Name: _____

Which of the following statements about ecosystem services are correct?

1. Ecosystem services are defined in terms of their ability to maintain high biodiversity. **B**
2. The flood control value of wetlands is an example of a regulating service. **A**
3. Corn production for food is an example of a supporting service. **B**
4. Wood production for fuel is an example of a provisioning service. **A**
5. Bird-watching is an example of a cultural service. **A**

Which of the following activities fall within the field of conservation biology?

6. Documenting extinctions caused by sea-level rise. **A**
7. Monitoring chemical pollutants that cause human birth defects. **B**
8. Helping to guide legislation to prevent the sale of potentially invasive pet fish. **A**
9. Breeding disease-resistance into crop plants. **B**
10. Developing human medicines from rainforest plants. **B**

Q7, 9, and 10 are wrong because they are all focused on human benefits rather than on preventing loss of biodiversity.

***Phragmites* is an introduced plant that has become invasive in North America. Based on the material presented in this class, which of the following statements are likely to be true about this plant?**

11. Its spread to North America was probably aided by low propagule pressure. **B**
12. It is a habitat generalist that is associated with disturbed habitats. **A**
13. It is likely that multiple introductions occurred before it became established. **A**
14. Early detection programs, such as IPANE are probably the most effective way of preventing *Phragmites* becoming a problem in new areas. **A**
15. A good way to reduce the biodiversity impact of *Phragmites* is to introduce as many of its natural predators from its native range as quickly as possible after they have been identified. **B**

The figure below comes from one of the discussion papers. Which of the statements that follow are supported by this figure?

16. The extinction debt hypothesis predicts that Type III cities would have experienced fewer extinctions between floristic surveys than Type II cities. **A**
17. The data in the figure provide strong support for extinction debt. **B**
18. Data collection began in 1600 AD. **B**
19. By the end of the study all three types of city had lost approximately the same number of species. **B**

20. Type I cities are likely to have been established earlier than those in the other two groups. **A**

Q16 is correct because Type III cities experienced native vegetation loss later than Type II cities. Consequently, many more of the extinctions that will eventually arise from that habitat loss will not have happened yet (i.e., that "extinction debt" is yet to be paid off). You didn't need to know this to answer the question, but if you look back at the paper this figure came from you will see that Fig 4 supports this prediction (data show that Type III cities did not lose many species and points lay well above the line for the predicted persistence). Note that this was one of the hardest questions on the test because it required that you to both understand some conceptually difficult theory and interpret a complex figure. Q17 was wrong because the graph does not show any data and does not address extinction debt. Instead this figure is designed to explain the underlying assumptions of the study (e.g., the assumed patterns of vegetation loss) and the timing of key events (e.g., the surveys during which data were collected).

Tropical forest destruction endangers many species, but exactly how many is not known. Why do we not have better estimates of the number of affected species?

21. Because we lack sufficient information on the range sizes of tropical forest species. **A**
22. Because species-area curve methods do not work in the tropics. **B**
23. Because the number of species that occur in tropical forests is not well known. **A**
24. Because rates of forest destruction are uncertain. **A**
25. Because so much forest has been lost that estimates are impossible. **B**

Uncertainty in the rate of forest destruction contributes to poor estimates of the number of affected species because the amount of habitat loss is a key variable that goes into estimates of extinction rates based on species-area curves.

Which of these statements about disease are true?

26. Disease can be effectively controlled in endangered populations, but only if all individuals are vaccinated. **B**
27. Introduced diseases have caused major changes to eastern North American forests. **A**
28. Studies clearly show that invertebrates are rarely threatened by disease. **B**
29. Disease is a major factor influencing the world's amphibians. **A**
30. Small population size makes species more vulnerable to disease outbreaks. **A**

Q28 tests your ability to recognize and understand potential biases in data sets. The Wilcove et al. study did show a low number of invertebrate species affected by disease. But we discussed the fact that there is a good chance that this result is biased, because disease tends not to be very well studied in invertebrates. Q29 refers to chytrid disease, which I gave as an example in the lecture on disease.

Which of the following organisms have undergone major declines following high levels of hunting?

31. Passenger pigeon. **A**
32. Mourning dove. **B**
33. Medicinal leeches. **A**
34. Large sharks. **A**
35. Cane toads. **B**

Q33 relates to an example I gave in the lecture on overharvest (remember the quote from one of William Wordsworth's poems?).

Which of these statements about habitat fragmentation are true?

36. Habitat fragmentation tends to be most harmful to edge species. **B**
37. A single large clear-cut is likely to reduce forest biodiversity less than lots of small clear-cuts that cover the same total area. **A**
38. Building dams is a serious cause of habitat fragmentation. **A**
39. Power-lines are a serious cause of habitat fragmentation. **A**
40. Species that are poor dispersers or that are area sensitive tend to be affected by habitat fragmentation. **A**

Q37 is correct because both types of forest loss will have similar direct effects on biodiversity (because the area is the same), but many small clear-cut will lead to more forest fragmentation, which increases the magnitude of indirect effects. Under the fragmentation scenario, forest interior species are more likely to be lost from the remaining habitat.

Which of the following statements about the species that remain to be described by scientists are true?

41. Based on most current estimates at least two-thirds of species have not been described. **A**
42. Scientists estimate that they will have described all species on Earth by 2020. **B**
43. The high speciation rate is a major reason why so many species remain to be described. **B**
44. Spraying insecticides into the canopy of tropical forests provided important data for early estimates of the number of undescribed species. **A**
45. Most of the species that remain to be described occur in the deep ocean. **B**

Q45 is incorrect even though it is true that there are probably many species that remain to be described in the deep ocean. Two different lines of evidence, from the class, support this conclusion. First, the oceans are not where most insects are found, and the vast majority of undescribed species are insects (see lecture 4). Also, later in lecture 4, I described a study that estimated the number of unknown species which concluded that only about ¼ of all undescribed species is in the oceans. Given this result, it would be impossible for most of the undescribed species to be in just one portion of the oceans.

Which of these statements about mass extinctions are correct?

46. The proportion of species that are currently endangered is similar to the proportion that went extinct during previous mass extinctions. **B**

47. Extinction rates are currently very high, but are starting to slow down. **B**
48. During geological time the majority of species went extinct during the five mass extinctions. **B**
49. The background extinction rate is about a million times lower than the current rate. **B**
50. During past mass extinctions, at least 3 out of every 4 species went extinct. **A**

Q46 was designed to test how well you understand the relationship between contemporary and past extinctions. Although the estimated rate of current extinctions is similar to that during past mass extinctions, the actual number of current extinctions that have happened remains very low. Even if we assume that all currently endangered species will go extinct, it will still be fewer extinctions than during past mass extinctions. This topic was discussed in the material for lecture 5 (and shown in the figure from Barnosky et al. from that lecture). The reason for this is that, although we appear to be on the road towards a mass extinction, we're still at a very early stage in the process. In other words there is a lot of extinction debt, but not much actual extinction has happened yet. Q48 deals with a related issue – although mass extinctions had much high rates of extinction than at other times, they did not contain the majority of all extinctions. Geological time lasted a long time and even small rates of extinction over very long times add up.

Species vary in their vulnerability to extinction. Which of these statements about this variability are correct?

51. Complex life-histories generally help protect species from extinction. **B**
52. Low reproductive rates are not a problem as long as survival rates are high. **A**
53. Extinction rates are higher on islands because populations fluctuate less than on the mainland. **B**
54. Population fluctuations are a more serious problem for small populations than for large populations. **A**
55. Diet specialists are more vulnerable to extinction than species with broader diets. **A**

Q52 recognizes that what really determines whether a species will decline is the balance between reproduction and survival. If a species is long lived (i.e., has a high survival rate), then it can "afford" to reproduce at a low rate, without undergoing population decline, as there will be many opportunities for individuals to replace themselves. In class I talked about this issue using albatross as an example.

Which of these statements about biological diversity are correct?

56. A comprehensive definition of biodiversity is: "all species of animals on Earth, including their genetic diversity". **B**
57. Species diversity encompasses variation in morphology, behavior, physiology, and taxonomic uniqueness, among other things. **A**
58. Temperature, humidity, and salinity are key aspects of biological diversity. **B**
59. Keystone species are those that have a disproportionately large influence on what biodiversity occurs in an area. **A**
60. Protecting the genetic diversity of species is an important aspect of their conservation. **A**

Which of the following statements about climate change are accurate?

61. Average global temperatures have increased about 5° C since the 1950s. **B**
62. Climate warming due to increased atmospheric carbon dioxide was predicted over a hundred years ago. **A**
63. Climate warming is predicted to be more severe at lower latitudes. **B**
64. Thermal expansion caused by heating up the oceans contributes more to sea-level rise than melting sea ice. **A**
65. Strong evidence for climate change comes from changes in the phenology of many species. **A**

The figures below plot the amount of bush meat consumption on the y-axis against household wealth on the x-axis. The graph on the left shows data for rural households, while the graph on the right shows data from urban households. Using these graphs and your knowledge of other information presented in class, which of the following statements about bush meat are correct?

66. Bush meat is primarily eaten by the poorest people in urban areas. **B**
67. Eating bush meat is a signal of status in rural communities. **B**
68. Bush meat primarily involves domesticated animals. **B**
69. Bush meat is exported from Africa for profit. **A**
70. Bush meat is an important source of protein in many areas of the world. **A**

In 1998, Wilcove et al. published a summary of the threats faced by endangered species in the U.S. Which of the following statements about their study are correct?

71. Climate change threatened the greatest number of endangered species. **B**
72. Pollution threatened more endangered plants than endangered animals. **B**
73. Most species were threatened by habitat loss alone. **B**
74. Invasive species threatened more species than did over-exploitation. **A**
75. The researchers were able to eliminate all sources of bias from their study. **B**

Q73 was designed to test whether you recognize, not only that habitat loss affects most species, but that most species are affected by multiple things. This same question was on the most recent homework (in a slightly different format) and a lot of people got it wrong. Anyone who had read over the posted homework answers should have had no trouble with this question. The other questions in the set were simply a matter of knowing the patterns in the data table that I presented in 3 or 4 different lectures (note that when I repeat something multiple times, it probably means that I think it is important).

Which of these statements about hotspots are accurate?

76. Richness hotspots are the focus of conservation biologists because they contain the greatest number of endemic species. **B**
77. Endemism hotspots are places with a lot of species found nowhere else. **A**

78. High overlap among taxonomic groups is a strength of the hotspot approach. **B**
79. Oceanic hotspots are all in temperate parts of the world. **B**
80. Richness hotspots would be expected at high elevations in temperate areas. **B**

Q78 was wrong because there is not good evidence that high overlap among taxonomic groups occurs (I presented an example of this from the UK).

Which of these definitions are correct?

81. Founder effects refer to the rapid population growth seen in some introduced species. **B**
82. Canopy fogging refers to an effect of climate change on tropical forests. **B**
83. Edge effects are caused by the slow erosion of species ranges through local extinctions. **B**
84. Beta-diversity refers to the change in species evenness over time. **B**
85. An extant species is one that has been extirpated. **B**

Q81 is wrong because "founder effect" refers to the loss of genetic variation and fixation of alleles that occurs when a new populations of very small size is formed. Founder effects are likely in introduced species (because they start with a small population size), but the term does not refer to rapid population growth. And Q84 is wrong because beta-diversity refers to changes in species richness (not evenness) in space (not time). Both these terms are defined in my lecture notes (and given in bold text to indicate that they are terms you should be able to define).

PART TWO: 4 short answer questions. In each case I have given plenty of space to answer the question, so you don't need to write pages to give adequate answers. The number of points is given at the end of each question.

86. Give an example of each of the following. In each case you must be specific to get the points. Listing lots of options will get no points unless all are correct. (4 points)

a) An invasive plant that is not mentioned anywhere else in this exam: Any verifiable example. Examples given in class include purple loosestrife, salt cedar (tamarix), prickly pear cactus, and kudzu. Examples from any of the news articles I've tweeted about would also be valid. If you got this question marked wrong, but believe your example is valid, then I will consider a re-grade if you can provide convincing evidence to support your claim.

b) An invertebrate that has been overharvested: Any verifiable example. Lots of options here, but among those discussed in class are medicinal leeches, cone snails, and scallops. Shrimp (and various other marine organisms that form by-catch) would also be acceptable. Again, I will consider a regrade if you can provide convincing evidence to support your claim.

c) A species that has declined severely due to pollution: Any verifiable example. In class, I described the decline of three species of Asian vultures due to diclofenac. I also stressed the importance of reading the pollution section of the text book, where other examples are given (e.g. various birds of prey affected by DDT). Again, I will consider a regrade if you can provide convincing evidence to support your claim.

d) The pollutant that caused the decline of the species named in (c): See above.

87. The figure below represents time-lines for two species that are thought to be extinct. On each time-line circles indicate years in which the species was seen and blank spaces indicate years in which it was not. Which species is most likely to persist in 2012 and why? (2 points)

Species B is most likely to be extant (1st point). This is because the long gaps between sightings means it is quite likely that this species could go undetected for several years. The lack of such gaps in the sighting record for species A means that it is extremely unlikely that it could have persisted for many years prior to 2012 without being seen (2nd point).

88. The graph below illustrates the relationship described by the equation $S = c*A^z$. Label the graph to indicate how the terms in the equation relate to the figure. Explain (by drawing on the figure if necessary) how you would use this graph to determine how many species would be lost from a patch if its size were reduced due to habitat destruction. (6 points)

Four points for accurately labelling the graph. For full points you needed to get at least four of these five things right: labels for (a) area on the x axis, (b) species richness on the y axis, (c) z as a constant describing the slope of the dotted line, (d) log c (or c) as the point of intersection between the dotted line and the y axis, and (e) recognizing that area and size should be plotted on log scales.

The other two points were for showing that you can plot the starting patch size (A_1) on the x axis, then go up to the dotted line, and then left to the y axis to figure out the expected species richness (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.

89. Compare the effects of hunting on mourning doves and passenger pigeons. What are the likely biological reasons for any differences or similarities? (3 points)

Hunting of mourning doves is sustainable and well-managed, despite a very heavy harvest. Hunting of passenger pigeons, by contrast, was not sustainable and was a contributing factor in the extinction of the species. The exact reasons for the differences are uncertain, but they probably arise from some combination of the following things: (a) it is likely that mourning doves have a high reproductive rate, (b) the lack of regulation on passenger pigeon hunting, (c) the simultaneous loss of habitat that passenger pigeons underwent, and (d) the need for social stimulation in passenger pigeons. For all three points you did not need to identify these exact reasons, but you did need to mention at least two plausible explanations to demonstrate that you can take general patterns described in class and use them to make reasonable inferences about patterns seen in nature.