July 31, 2017
Assignment Description for Assessment
BIOL 311 - Plant Ecology

Unit Within the Course
Processes of Natural Selection – Natural selection is one of four processes that can result in evolution. The other processes are mutation, genetic drift, and dispersal. There are three biological criteria for natural selection to happen. First, a phenotype that might be selected for must have different types in different individuals in a population. For example, if neck length is ever to be selected for there must be different individuals with different neck lengths in a population. Second, different types of a phenotype must be differentially fit. For example, if neck length is ever to be selected for, different individuals with different neck lengths must be more or less likely to survive or have more or fewer babies. Third, the phenotype must be, at least partially, determined by genetics. For example, an animal with a longer neck got that longer neck because it has different alleles for a gene than an animal with a shorter neck.

Assignment
Competing selective forces in the environment
Integration of past material and just so stories
Document File – "Assignment Description Student_Assignment Alignment_Just So Story-Leaf Shape.docx"

Question to be answered in this assignment: How might natural selection lead to the evolution of underwater leaves with a different shape (i.e. phenotype) than above water leaves of the same species?

All organisms live and reproduce in environments with multiple stressors or selective pressures. In the context of natural selection and evolution, different stressors may affect survival and/or reproduction in different ways. This means that different phenotypes (e.g. morphologies, anatomies, physiologies, or behaviors) may be selected for in the same environment.

The purpose of this writing is for the student to read and understand a set of facts about the environment and plant phenotypes and formulate a narrative that integrates the given facts, known concepts of natural selection, and how the competing environmental stressors likely result in the evolution of specified phenotypes.

Evaluation Information
I view this assignment as a formative assessment. Before students are evaluated on an exam, I want to read how they think about these important ideas and if they can apply these ideas to a specific plant phenotype example. This is an important way of thinking in ecology, "Can we make sense of organisms' features as a possible result of natural selection and evolution? Can we make sense of these features as 'adaptations?" While I consider the assignment formative, I do grade students' work out of 15 pts. I consider these 15 pts. to be small. These 15 pts. are out of a total of 796 pts. for the course (Fall 2016). I apply these points as a simple motivation for students to complete the work.

Assessment broad goals:
- incorporate all of factual information
- show how evolution of narrow leaves would result

Assessment Specifics Rubric – Competing selective forces in environment	
√, √-, or 0	Content criterion
	incorporates all relevant factual information
	makes clear the role of individuals in natural selection
	makes clear the role of populations in natural selection
	includes all criteria for natural selection in descriptions • phenotypic variation (not included if given to students) • differences in fitness (not included if given to students) • genetic cause of phenotype (not included if given to students)
	provides reasoned explanation of which leaf type evolves and why that type evolves

Description of instructional processes, techniques, and strategies
Leave for now.

Description of relationship between learning outcomes and evaluation criteria

I have written the "Assessment broad goals" and the "Assessment Specifics" based on my SLOs for this assignment. I mean for my assignment description to present a complete and clear description of what I want each student to include in the written response for the assignment. If a student's written response includes all the components I've described, then this writing will demonstrate the student's knowledge and understand of these concepts.

[This following was taken directly from the brief "Assignment Description.]

I do not assess students' narratives for writing quality, except for the writing as a stand alone narrative / essay. This is covered by the first of the four bullets here. I assess these narratives for

- Quality of re-presentation of facts,
- Quality of descriptions of the relevant natural selection concepts,
- Quality of integration of facts and concepts, and
- Quality of conclusions correctly drawn based on the integration of facts and concepts.

Each of these qualities has an accompanying SLO. Students will show their ability to:

- Re-describe a set of facts from the example about the environment, environmental stressors, and plant phenotypes,
- Name all of the three criteria for natural selection to happen,
- Apply each of the three criteria to the example given,
- Draw correct conclusions about how natural selection has led to the evolution of the specific type of the phenotype given.

Each of these four SLOs is directly connected to one or more of the "Content Criterion" in my rubric. The first bullet maps to the first item in the rubric. The second bullet maps to the 2nd, 3rd , and 4th items in the rubric. The 3rd and 4th bullets map to the 5th item in the rubric. [After writing this, I see that my measurement, at least of the 3rd and 4th bullets**,** vague. This needs some work.]

Why are the evaluation criteria good and appropriate indicators (i.e. measures) of a student learning outcome? On their face, the rubric's "Content criteria" match the SLOs nicely because the wording matches. This suggests that I am looking for the same facts and ideas as I grade that I said I would look for in the

student's copy of the assignment. But, as currently stated, the measurement part of the rubric is missing or vague. The rubric is set up to specify levels of response through the use of √, √-, or 0. What the rubric does not yet describe is what kind of responses will suggest high (√), medium (√-), or low (0) quality responses.

Here is how I might build a more detailed rubric that better specifies levels of quality:

Content criterion	√	√-	**0**	**pts. (15 total)**
incorporates all relevant factual information	All factual info present and orderly. Narrative is clear and concise	Some factual info may be missing, with only some harm to understanding	All factual info missing or reader cannot understand relevance	2
makes clear the role of individuals in natural selection				2.5
makes clear the role of populations in natural selection				2.5
includes all criteria for natural selection in descriptions • phenotypic variation • differences in fitness • genetic cause of phenotype				4
provides reasoned explanation of which leaf type evolves and why that type evolves				4

The content criterion are each a brief statement of what determines high quality. The level of quality statements are meant to be specific enough to suggest objective differences between a theoretical model and a student's writing. Very good to excellent (√ level) for "incorporates all relevant factual information" has two (2) components, amount of factual information and how those facts were written about (clear and concise). The amount of information a student includes will be easily compared to the original facts so this is objective. Writing clarity is objective, if the reader can objectively place themselves in the place of the reader. It is clear that this is less objective than amount of information.

Description of relationship between assignment learning outcomes and course learning outcomes

The related Course Student Learning outcome is that the student will be able to name and describe the processes of natural selection and how these processes lead to the evolution of phenotypes we call adaptations. This assignment's SLOs are a restatement of the course SLOs with some detail added. My assignment SLOs isolate

the details of the process of natural selection as 1) the role of individuals in natural selection, 2) the consequence in populations to natural selection, 3) the requirement of the three criteria, phenotypic variability, differential fitness, and genetic causes, for natural selection to happen, 4) application of the previous 3 concepts to a specific example.

Any biologist would agree that the first three ideas are the core ideas behind the processes of natural selection, so this part of the assignment and assessment align well with the course learning outcomes. The fourth idea, the application of idea to example, is, I believe, a fundamental of learning. The concepts within the process we call natural selection are generally true and so, should apply to any specific example of natural selection. Anyone who understands natural selection should be able to apply the concepts to natural selection to any specific example. This should be as simple as replacing general terms (e.g. phenotype) with terms from an example (e.g. neck length). I do know from experience that writing this narrative type, a carefully written Just-So-Story, is a good writing exercise for all of my students. For the best students, it is reinforcement of their knowledge. For other students, this is a good challenge that can generate "Aha!" moments.

There are two outcomes related to these natural selection concepts I do not include in this brief narrative assignment. First, students need not address gene-environment intereaction, an important set of natural selection ideas, that result in phenotypic plasticity. Also, I do not require students to create and interpret graphs as they show processes of natural selection. In short, this assignment asks students to convey the core of ideas about natural selection and it leaves out some ideas and science methods of representation.

[After writing this, it became clear to me that responses to this assignment do NOT require a student to explain the WHYs behind the criteria. This part is a listing of the criteria applied to an example.]

How directly can the measures used for this assignment be translated to my needs in course assessment? The rubric and the numbers produced from using this rubric have clear connections to the measurement of my course SLOs. There are 5 elements in this rubric. All elements except the first tell me something about a student's ability to communicate fundamental concepts of natural selection (NS): the role of individuals, the result in populations, the requirements for NS to happen, and how these elements come together in this example adaption (i.e. leaf shape). I typically calculate score distributions, both totals and for individual elements, to get a sense of the level of knowledge of the whole group of students. I can easily write "success criteria" for a group of students. See the table below for an example of this analysis of these measures.

			Frequency of scores			
Content criterion	**Possible pts.**	**Success Criteria**	**0**	**1**	**2 or 2.5**	**3 or 4**
incorporates all relevant factual information	2	100% score 2.5	0	5	15	
makes clear the role of individuals in natural selection	2.5	100% score 2.5	0	8	12	
makes clear the role of populations in natural selection	2.5	100% score 2.5	2	5	13	
includes all criteria for natural selection in descriptions	4	80% score 3 or 4	0	1	3	16
provides reasoned explanation of leaf shape evolution	4	80% score 3 or 4	2	2	2	14
Total	15					

Description of relationship between assignment learning outcomes and department learning outcomes
[The first 1 or 2 paragraphs was copied directly from my brief assignment description for this project. The wording of my SLOs and department SLOs are very similar on purpose. So my argument may sound repetitive, but this is true by design!]

The current assignment SLO and Course SLO addresses the department's Program Goal 1 (PG1) and its first SLO (SLO1). PG1 addresses "Core Concepts of Biological Literacy." SLO1 under PG1 is called Evolution. This is the Performance Cloud description of PG1 / SLO1 (quoted originally from AAAS 2011), emphasis added:

> The diversity of life evolved over time by processes of mutation, **selection**, and genetic change. Darwin's theory of **evolution by natural selection** was transformational in scientists' understanding of the patterns, processes, and relationships that characterize the diversity of life. Because the theory is the **fundamental organizing principle** over the entire range of biological phenomena, it is difficult to imagine teaching biology of any kind without introducing Darwin's profound ideas. **Inheritance, change, and adaptation are recurring themes** supported by evidence drawn from molecular genetics, developmental biology, biochemistry, zoology, agronomy, botany, systematics, **ecology**, and paleontology. A strong preparation in the theory of evolution remains essential to understanding biological systems at all levels.
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> **Themes of adaptation** and genetic variation **provide rich opportunities for students to work with relevant data and practice quantitative analysis and dynamic modeling**. Principles of evolution help promote an understanding of natural selection and genetic drift and their contribution to the diversity and history of life on Earth. These principles enable students to understand such processes as a microbial population's ability to develop drug resistance and the relevance of artificial selection in generating the diversity of domesticated animals and food plants.

This departmental SLO (PG1/SLO1) clearly aligns with my assignment SLOs. As suggested by the emphasis in the first paragraph. The natural selection of leaf shape and evolution of highly divided leaves under water are clear examples of a fundamental organizing principle in biology. As students write about the three criteria for natural selection, they are describing inheritance and changes that result in highly dissected leaves (i.e. an adaption) in underwater leaves.

The emphasis in the second paragraph suggests part of this department SLO that is not addressed in my assignment. But, this assignment is meant to be limited in this way. These SLOs are addresses in classroom work, assignments, and / or evaluations.

How directly can the measures used for this assignment be translated to the needs of department assessment? From my experience in my department, these measures can very easily be translated to scores for department assessment. My department often uses rubrics on a 3 – 5 point scale. Either the element score or the total score can be scaled to one of these 3 – 5 point scales. If I were writing a new scale for a new rubric, I should compare my scale and criteria to the department scale and criteria for similar SLOs. If they do not align, I would consider:

1) Changing the criteria for my measurement of the SLO,
2) Writing a new assignment to better match and measure department SLO, or
3) Negotiating changes in department SLO and /or criteria until my measures and their measure align.

Description of relationship between assignment learning outcomes and General Education SLOs
[As I think about this, a few things could happen.

1) SLO's could align very nicely.
2) The assignment chosen may not be at all relevant all the way through to Gen Ed SLOs. So, this part becomes simple or simply irrelevant
3) The assignment SLOs should be relevant and therefore should align, but they do not.]

Because my assignment SLOs and measures align cleanly and directly with department SLOs and measures, I will only address alignment between department SLOs and General Education SLOs. I need not talk about measures because in the past the UMW Office of Institutional Analysis and Effectiveness has accepted the department's measures of Gen Ed SLOs.

As a reminder, the department SLO we are considering is Evolution (SLO1) under the Program Goal called Core Concepts in Biological Literacy. The department has adopted this Program Goal, and two of our other Program Goals, from the core concepts and core competencies of a national program called Vision and Change in Undergraduate Biology Education (AAAS 2011). Therefore, the department is using SLOs that have been vetted and agreed upon by thousands of biologists and educators across the U.S. Furthermore, these biologists and educator describe Evolution, quoted from department SLOs and AAAS 2011), as

> …Because the theory is the **fundamental organizing principle** over the entire range of biological phenomena, it is difficult to imagine teaching biology of any kind without introducing Darwin's profound ideas. **Inheritance, change, and adaptation are recurring themes** supported by evidence drawn from molecular genetics, developmental biology, biochemistry, zoology, agronomy, botany, systematics, **ecology**, and paleontology. A strong preparation in the theory of evolution remains essential to understanding biological systems at all levels.
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> … Principles of evolution help promote an understanding of natural selection and genetic drift and their contribution to the diversity and history of life on Earth.

The UMW Natural Science General Education learning outcomes are those most closely connected to our Biology Program Goals. Here is the list of institutional SLOs that fall under the Natural Science General Education requirements:

- Students will be able to describe the scientific methods that lead to scientific knowledge
- Students will be able to report and display data collected, interpret experimental observations and construct explanatory scientific hypotheses
- Students will be able to use theories and models as unifying principles that help us understand the natural world
- Students will be able to identify current issues in which scientific progress may challenge traditional social ideas or present moral or ethical dilemmas

Natural selection and evolution are both theories and models used as unifying principles (AAAS 2011) that help us understand the natural world. Clearly our department SLOs translate cleanly and clearly into this UMW General Education SLO.

References

Cynthia Bauerle, David Lynn, Susan Singer, Charles W. Anderson, Diane Ebert-May, Jay Labov, Pratibha Varma-Nelson, Kimberly Tanner, William Wood, Clare O'Connor, et al. 2011. VISION AND CHANGE IN UNDERGRADUATE BIOLOGY EDUCATION A CALL TO ACTION. Washington, DC: American Association for the Advancement of Science. [accessed 2016 Jun 27]. http://visionandchange.org/files/2013/11/aaas-VISchange-web1113.pdf.