EEB 2208 (Introduction to Conservation Biology)

Homework 3: Lectures 1-6

Using only Figure 3 in Hahs et al. (in the exam I would give you the figure and the legend), which of the following statements is correct?

1. The oldest cities have the highest extinction rates. **B**
2. Extinction debt is lowest for Type III cities. **B**
3. The number of extinctions is lowest for Type III cities. **B**
4. Extensive transformation after 1600 is associated with relatively high extinction rates. **A**
5. The youngest cities have highly variable extinction rates. **A**

This set of questions is designed to test your ability to interpret graphs. Questions 1, 4 and 5 can be answered simply by looking at the scatter of points, and test your ability to read information off a graph. The other two questions are probably harder, but are designed to test a more fundamental skill – did you make sure you understood what the graph is illustrating (and what it is not). Q2 is incorrect because the figure provides no information about extinction debt (if you are not sure what extinction debt is, read the lecture notes and go back over the Hahs et al. paper). Q3 was designed to test whether you really understood what is being plotted on the axes: specifically, the number of extinctions is not plotted (y = extinction rate; the proportion of species that go extinct per century), so there is no way to know whether 3 is correct. Note that if there is no way for you to know if something is correct, then you should assume it is not until you have evidence otherwise – this is how you would act in real life and so it's the appropriate response here.

How does the current rate of extinction compare to the background rate? (5 points)

6. They are about the same. **B**
7. Both are estimated to be greater than 10,000 species/year. **B**
8. The current rate might be as much as ten thousand times greater than the background rate. **A**
9. The current rate is estimated to be about 100-1000 times greater than the background rate. **A**
10. Comparisons between the two numbers are meaningless. **B**

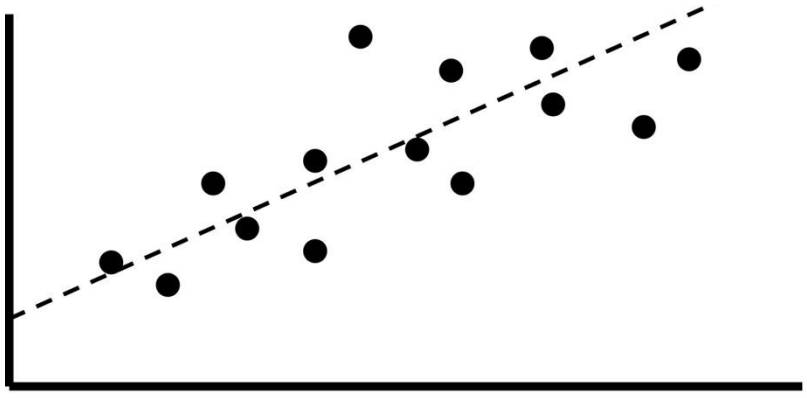
If I ask you about numbers presented in class, the questions will be something like those given here. E.g., I will expect you to know things approximately (e.g., to within an order or magnitude or so), but I won't expect you to know the exact numbers. I ask questions this way, because this is the level of knowledge that would likely be expected for a job in this area. Questions 6, 7 and 9 test whether you know the actual rates of extinction – getting these parts right tells me that you know the basic, most important, information. Question 8 tests whether you understand that there is uncertainty, and roughly what magnitude it has – getting this part right tells me that your knowledge is more sophisticated than just basic memorization. Question 10 tests whether you understand that, even though there is uncertainty, we can still draw useful conclusions – getting this part right in addition to the other parts, tells me that you really understand all of the important issues I talked about when discussing these numbers in the lecture.

Which of the following statements about extinction are correct?

11. Mass extinctions have been very common throughout geological time. **B**
12. Extinction rates were far higher during past mass extinctions than they are today. **B**
13. Extinction is a natural process. **A**
14. Extinction rates in marine species are much higher than for terrestrial species. **B**
15. Extinction rates in birds are very similar to all other groups. **B**

Questions 11-13 test basic knowledge of things I talked about in lecture. There have been only 5 mass extinctions in all of geological history, so they cannot be considered common, let alone very common (Note that when I asked this question on an exam a lot of people asked questions about the word "very", which they felt made the question "tricky". This surprised me, because I had purposefully included that word thinking that it would remove any possible doubt and make the question easier. This case is a great example of people trying to read way more into a question than is appropriate!). Current rates of extinction are estimated to be similar to those during mass extinctions, and most extinctions happened before humans appeared on Earth. Questions 14 and 15 are harder (because exact extinction rates are not known) and test your ability to make reasonable inferences from the information presented in class. There is no reason to believe that extinction rates in the ocean are much higher than for terrestrial species – in fact, since past marine extinction rates are used as a proxy for the global background rate, it is assumed that the rates are similar (although we do not know this for certain). On the other hand, endangerment rates do vary considerably among taxonomic groups and so it seems unreasonable to conclude that all groups have similar extinction rates (I also presented numbers for birds that differ from some other groups – e.g., fungi – but even without those, the right answer could have been inferred).

The graph below illustrates the relationship described by the equation $S = c*A^z$, which I discussed in class. Which of the following statements about this figure and equation are correct?



16. The "A" in the equation refers to Area, which increases from left to right. **A**
17. The "S", "c" and "z" in the equation are all constants. **B**
18. The equation and graph represent the change in species richness across a series of islands of different sizes. **A**
19. Each dot on the graph represents a different species. **B**
20. The figure shows the relationship described by the equation after taking logs. **A**

This set of questions is designed to test your understanding of the species-area relationship that is central to island biogeographic theory. Questions 16 and 18 should have been straightforward. In question 17, S is not a constant (because islands do not all have the same number of species – hence, S is a variable), although c and z are (you should also know what c and z represent). Question 19 tests whether you understand that the sampled units are islands – for each island, the area and number of species are measured. Finally, question 20 tests whether you understand that you will only get the straight line relationship shown in the graph if you plot the data on a log-log scale (and take logs of the equation to change its form to that of a straight line).

Which of the following statements about extinction are correct?

21. A good way to define extinction is that a species has not been detected for 50 years. **B**
22. The term extinction debt refers to extinctions that are expected to happen due to past actions. **A**
23. In the Singapore extinction study discussed in class, extinctions rates were uniformly high across habitats and taxonomic groups. **B**
24. One way to determine whether a species is likely to be extant is to look at the length of the time gaps between past sightings. **A**
25. Because of extinction debt, scientists have suggested that only about half of the extinctions that will ultimately be caused by habitat losses will occur within the first 50 years. **A**

Question 21 refers to a method that has been used to define extinction, but that is used less and less because it has a lot of problems (e.g., time frame is arbitrary, suitability varies among organisms with different generation lengths, etc.). Question 23 was designed to test whether you understand that, although extinction rates in Singapore were high, they were far from uniform – this leads into the idea that extinction risk is at least somewhat predictable based on a species' characteristics. Question 24 refers to a method described in class and should have been easy if you were in class. Questions 22 and 25 are simply factual and test whether you understand the meaning (22) and consequences (25) of extinction debt.

Why are there more endangered species in Hawaii than in California? (5 points)

26. Hawaii has more large species than California. **B**
27. Hawaiian species have more complex life-histories than Californian species. **B**
28. Hawaii is a group of remote islands. **A**
29. Humans have destroyed more habitat in Hawaii than in California. **B**
30. Introduced predators have a bigger impact on island species than on mainland species. **A**

There is no reason to believe that Questions 26, 27, or 29 are correct so they shouldn't be marked as true (although if they were correct, they could account for the difference). On the other hand, species on remote islands are known to be more vulnerable (several reasons and a couple of examples given in class), and introduced predators on islands are well known to increase extinction rates (again, discussed in class).

A recent study by Koh et al. described patterns of co-extinction. Which of the following results arose from that study?

31. Many symbiotic species are vulnerable to extinction. **A**
32. Most future extinctions are likely to be due to co-extinctions. **B**
33. The risk of co-extinctions is far less serious than previously thought. **B**
34. The extinction of currently endangered species will result in 1000s of co-extinctions. **A**
35. In the past 100 years, millions of species have gone extinct because their host species have gone extinct. **B**

Questions 31, 33 and 34 should have been straightforward because they address the primary results that I described in class. Question 32 was harder because there will be a lot of co-extinctions in the future…but they will certainly not account for "most" extinctions. In the example I gave in class, for example, the number of predicted co-extinctions was a lot less than the number of host species known to have gone extinct. Based on that result, the number of co-extinctions is expected to be less than half of all future extinctions (about 30-40% if you do the math, based on the example). Although question 35 related to co-extinctions, it was designed primarily to determine whether you know the approximate number of

extinctions in recent times. Given that the current estimate of the number of species on the planet is only 5-10 million, it is very unlikely that millions of species could have gone extinct in the past 100 years. If you then limit things further by focusing only on co-extinctions, then it is even less likely.

PART 2:

36. Define the following terms. Give examples of (a), (b) and (c), and explain how (d) is different from species evenness. (8 points)

a) Endemic species: See notes to Lecture 5. One example I have mentioned is the po'ouli (endemic to Hawaii); many others will come up as we proceed through the course.

b) Extinct in the wild: See notes to Lecture 5. One example I have mentioned is California condor, which was extinct in the wild for a while (but is not anymore).

c) Symbiotic: See notes to Lecture 6. Symbiotic species are those that have a close interactive relationship with another species. Frequently, they rely on that other species to survive, and this is the context in which I've talked about them in class. One example I have mentioned is the large blue butterfly, which has a symbiotic relationship with a species of ant.

d) Species richness: See notes to Lecture 3. Species evenness would also take into account the relative abundance of each species.

37. Explain how the equation and graph given for Q16-20 (above) could be used to estimate how many species will go extinct following the loss of 50% of the world's coral reef habitat. Include in your explanation the pieces of information that would be required to do this calculation. (3 points)

This question tests whether you understand how people have used the species-area relationship to estimate extinction rates (specifically, how EO Wilson used it in one of the first attempts). To estimate the number of extinctions you would need an estimate of (i) the total area (A) of coral reef habitat and (ii) the number of species (S) that are unique to coral reef habitats (others would persist elsewhere). You would then have to make some assumptions about what values to use for c and z (e.g., you could use z = 0.15, which was used in the rainforest example I gave in class, and told you was conservative based on many studies in different systems). You could then solve the equation to give S for ½A.

Alternatively, you could plot data for a series of coral reef habitat patches ("islands") to generate a species-area relationship specific to coral reefs. You could then use that relationship to estimate the number of species in all reef habitat and the number in half that area. This approach might be ok but would require extrapolating well beyond the data (because the largest patch you could survey would be far smaller than the total area of all reef patches), which could be problematic (see Lecture 2).

Finally, if the question was a little different and asked how many extinctions there would be if a single patch was reduced to half its current area, and you had a graph that describes the relationship for coral reef patches, it would be quite easy to obtain an answer graphically. To do this, you would need to know the starting patch size (A_1), which you would locate on the x axis. You could then read up to the dotted line, and then go left to the y axis to figure out the expected species richness in a patch of that size (S_1). You can repeat this for the reduced patch size (A_2)

to get the species richness after habitat loss (S_2). The difference (S_1 - S_2) is the amount of species loss due to habitat destruction in that patch. And, since your graph is on a log scale, you will then need to convert the difference back to the standard number scale by taking the antilog. This last part is NOT what this question asks – but it is something you should understand.

38. List 4 factors that make species vulnerable to extinction. Give a specific example for each. (4 points)

See notes to Lecture 6, in which I listed 10 things that could have been used here. 0.5 points for each item and 0.5 for each example. Any appropriate examples would work (could come from lectures, textbook, discussion readings, or your general knowledge – I just need to be able to verify that they are appropriate).