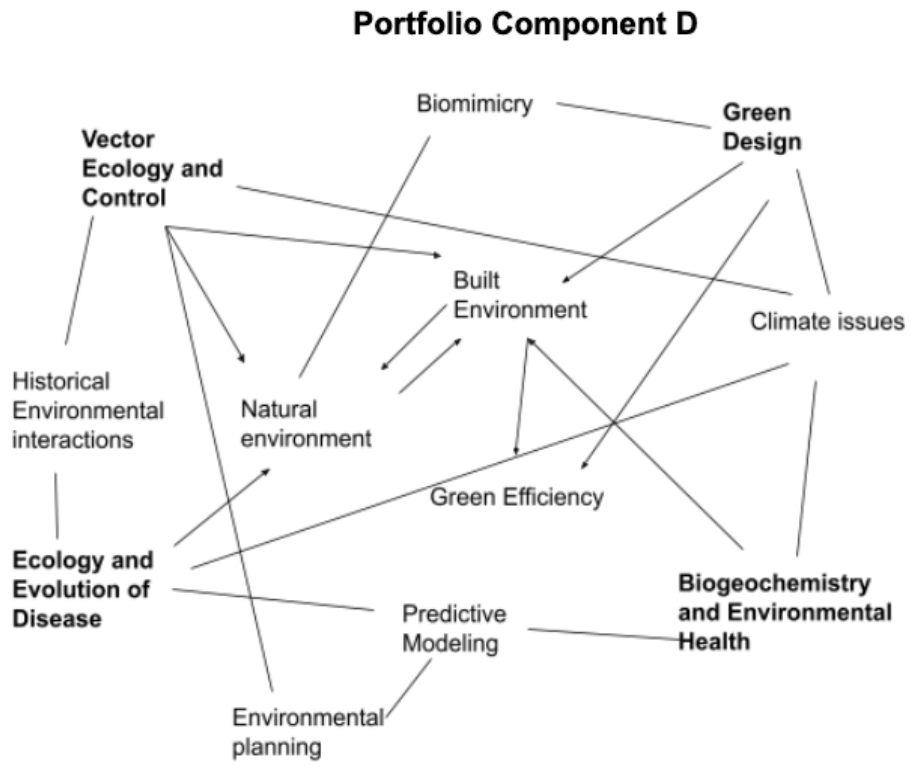

Figure 2. Sample concept map 2 showing connection in advanced elective classes.

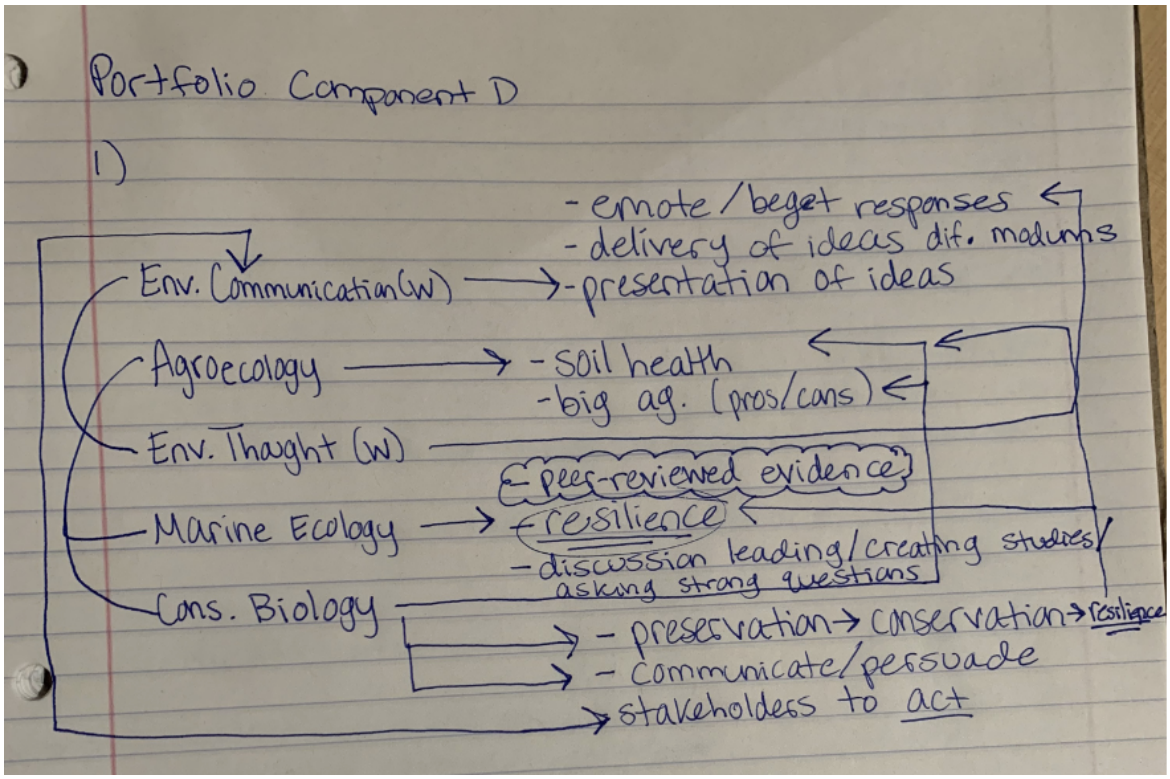

Figure 3. Sample concept map 3 showing connection in advanced elective classes.

As we reported in our Fall 2021 assessment, awareness of the interdisciplinary aspect of the environmental sciences field continues to be strong among our graduates, though they are not commonly understanding the benefits/shortcomings of disciplines. This matches the results seen in Table 10, but the examples of interdisciplinarity are typically more developed in the portfolios than in the case studies, which provides encouragement that students are meeting this learning outcome. Some of this strength could be because the concept map requirement in the portfolio forced students to think about connections between classes. Some evidence from their portfolios (specifically, summaries of intermediate breadth classes and independent study work) suggested a tendency to compartmentalize tasks during multi-disciplinary projects. This is not surprising, given that even when experts work together, they often divide up the workload in accordance with each person's particular expertise and discipline. However, it does suggest that there is a need for faculty to more explicitly encourage students to think about interdisciplinary solutions to environmental issues. As a department we also need to ensure that substitutions approved for classes meant to be interdisciplinary meet that goal. Nevertheless, we are pleased that our students recognize the intersections of natural and social sciences, history, communication, and place.

3c) Learning Outcome 4 Results

Our analysis of major progress shows that forty-two students will graduate with a major in ENVS in either Fall 2022 or Spring 2023. Of the BA majors (n=10), 90% have completed more than one primarily experiential course (compared to 93% in 2021-2022); 30% have completed three or more courses in this category (30% in 2021-2022). Of the BS majors (n=32), 94% have completed more than one experiential course (80% in 2021-2022); 66% have completed three or more (up from 20% in 2021-2022). Across all 42 senior ENVS majors, a total of 114 experiential courses were taken, for an average of 2.65 courses per student. Approximately two-thirds of them completed at least one experiential course at the intermediate level (i.e., courses at the 200-level), with 64% of graduating ENVS majors taking at least one experiential course at the 400-level.

These results meet this learning objective, especially since not all lab/field or independent study classes are included in this evaluation. These reduced-enrollment, experiential classes require significant staffing demands, but these experiences serve students well for the next step in their careers. We are especially excited to see that significantly more of our graduating BS majors have been able to take more experiential classes to help them gain relevant skills needed in the field.

3d) Learning Outcome 6 Results

Objective 6a: 79% of current seniors had completed our introductory field course (ENVS 131) by the end of their sophomore year (Figure 4), with most majors are taking ENVS 131 as sophomores. We suspect this is due to two factors: (1) not deciding to major in ENVS until after their first year; and (2) not being able to get into ENVS 131 as incoming students. Some students may not declare until their sophomore year and would be delayed in enrolling in ENVS 131 until their 3rd year. The earlier our majors can take ENVS 131, the faster they can progress to intermediate and advanced requirements. In 2019-2020 we had a large backlog of demand for ENVS 131 that caused students to not enroll until sophomore or junior year, but by offering more sections of the class we have been able to enroll more freshman and sophomores.

However, only 36% of seniors had completed both ENVS 131 and at least one methods intermediate breadth course by the end of their sophomore year (down from 50% in 2021-2022). This combination is important to complete early if they are going to be able to scaffold into advanced methods and application classes in their junior or senior years. This significant drop is likely due to students not being able to get into two of the popular methods classes (ENVS 250 and ENVS 270) until their senior years (Figure 5). By comparison, only 13% of current junior had completed ENVS 131 and their methods course by the end of their sophomore year. The numbers for both seniors and juniors are below our target (2/3 -3/4 of students), and the ENVS department needs to consider offering more sections of ENVS 250 and ENVS 270 if this trend of delayed access to methods classes continues.

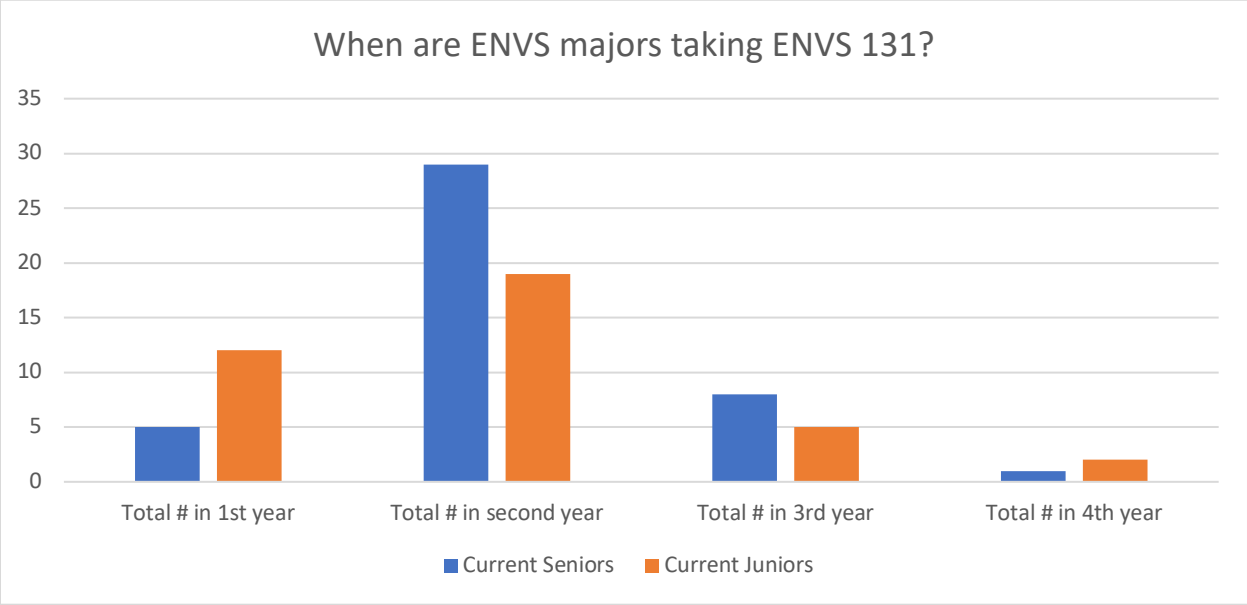

Figure 4. Raw count of current seniors (blue) and juniors (orange) by year that they took ENVS 131, Intro to Field Studies. Juniors that have not yet taken 131 are counted as having to take it in their 4th year since ENVS 131 is not being offered in Spring 2023.

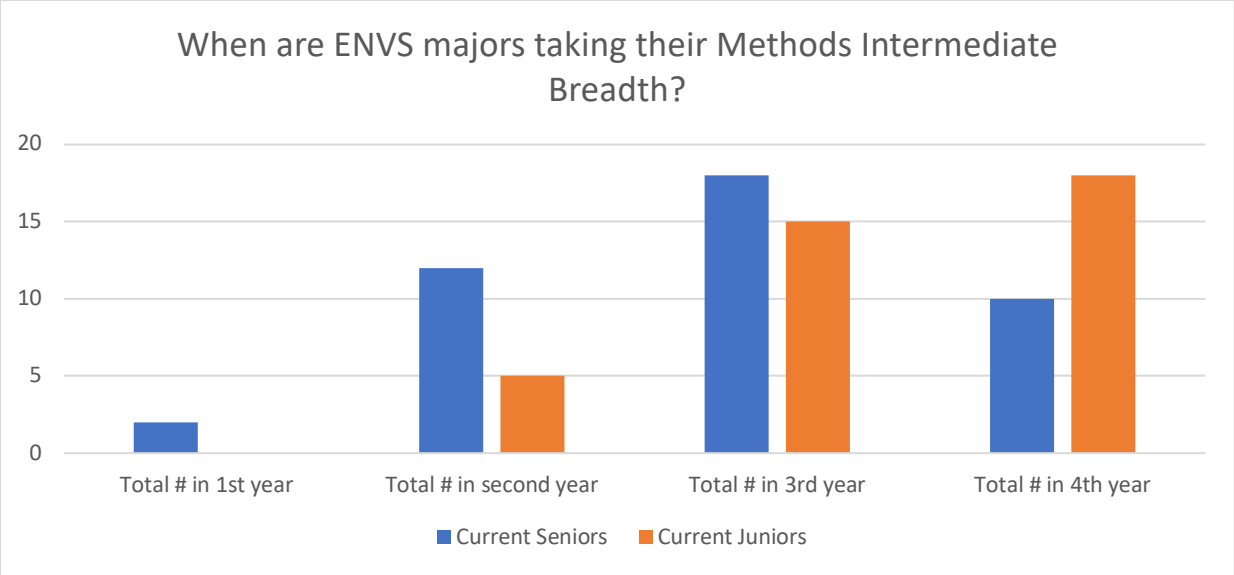

Figure 5. Raw count of current seniors (blue) and juniors (orange) by year that they took their first Intermediate breadth methods course (ENVS 250, 260, or 270). Juniors that have not yet taken methods are counted as having to take it in their 4th year, though it is likely that some may take a class in Spring 2023.

Objective 6b: Of the 80 current juniors and seniors majoring in ENVS, approximately 56% (24 seniors and 21 juniors) have (or will have, for current juniors in the Fall 2022 semester) completed at least two-thirds of their content-based intermediate breadth requirements for the ENVS major by the end of first semester, junior year. This number, similarly to the % for Objective 6a, is lower than our target goal (2/3-3/4 of students), but has increased from 50% in our 2021 assessment. This still suggests that we need to do more to encourage students to take their 200-level intermediate breadth classes early enough that they can build on content as upperclassmen. We note that most current juniors (n=38) have taken their EAS (n=33) Breadth, about half (n=21) have taken their ECO/EVH Breadth, and only a third (n=13) have taken their Social Science + Policy (SSP) Breadth. The delayed access to SSP classes comes from heavy demand delaying enrollment until senior year, and students from Oxford not having options to complete the requirement there.

Objective 6c: Using student portfolio submissions, we were able to record instances of scaffolded student learning, though more often involved building on components in classes unintentionally. Selected examples are presented below.

Example from introductory lecture- *"ENVS 120's introduction to the greenhouse gas effect helped me fully understand this process for the first time, and I am grateful for this as I later went over this process on multiple other occasions in classes that I took later on in the process."*

Example from ECO/EVH intermediate Breadth- *"ENVS 240 has been one of the most valuable classes I have taken—it has provided me with foundational ecosystem knowledge for understanding nutrient cycling in soil science (ENVS 285), the dynamics of a barrier island ecosystem (ENVS 342), and the severity of the threat of habitat fragmentation (ENVS 491)."*

Example from Intermediate Breadth connecting to advanced electives- *student noted 240 as foundation and field botany building on that in both skills and content*

Example from advanced electives- *"I really enjoyed both Atmospheric Science and Oceanography, which to me felt like two halves of one class. I took them in back-to-back semesters, so I was able to the see the similarities between the atmospheric and marine systems and how strongly they influence each other."*

Example from reflection on independent study project- *Student discussed how they used knowledge and skills from ENVS 270 in their ENVS 491 project. (The same student also discussed using the concept of the Anthropocene from ENVS 120 in their group-led discussion, and how 255 communication skills were useful in 270.*

Example from advanced electives showing **lack** of scaffolding opportunity- "*I wish there was an advanced ecology in spring to follow up 232."*

In terms of scaffolding classes, only about half of our students are taking introductory and content-based intermediate breadth classes early enough to build on with more advanced classes later. As a department, we want this value to be at least 2/3 of our majors, and ideally 75% of our majors. The portfolio responses suggest that students are not making an intentional choice to scaffold their learning, and are mostly just selecting electives they think they will enjoy, or what fits their schedules. The evidence in the portfolios implies that students can acknowledge how content from previous classes is complementary, but that they are not being presented with opportunities to build upon intermediate level classes directly. Our changes to the BS major that require advanced electives to be taken along a specific track should help to meet some of these goals, but to really allow students to develop depth in a subject area we need to offer more advanced electives and help students see a clear pairing between classes. Our departmental curriculum could also offer more advanced classes that have prerequisites, which would allow faculty to build on skills more explicitly in advanced classes.

3e) Learning Outcome 7 Results

Objective 7: Using student portfolio submissions, we were able to record several examples of student awareness of their learning, including both strengths and weaknesses.

Example from 130-"*I realized that I had not given my classes the effort that they deserved, and I used that reflection to put myself on a healthy yet productive track going forward. On the surface, it may appear that ENVS 130 did not advance my learning goals very far, but without that class, I may not have figured out how to properly navigate through my new academic institution."*

Example from ENVS 131_OX- *"For one, looking back on these materials made me realize how much I have grown as an ENVS thinker and humanitarian, but it also makes me grateful for the careful planning that goes into Emory ENVS labs and coursework."*

Example from 131- *"In fact, Dr. Hall's final comment rings true to this day – that field work, over the course of my time in the ENVS department, has become my own getaway. Rather than rush to finish my observations, I relish in the opportunity to sit in nature and simply observe, which, as Dr. Hall notes, is a rare phenomenon nowadays. I gained more than hard facts about plants from my field notebook, I learned to use it as almost a meditative practice which significantly improved my semester and study habits."*

Example from methods independent intermediate breadth- "*I wish I had taken GIS or Data Science for my methods class, as I feel that those would have provided me with more long-term skills for this requirement."*

Example from methods independent intermediate breadth- "*I took 260 too early when I had little idea about the type of research I would like to conduct, so the application aspect didn't hit as hard."*

Example from advanced elective classes- *"My other impressions were about the state of the Anthropocene, specifically the tragedy of the commons. Learning about that phenomenon gave me the impression that ENVS was something of a depressing field, one in which the problems often outnumbered the solutions. I developed gradual climate anxiety as a result of my initial introduction to the field and climate change. However, those initial impressions have thankfully been challenged in the last four years."*

Example from advanced elective classes- *"After taking ENVS 446, I used to have existential dread because our constructs of politics and economy were too vague when seeing human-animal conflict exacerbated by intense droughts firsthand. After a pandemic and taking more electives such as ENVS 347, ENVS 241 + 242, and ENVS 331, I now am reassured that the world won't end because Earth is a self-regulating system. Still, humans will struggle to survive if we don't take decisive and collaborative actions to mitigate and adapt to climate change. With this perspective, I found that learning more about ENVS has made me less frantic and more strategic."*

Example from independent study (internship)- *"I had always loved the study of ENVS, however actually practicing research turned out to be an experience that, in the end. I decided it was not a career path that I want to pursue even though I came into the program thinking that research would be my end goal."*

These examples suggest that our graduating seniors can successfully reflect on their learning and changes to their though processes by the time they are about to graduate, but that they may not reflect well in the moment. We can use this knowledge to incorporate more reflective opportunities into classes themselves. Our major requirements give students a lot of flexibility in choice. This means that ensuring that students are aware not only of what they do know, but also what they don't know is important in helping them make decisions about which classes or experiences they should participate in to create a well-rounded educational experience. Several students commented on how they learned what wasn't for them (fieldwork, research, etc.) through their major requirements. Thankfully, most noted that their lab/field classes and independent study helped them gain confidence in "being scientists".

4. USE OF RESULTS TO IMPROVE PROGRAM

Since we are still in the process of shifting our majors to the new BA and BS requirements, we do not plan on making any drastic changes to the major based on these results. But we can use these initial results to consider how our courses incorporate environmental science methods and encourage our faculty to (1) discuss the benefits and limitations of discipline-specific approaches more explicitly, and (2) give students more opportunity to actively reflect on their learning. We can also improve our departmental advising process, so our students know to take the intermediate breadth classes earlier, and to make sure that we offer enough spaces in these classes (especially SSP and Methods). We are planning to create lists of potential class path schedules for BS tracks to help encourage scaffolding and have added a portfolio component where seniors give anonymous advice to new majors, which will hopefully help to encourage them to reach for more advanced classes as they progress through the program vs. realizing they should have taken different classes right before they graduate.

5. FACULTY INVOLVEMENT

Departmental faculty were heavily involved in this process. Three faculty members serve on the ENVS Undergraduate Curriculum Committee (including the DUS), and the Chair, while not a permanent member of the committee, is significantly involved in the conversations and planning surrounding undergraduate curriculum. The assessment, curriculum review, analysis, and revisions are part of an ongoing processes conducted by the Undergraduate Curriculum Committee. As such, the Committee discusses progress with the department faculty at regular intervals throughout the assessment process.

Specific contributions from faculty in the department related to this assessment are below:

- The case study prompt was written by the ENVS Undergraduate Curriculum Committee: the DUS, 3 ENVS faculty members, and the Academic Coordinator.
- All faculty contributed to an evaluation of content and skills included in each of their classes in 2018. This list was used to calculate student exposure to classes reported as 50%+ 'experiential' by faculty in Section 3c of this report.
- All faculty discussed and voted on the 7 learning outcomes presented in Section 1 as part of our major change proposal in 2019.
- 8 faculty members and 1 staff member provided feedback on the list of topics relevant to the case study presented in Table 6. This group also made suggestions for improvements to the case study prompt to incorporate in future years.
- 4 members of the faculty scored of the case studies using the rubrics presented in Tables 5 and 7

6. PLANS FOR THE NEXT YEAR

Our first goal for the next assessment round is to repeat all components of this report now that the groundwork of developing rubrics and assessment tools is completed. Two years from now we should have some before and after case study responses so we can compare student growth along with overall knowledge of graduating seniors.

We will continue to track student progress through the major to see if we can increase opportunities to take foundational and intermediate classes earlier, scaffold content by adding advanced electives, and improve the student advising experience.

Now that all seniors will take ENVS 490 in their final semester we will reinstitute focus groups and incorporate that feedback into our next assessment.

Finally, as general goals for the undergraduate curriculum, we will continue to work to offer more classes that have a large experiential component and update our list of experiential courses shown in Table 8.

Department Chair

12 December 2022
Date