BIO205 Summer 2023
Final Exam Evaluation Guide

How To Use This Guide

Based on your answer, you will evaluate how many points you earned. If you did not earn all of the points, you have the opportunity to reflect on your answer and earn partial credit on the questions you answered. Your reflection must describe your thought process and explain why you gave that answer. Stating the correct answer alone is not sufficient to earn partial credit. If you think your answer is correct and is not one of the listed options, please complete the reflection for that question. **We all make mistakes as that is the process of learning, and reflections help us to become better learners.**

Unlike the term test, the final exam will be largely driven by self-evaluations. Your TA has not indicated which questions where you did not earn all of the points. With this detailed evaluation guide, you have all of the tools and resources you need to make an accurate self-evaluation.

As the course instructor, I will review all exams and self-evaluations. I will do this do determine if you earned partial credit and to check for under- and over-inflating point totals. **Accurate self-evaluation is an essential tool for your learning, and it is also essential for a fair and equitable learning experience for all students in BIO205.**

The overview and thought process for each process is provided in the next section. Additionally, **detailed point-by-point evaluation guides for each question are provided.**

Exams are viewable on Crowdmark. If the scan of your exam is not readable, please let me know as soon as possible and include your booklet number in the email.

Here is a table with the point distribution for each question, with space for you to enter or write the number of points you earned to help with the self-evaluation process. **You will view your final exam on Crowdmark,** and the **final exam self-evaluation will be submitted via Quercus and is due by June 27 at 11:59 PM (strict deadline).**

Question	Points to be Earned	Earned Points
Question 1		
Q1	15	
Question 2		
Q2.1	6	
Q2.2	6	
Q2.3	6	
Q2.4	6	
Q2.5	6	
Question 3		
Q3.1	10	
Q3.2	10	
Q3.3	5	
Question 4		
Q4	20	
Question 5		
Q5	10	Evaluated by the Instructor
Total	**100**	

Question Overview & Thought Process

Question 1: Concept Map.

Concept maps area way for you to synthesize, diagram, and show your learning. Here, you are demonstrating your understanding of ecology and how different components are linked in a larger system. Given the diversity and complexity of ecology, no two concept maps will be identical. The map you drew will demonstrate your knowledge, understanding, and perspective in ecology.

The concept map asked you to define 4 levels of the ecological hierarchy (individual, population, community, and ecosystem). You then had to identify upward links (lower-to-higher complexity) and downward links (higher-to-lower complexity).

Question 2: Species interactions.

For each example, you were tasked with evaluating the provided information and evaluating the figures to determine how the species interaction vary in space (i.e., depended on the environment) and time.

You also had to use the provided information and your understanding of ecology to propose an ecological explanation for the observed results. In doing so, you were pulling from multiple ecological levels (individual, population, community, and ecosystem) to take a holistic approach when evaluating each case study.

Question 3: Transfer of energy, nutrient cycling, and communities.

Here you were predicting the effects of anthropogenic influence on the carbon, nitrogen, and phosphorus cycles. You were primarily focused on the ecosystem level, but some questions looked at the community-level consequences of changes to these nutrient cycles/transfer of energy. You again had to pull you knowledge across ecological hierarchies (individual, population, community, and ecosystem) to answer the questions. (We worked on all these examples in some capacity in lecture).

Question 4: Biodiversity and instrumental values at UTM.

You had to determine the patterns of biodiversity on the UTM campus and based on your knowledge and observation of these habitats, indicate at least 2 instrumental values provided by that habitat. You were provided with a figure showing the patterns of species richness across all habitats. You also observed these habitats during the preliminary observations in Practical 1 and the data collection in Practical 3. This question required you to take your personal experience, observation, and knowledge of ecosystems on campus to determine what instrumental values are provided by each ecosystem.

Question 5: Directed reflections.

Each question prompt was evaluated for completion by the course instructor. You cannot get credit for the directed reflections during the self-evaluation.

Question 1. Synthesize your knowledge of ecology across hierarchical scales by drawing a concept map that:

- Includes individual, population, community, and ecosystem levels.
- Summarizes key characteristics for each level of ecological organization.
- Indicates links across ecological levels.

Concept map = 15 points

You had to:

1. Briefly describe each level of the hierarchy in terms of what it focuses on and how it approaches ecology.
2. Draw and identify/label links from less (i.e., individual) to more (i.e., ecosystem) ecological complexity.
    a. 3 upward links for individual, 2 upward links for population, and 1 upward link for community.
3. Draw and identify/label links from more (i.e., ecosystem) to less (i.e., individual) ecological complexity.
    a. 3 downward links for ecosystem, 2 downward links for community, and 1 downward link for population.

1.5 points for describing each level (6 total points)

- **Individual** = Evaluates how an individual's morphology, physiology, and behaviour enable it to survive to the environment (i.e., adaptations).
- **Population** = Examines the number and distribution of individuals in space and time; can include characteristics of the individuals, such as sex ratio, age/stage classes, and genetic diversity.
- **Community** = Concerned with the relative abundances and diversity of different organisms, including species interactions.
- **Ecosystem** = Focuses on the storage and transfer of energy/matter/nutrients.

0.75 points for each identified and described upward link (6 links, 4.5 total points)

Example links:

- **Individual (3 links)** = I → P = physiology/morphology relates to the niche, I → C physiology/morphology relates to species interactions, I → E = adaptations to the environment affect the type and amount of nutrients being excreted.
- **Population (2 links)** = P → C = distribution/abundance of populations affects patterns of diversity, P → E = population size affects the amount of energy and nutrients required.
- **Community (1 link)** = C → E = biodiversity can influence ecosystem functions

0.75 points for each identified and described downward link (6 links, 4.5 total points)

Example links:

- **Ecosystem (3 links)** = E → C = amount of nutrients can affect species interactions, E → P = changes to nutrient cycling/transfer of energy controls how populations are regulated, E → I = selects for adaptations to the environment.
- **Community (2 links)** = C → P = species interactions can regulate population dynamics/distributions, C → I = species interactions can affect the adaption of individuals through coevolution.
- **Population (1 link)** = P → I = population distributions can influence adaptations related to the niche.

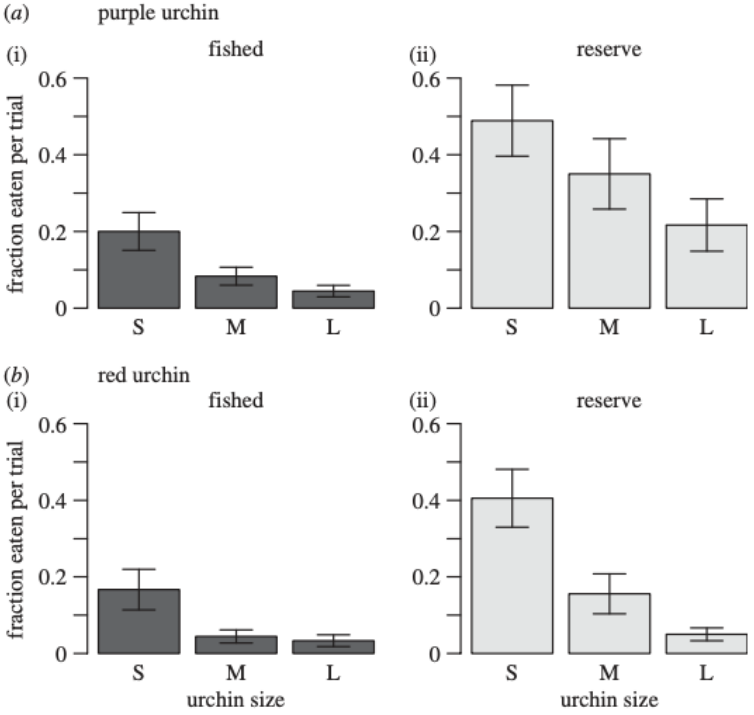
I = individual, P = population, C = community, and E = ecosystem

Question 2. For each of the following species interactions, use the provided information and interpret the figure to describe how the interaction depends on the environment. **(30 total points)**

Note: The provided explanations are not exhaustive, and if you think your explanation is valid please indicate that when determining the points you earned on your self-evaluation and the reflection.

Question 2.1

In California kelp forests, herbivorous sea urchins are predated by California sheephead fish (*Semicossyphus pulcher*). Selden et al. (2017) evaluated how fishing of predators like the California sheephead affects predation on sea urchins. They sampled fished habitats and marine reserves and compared how many urchins were consumed by the predator.



- How do patterns of predation on purple/red urchins differ? **(3 points)**

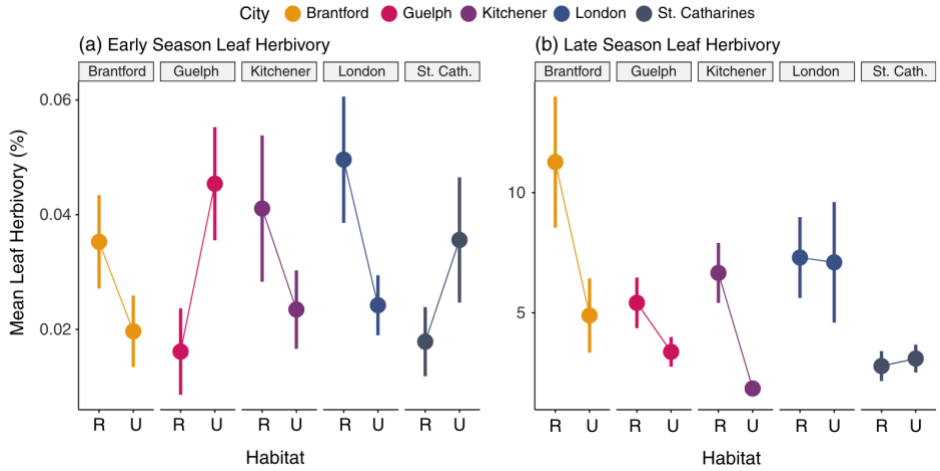
There was greater overall predation on purple urchins compared to red urchins (**1.5 points**), with stronger predation on purple urchins in the marine reserve habitats (**1.5 points**).

- Propose an ecological explanation for the observed response. **(3 points)**

At least one of the following:

- California sheephead preferred to predate upon purple urchins.
- Structural defence, such as increased spines, provided more protection to red urchins than purple urchins.
- Fishing reduced the number of predatory California steelhead, which increased predation in the marine reserve.

Question 2.2
Urbanization can affect herbivore communities, but there can also be differences in herbivory through time. Miles et al. (2022) sampled 5 cities in southern Ontario to evaluate herbivore community diversity and abundance in addition to patterns of herbivory on the common milkweed (*Asclepias syriaca*). Leaf damage was assessed in the early and late summer, and each city had an urban (U) and rural (R) habitat.



- How does leaf herbivory vary with season? **(3 points)**
    - (Note: you do not need to consider city or habitat for this question)

Leaf herbivory is much higher in the late season (check the y-axis: ~2.5%-12%) compared to the early season (check the y-axis: <0.1%), regardless of city identity or habitat type.

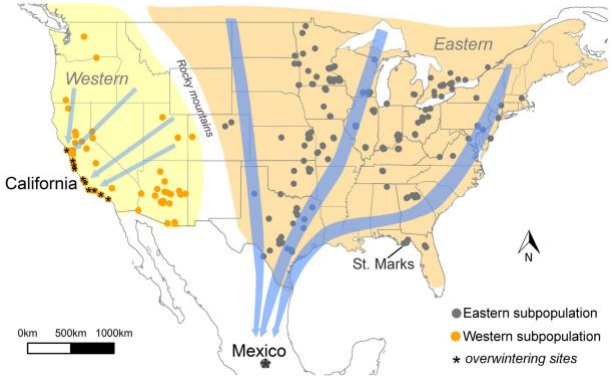
- Propose an ecological explanation for the observed response. **(3 points)**

At least one of the following:

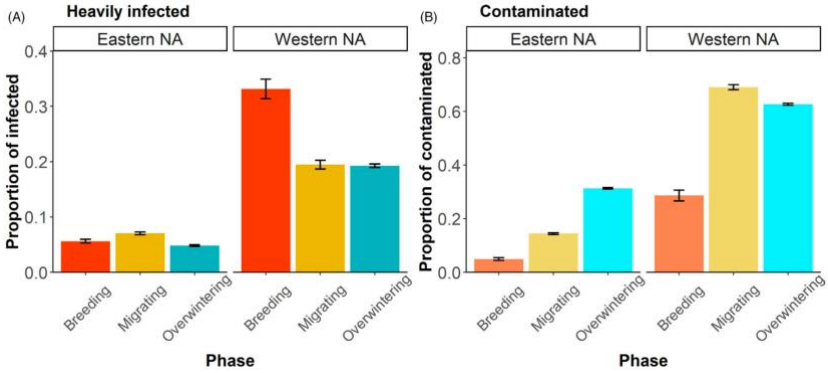
- Herbivores were more abundant in the late season as it took time for the herbivores to develop and grow in abundance (i.e., phenology).
- Leaves accumulated more herbivory through time as herbivores had more time to consume the leaves.

Question 2.3

Monarch butterflies (*Danaus plexippus*) undergo extensive seasonal migrations for both its eastern and western subpopulations. Monarchs overwinter in Mexico (eastern populations) or in California (western populations), known as the overwintering stage. They then have a multi-generation migration back north (migratory stage) where they breed (breeding stage).



Unfortunately, monarch populations are experiencing declines. An emerging concern is the threat of a protozoan pathogen, *Ophryocystis elektroscirrha* (OE), which spreads through spores that monarchs acquire during their migrations. Heavily infected monarchs have >100 OE spores, while contaminated monarchs have <100 OE spores. Heavy infections lead to increased mortality, while contaminated monarchs survive but can spread the pathogen; infection requires the pathogenic spores are ingested. Majewska et al. (2022) wanted to evaluate how infection patterns varied between the two major monarch populations (eastern and western), infection status (heavily infected or contaminated), and phase of the migration (breeding, migrating, or overwintering).



- How do the eastern and western populations differ in the proportion of heavily infected monarchs? **(3 points)**

Western populations had greater proportions of heavily-infected monarchs (**1.5 points**), with breeding phases of western population having the highest proportions of heavily-infected monarchs (**1.5 points**).

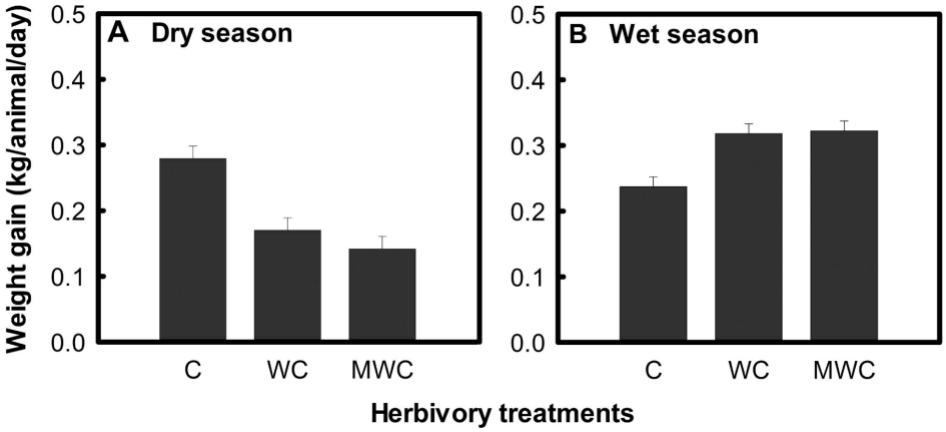
- Propose an ecological explanation for the observed response. **(3 points)**

At least one of the following:

- There were more contaminated individuals in the overwintering and migrating populations that could transmit the pathogen.
- Breeding populations were more clustered or at higher densities, increasing the chances of pathogen transmission.
- Habitats used by western populations had higher abundances of the pathogen, increasing the chances of pathogen transmission and infection.

Question 2.4

Savannas are crucial ecosystems for biodiversity and social, economic, and cultural values. As wildlife and livestock share these ecosystems, Odadi et al. (2011) conducted an experiment to test for competition between cattle, wild ungulates (e.g., zebra, oryx, gazelle), and megaherbivores (e.g., African elephant, giraffe) in an African savanna. They designed an experiment to test for the effect of just cattle (C), wild ungulate and cattle (WC), and cattle, wild ungulates, and megaherbivores (MWC) on food intake and weight gain between the dry and wet seasons.



- How does the wet season affect competition for resources and weight gain between wild ungulates (WC) and megaherbivores (MWC)? **(3 points)**
    - (Note: because both treatments include C, you can assume the differences between WC and MWC are due to the presence of megaherbivores).

There is no evidence for competition between wild ungulates and megaherbivores, as weight gain was essentially identical for both the WC and MWC herbivory treatments.

Alternate (if both dry and wet seasons were compared): Megaherbivores reduced overall weight gain in the dry season, but there was no effect of competition between wild ungulates and megaherbivores in the wet season.

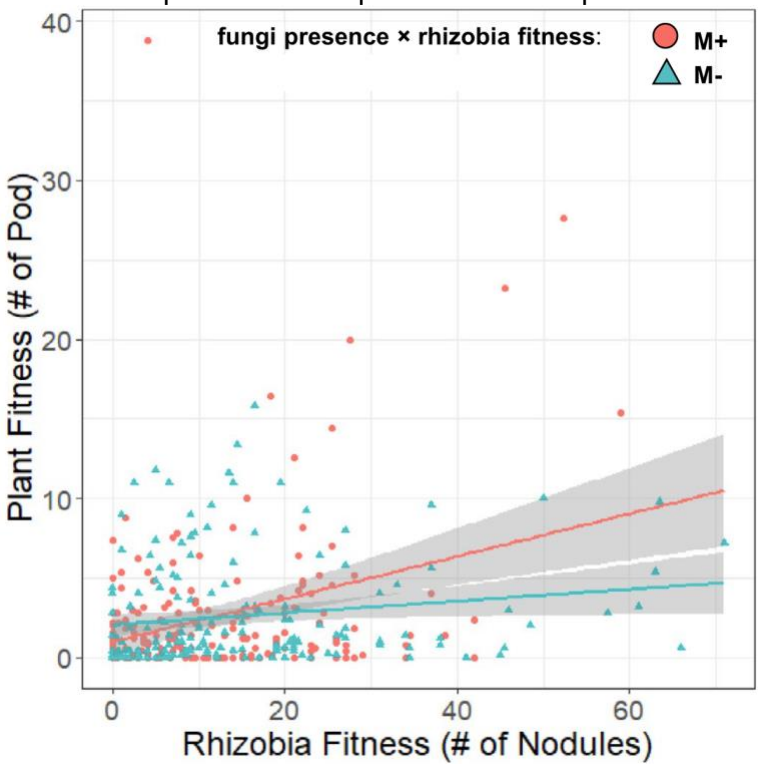
- Propose an ecological explanation for the observed response. **(3 points)**

At least one of the following:

- There is greater primary productivity in the wet season, so there is relaxed competition in the wet season.
- Wild ungulates and megaherbivores consumed different types of vegetation, so they were not competing for the same resource.

Question 2.5

Many organisms are involved in a mutualism with at least one partner. Afkhami et al. (2021) examined the effects of multiple mutualists (rhizobia and mycorrhizal fungi) on the barrel medic plant (*Medicago truncatula*). Rhizobia provide nitrogen to the host plant, while mycorrhizal fungi provided phosphorous. They inoculated the plant with either just rhizobia (M-) or both rhizobia and fungi (M+). They then measured how the plant fitness depended on the presence of multiple mutualists.



- How does the relationship between plant fitness and rhizobia fitness differ with (M+) and without (M-) fungi? **(3 points)**

The relationship between plant fitness and rhizobia fitness became more positive in the presence of mycorrhizal fungi.

- Propose an ecological explanation for the observed response. **(3 points)**

At least one of the following:

- Rhizobia and mycorrhiza provide different resources that are needed for the plant to grow, so having both is beneficial for all species.
- Without mycorrhiza, the plant was phosphorus limited, but with mycorrhiza it was able to acquire phosphorus and both the plant and rhizobia increased in fitness/growth.

Question 3. Describe the ecological consequences of anthropogenic disturbance on the carbon, nitrogen, and phosphorus cycles. **(25 total points)**

Diagrams are accepted if they provide the same information in graphical form.

Question 3.1.
For the carbon cycle…

- How would increasing temperatures, particularly at higher latitudes, affect the type and amount of carbon produced through soil microbial respiration? **(5 points)**

Frozen peat at high latitudes will thaw and decompose with increasing temperatures (**2 points**). Because this decomposition process occurs under anaerobic conditions, more carbon will be released from these ecosystems in the form of methane (**3 points**).

- How would increased atmospheric CO2 affect primary productivity? **(5 points)**

Increased CO2 would increase primary productivity (**2.5 points**) until water and/or nutrients became limiting (**2.5 points**).

Note: Both prompts are included as Question 3.1. My apologies for any confusion!

Question 3.2
For the nitrogen cycle…

- How would increased nitrogen fertilizer use in agriculture alter the mutualisms between plants, rhizobia, and arbuscular mycorrhizal fungi? **(5 points)**

(Remember: rhizobia provide nitrogen to the plant, while arbuscular mycorrhizal fungi provide a combination of nutrients, primarily phosphorus and nitrogen.)

If there is increased nitrogen available, the plant will not need rhizobia for nitrogen and that aspect of the mutualism will be reduced/breakdown/become less beneficial (**2.5 points**). In contrast, because arbuscular mycorrhizal fungi can also provide phosphorus to the plant, there will likely be increased reliance on them for phosphorus to prevent P-limitation and that aspect of the mutualism will become more beneficial (**2.5 points**).

- How would you expect plant community diversity to respond to increased nitrogen? **(5 points)**

Nitrogen is often a limiting resource (**1 point**), so nitrogen addition will initially increase plant diversity (**1 point**). However, increased nitrogen can allow for some plants to grow larger and outcompete other plants (**1.5 points**), resulting in dominance by a few species and lower overall diversity (**1.5 points**).

Note: Both prompts are included as Question 3.2. My apologies for any confusion!

Question 3.3
For the phosphorus cycle…

- How does increased phosphorus affect oxygen levels in coastal marine ecosystems? **(5 points)**

Phosphorus is often the limiting nutrient in aquatic ecosystems (**1 point**). Fertilizer used for agriculture drains into streams and rivers, ultimately reaching low-nutrient coastal marine ecosystems (**1 points**). When the nutrients reach the coast, they stimulate phytoplankton blooms. As the phytoplankton are consumed by zooplankton or die and decompose, that increases the consumption of oxygen via respiration and causing hypoxia (**3 points**)

Note: If you forgot to note that N (Question 3.2, second part) or P (Question 3.3) were the limiting nutrient, you can just state that it was the limiting nutrient in the reflection for partial credit. There is no real way to explain how that point wasn't earned without just stating the answer.

Question 4. You are a scientist for a local conservation authority tasked with assessing the biodiversity status and instrumental values across the UTM campus. For each of the following habitats, rank its biodiversity (1 = lowest, 4 = highest) and name 2 instrumental values provided by that habitat to us. **(20 total points)**

Forest **(5 points)**
Biodiversity ranking = 1/lowest (**1 point**)
Instrumental values (**2 points each**)
At least two of the following:

- Regulating = climate control (shading by the trees)
- Cultural = recreation (nature trail/walking)
- Supporting = primary production
- Supporting = nutrient cycling

Grassland **(5 points)**
Biodiversity ranking = 2/third highest (**1 point**)
Instrumental values (**2 points each**)
At least two of the following:

- Cultural = recreation (nature trail/walking)
- Supporting = primary production
- Supporting = nutrient cycling

Wetland **(5 points)**
Biodiversity ranking = 4/highest (**1 point**)
Instrumental values (**2 points each**)
At least two of the following:

- Regulating = water filtration
- Regulating = flood control
- Supporting = primary production
- Supporting = nutrient cycling
- Cultural = recreation (birdwatching)

Disturbed **(5 points)**
Biodiversity ranking = 3/second highest (**1 point**)
Instrumental values (**2 points each**)
At least two of the following:

- Supporting = primary production
- Supporting = nutrient cycling
- Cultural = recreation (birdwatching)

~~If only the type of instrumental value was provided (e.g., regulating, provisioning, supporting, or cultural) and not a specific example, that is only half credit (0.75 points).~~

Updated: Because the wording of the question was not clear, just stating the type of instrumental service without a specific example is sufficient for full points. The list for each habitat is not exhaustive, so you may have also suggested an acceptable instrumental value outside the provided list.

Question 5. Directed reflection questions. **(10 total points)**
All direction reflection questions will be evaluated by the course instructor.