Ecology Practice Exam Questions: Abiotic Factors & Ecosystems – Answer Key

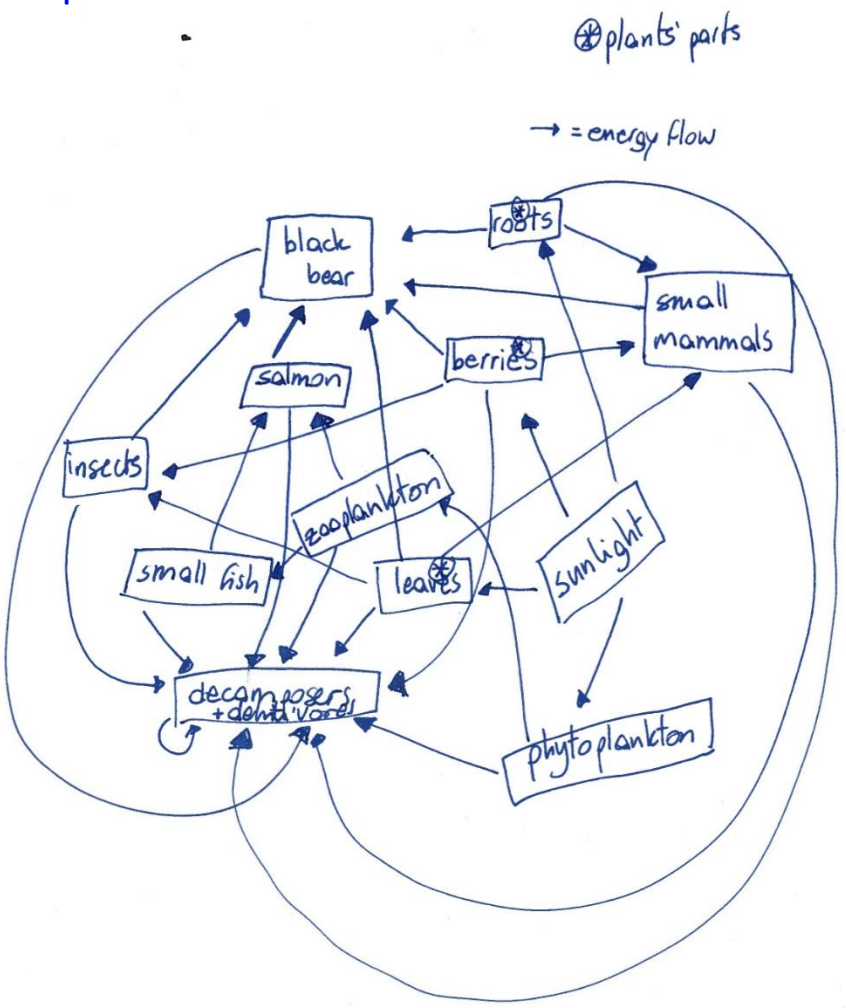
1. On Vancouver Island there are some remaining areas dominated by temperate rainforest that harbor great biodiversity and are home to a number of black bears (*Ursus americanus vancouveri*). One interesting feature of these forest, and Vancouver Island in general, is the absence of grizzly bears (*Ursus arctos horribilis*).

a. What are some of the resources that black bears on Vancouver Island need to survive, grow and reproduce? List five of them.

Any five that make sense, e.g., : food, shelter, air, water, mates (OK to be general here, and also OK to give examples of each of the factors).

b. Draw a food web for black bears on Vancouver Island. Include as many sources of food as you think the bears might be using, and for each of these sources trace the flow of energy all the way from sunlight.

Example:



c. Imagine that a family of grizzly bears swam all the way to Vancouver Island and settled in an area populated by black bears. Predict how the grizzlies would affect the black bear food web that you drew in part b. Explain your answer and include any assumptions you are making (e.g. "I assumed that grizzlies don't eat blackberries", "I assumed that grizzlies and black bears ignore each other", etc.).
Answer must be reasonable in terms of content, well explained, and the assumptions really need to be stated.
Example:
Grizzly bears are omnivores, like black bears. I assume they will have the same diet as black bears, so on the food web, each energy source originally only used by the black bears will now have to be shared between black bears and the grizzlies. Moreover, grizzlies are larger than black bears, and I assume they might even include black bear cubs in their diet if the opportunity presented itself. So, black bears would occasionally be a source of energy for grizzlies. On the other hand, grizzlies would be an additional source of energy for decomposers and detritivores.

d. Use the perspective of a community ecologist, and your answer to part c, to predict the interaction(s) that would take place between black bears and grizzlies on Vancouver Island.
Black bears and grizzly bears would be in competition with each other for food, and also most likely for space (den space and territory). Moreover, if grizzlies could attack and eat black bear cubs, there would be predation between the two (predator = grizzly, prey = black bear).

2. In any stable community or ecosystem on Earth, big, fierce predators are rare. Use your knowledge of ecosystem ecology to provide a hypothesis that explains this.
Big fierce predators are usually secondary or tertiary consumers (sometimes even quaternary!). Let's look at a case where the big, fierce predator is a secondary consumer.
A secondary consumer needs to eat many times its body weight worth of prey to grow up to adulthood and possibly reproduce, because most of the energy derived from food (prey, primary consumers) is used for maintenance of metabolic functions. Hence, the total biomass of primary consumers needed to maintain a population of secondary consumers is up to 10 times as large as the biomass of secondary consumers. In turn, primary consumers need to eat many times their body weight worth of producers (same reasoning as above), so we need a very large biomass of producers, up to 5-10 times the total biomass of primary consumers, to maintain these primary consumers.
So, if we compare the total biomass of producers, vs. primary consumers, vs. secondary consumers, we'll find that the biomass of secondary consumers is very small. Moreover, if these secondary consumers are big, their small total biomass means that there are really few of them!

3. Kokanee salmon are a sub-species of Sockeye salmon (*Oncorhynchus nerka*), and are often considered "almost a separate species". They differ from Sockeye in that they spend their entire lives in freshwater, and they are typically smaller. Kokanee salmon typically eat plankton, insects, freshwater shrimp and small fish.
You have been hired by a team of fish biologists, and your job is to figure out the respective trophic levels of the various sources of energy used by Kokanee salmon. To do so, you collect multiple samples from Okanagan Lake and measure the relative biomass of plankton, insects,

shrimp, and small fish present in each sample and calculate the mean for each organism. The results are as follows:

Plankton:	90.63%
Insects:	0.95%
Shrimp:	8.30%
Small fish:	0.12 %

Based on these results, draw a food chain for the Kokanee salmon in Okanagan Lake that includes plankton, insects, shrimp, small fish and, of course, Kokanee salmon.

Plankton → shrimp → insects → small fish → Kokanee salmon
[arrows indicate the direction of energy flow]

4. When studying the Great Bear Rainforest we said that in this ecosystem, salmon are a very important species for the health and productivity of the ecosystem. Past students, however, have argued that it is not salmon, but bears that are critical to the health and productivity of the ecosystem. Do you agree or disagree with this view? Explain your reasoning.
Both answers are OK, BUT they have to be properly justified. Also, you need to pick one answer, you can't both agree and disagree.
Example 1:
I agree with the past students. The black bears' behaviour (taking the salmon into the forest, eating only the best parts, and leaving the rest behind) has an enormous impact on the nitrogen flow and on the forest soil fertility. If black bears ate salmon right by the river, and did not leave anything behind (or, if they dropped the carcass in the river) then most of the nitrogen would not make it into the forest soil. In addition, the biomass of black bears is smaller than the biomass of salmon, so we could say that the black bears have a larger impact with a smaller biomass → they are more of a keystone species.

Example 2:
I disagree with the past students. Salmon are absolutely necessary to make the forest soil so fertile; we know this because forests that have black bears, but no salmon (e.g. more inland) have a much less fertile soil (much more nitrogen-poor), and these forests are not so bio-productive. So, black bears on their own don't really contribute much to forest bio-productivity, they don't have much of an impact on the ecosystem, and should therefore not be considered a keystone species.

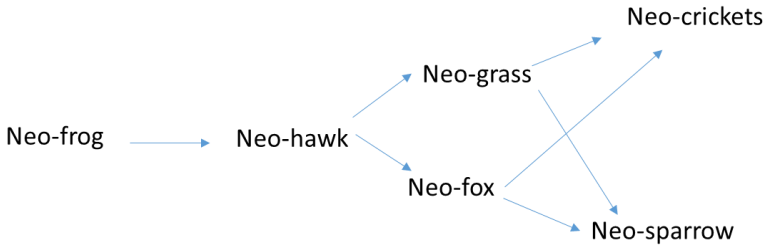
5. In a post-apocalyptic world thousands of years into the future, several of the species that are alive have changed substantially since the 'ancient times' (i.e.,: 2015). Your PhD supervisor has asked you to reconstruct the trophic levels and food web of the 'new world' based on the amount of biomass one his colleagues has collected. He hands you the following data:

a. Using your knowledge of productivity and trophic levels, identify the trophic level of each species listed.

Amount of biomass (kg/m^2)	**Species**	**Trophic Level**
1.5	Neo-crickets	**Tertiary consumer**
15	Neo-grass	**Secondary consumer**
1.5	Neo-sparrow	**Tertiary consumer**
1000	Neo-frog	**Producer**
15	Neo-fox	**Secondary consumer**
200	Neo-haw	**Primary consumer**

The point is for students to use the data to decide about trophic level.

b. Based on your answer to a, draw a food web for this ecosystem.
It doesn't really matter if the crickets and sparrow eat only grass or only foxes, or both



c. What do you expect would happen to the fox population if we removed all grass? Explain why.
There would be an increase in the hawk population. Assuming that the neo-crickets and neo-sparrows consume both neo-grass and neo-foxes, if neo-grass are removed then there will be more consumption of the neo-foxes (by the neo-sparrows and neo-crickets, as they will have lost a food source). This will reduce the size of the neo-fox population, which in the long run could further result in an increase in the neo-hawk population, and thus decrease the neo-frog population (because neo-hawks are consuming neo-frog).

e. What can we say for certain about Neo-frogs?
They are producers.

6. Answer the practice question below:

Practice Q

Estes *et al.*, 2011

Arctic foxes consume sea birds.
When foxes are present (blue bar) there is less phosphorous in the soil compared to when foxes are absent (brown bar)
Note, phosphorus is a limiting nutrient. Propose a relationship between the foxes and seabirds and the artic tundra ecosystem landscape. Explain your reasoning.

Note, you cannot answer this question using memorized information. You must generate a logical prediction based on your knowledge of the relationship between organisms in a community/ecosystem. How do/can abiotic and biotic factors influence the productivity and structure of an ecosystem?

When foxes are present, there are fewer sea birds and therefore less waste (urine and feces) from the sea birds entering this tundra ecosystem. The waste from the sea birds is likely contributing phosphorus to the soil, which becomes available to producers. If phosphorous is limiting, having increased amounts in the soil results in more growth of the producers. In contrast, when the foxes are present they consume the sea birds, reducing the number of birds in the area and therefore reducing the amount of phosphorous in the soil. Reduced phosphorous results in limited/reduced growth of producers.