BL 419/519 Conservation Biology Midterm

Answer the questions below on your own, based on your independent analysis and/or interpretation of data. I will not require that you turn in supporting analyses with your completed exam, but you should be prepared to provide documentation of your analysis if requested. The exam is open-book and open-note, so feel free to consult whatever resources you deem necessary. See me if you have any questions. Your exam should take three to four hours to complete, and must be returned to me by noon on Friday 18 March.

1. 10 points: You have been provided with a small biodiversity sample from a rapid biological inventory of fish diversity in 10 different wetlands. Based on the data provided, calculate the observed species richness (α) for each wetland. Fill the richness data in the appropriate column in the table below. Calculate log 10 (Area) and log 10 (Species richness), paste the data in the table, and plot the species-area relationship (SAR) using the transformed species and area data. Paste the scatterplot of the SAR below the table, and indicate the *z* and *C* values for the log-log SAR here:

*C*: 0.6444 \_

*z*: 0.1189\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Wetland | Area (km2) | Species richness (α) | Log 10 (Area) | Log 10 (Species richness) | Chao 1 | Log 10 (Chao 1) | Sampling efficiency |
| A | 3.6 | 4 | 0.556303 | 0.60206 | 4 | 0.60206 | 1.000000 |
| B | 113.93 | 8 | 2.056638 | 0.90309 | 17.77 | 1.249687 | 0.450197 |
| C | 734.39 | 9 | 2.865927 | 0.954243 | 9 | 0.954243 | 1.000000 |
| D | 17.9 | 6 | 1.252853 | 0.778151 | 6.98 | 0.843855 | 0.859599 |
| E | 18.9 | 11 | 1.276462 | 1.04139 | 13.97 | 1.145196 | 0.787402 |
| F | 1375.99 | 7 | 3.138615 | 0.845098 | 7.48 | 0.873902 | 0.935829 |
| G | 3.3 | 4 | 0.518514 | 0.60206 | 4 | 0.60206 | 1.000000 |
| H | 137.17 | 10 | 2.137259 | 1.000000 | 12.98 | 1.113275 | 0.770416 |
| I | 1350.82 | 12 | 3.130597 | 1.079181 | 16.48 | 1.216957 | 0.728155 |
| J | 11.5 | 6 | 1.060698 | 0.778151 | 6.97 | 0.843233 | 0.860832 |

1. 5 points: Based on the SAR you calculated for 1, what is the size of the extinction debt that would be paid if a wetland of 1000 km2 is reduced to 100 km2?

An estimated 23.95% reduction in species.

1. 15 points: Use EstimateS to estimate extrapolated species richness for each wetland using the Chao1 estimator. Follow the instructions in EstimateS for reporting classic or bias-corrected estimators. Complete the table with the Chao 1 data in the appropriate column. Paste the scatterplot of the log-log SAR below. Assuming these patterns are representative of biodiversity in general across the wetlands, would you make different decisions about conservation priorities based on the observed versus estimated richness data? Explain your answer in a short paragraph below.

Based on the above graphs that represent observed and estimated species-area relationships for these wetlands, I would feel justified using the estimations of richness data to make conservation management decisions. The relationships are very similar, and the slopes of the lines of best fit are not highly dissimilar. In fact, the estimated richness data may be more useful in conservation decisions; the steeper relationship (taken from the slope of the line of best fit) among these data points would suggest that a reduction in habitat size has a greater impact on species richness at each wetland. This indicates to me that estimators of richness data can be highly useful in making conservation decisions, and also allow conservationists to use their time and funding more efficiently, as opposed to having to spend longer times in the field determining accurate species richness data.

1. 10 points: Use the Chao-1 metric to estimate sampling efficiency by calculating Sobserved/Sestimated for each location. Recalculate the SAR using the observed data only for those locations where sampling efficiency > 0.75. Provide the *z* and *C* values below. **(New equation y = 0.0162x + 0.7022)**

*C*: \_0.7022\_

*z*: \_0.0162\_

1. 20 points: In class we talked about five major negative impacts of invasive species. Which of these do you personally consider to be the most problematic, and why? Use the primary scientific literature to support your viewpoint. Your answer should be about a page.

Plants, fungi, and animals are all rather easily, and frequently, introduced to non-native regions, and they may subsequently establish populations that persist on their own. When these introduced species that have become naturalized in a non-native area adversely affect human health, economy, or the environment they were introduced or spread into, they are considered an invasive species. While some introduced species do have positive impacts in their new range (i.e. the European honeybee, *Apis melifera*), invasive species have a variety of significant negative impacts. These negative impacts include damage or losses with regards to the economy, displacement or declines of native species, hybridization and introgression with natives, alteration of native fire regimes, and disease transmission. Of these, the most significant negative impact seems to be the displacement and decline of native species resulting from establishment of an invasive species. Although economic losses can be severe and disease transmission is a serious concern for biodiversity conservation, the decline of native species has far-reaching implications that even tie in to and exacerbate the other aforementioned negative impacts.

The most glaring evidence in support of this argument is that declines due to invasive species clearly lead to species extinction. Now, although Gurevitch and Padilla (2004) suggest that invasive species likelycontribute to extinctions while asserting that clear conclusions cannot be made based on our current approaches, an analysis of the IUCN Red List database by Clavero and Garcia-Berthou (2005) suggests that of 680 extinct animals, invasive species were implicated in 54% of the cases that could be assigned a cause for extinction (91 of 170 species). Moreover, 34 of these cases (20% of total cases that could be assigned a cause) were driven solely by invasive species. Compared to the obvious drivers of extinction, habitat destruction and harvesting, which were implicated in about 80 cases each, this suggests that invasive species are significant drivers of change and species extinction. What’s more, certain taxa are particularly vulnerable to declines due to invasive species; invasives are the leading cause of extinctions in 27 of 40 Norther American fish species (Miller, 1989), 11 of 23 globally-distributed fish species (Harrison and Stiassny, 2004), and 12 of 25 extinct mammal species (McPhee and Flemming, 2004).

Aside from direct extinction due to declines of native species, the resulting declines due to invasives can exacerbate other negative impacts like economic losses and even disease transmission. For example, Asian carp are rapidly-growing fish that have been introduced all over the US, and feed on native mussels and snails, some of which are currently endangered. They easily outcompete other native fish species, some of which are economically-valuable gamefish (Zambrano et al., 2006).

Literature Cited

Gurevitch, J., & Padilla, D. K. (2004). Are invasive species a major cause of extinctions?. *Trends in Ecology & Evolution*, *19*(9), 470-474.

Clavero, M., & Garcia-Berthou, E. (2005). Invasive species are a leading cause of animal extinctions. *TRENDS in Ecology and Evolution*,*20*(3), 110-110.

Miller, R. R. (1989). Extinctions of North American fishes during the past century. *Fisheries* 14, 22-38.

Harrison, I. J., and Stiassny, M. L. J. (2004) CREO List of Fish Extinctions since AD 1500, American Museum of Natural History, Committee on Recently Extinct Organisms.

McPhee, R. and Flemming, C. (2004) CREO List of Fish Extinctions since AD 1500, American Museum of Natural History, Committee on Recently Extinct Organisms.

Zambrano, L., Martínez-Meyer, E., Menezes, N., & Peterson, A. T. (2006). Invasive potential of common carp (Cyprinus carpio) and Nile tilapia (Oreochromis niloticus) in American freshwater systems. *Canadian Journal of Fisheries and Aquatic Sciences*, *63*(9), 1903-1910.

Read the article describing some conservation issues in southeast Asia [here](http://www.sciencedirect.com/science/article/pii/S0169534704002666). Consult the supplementary data in the online appendix (you will probably need to change the font to read the table accurately). Fill in the table below and answer the following questions:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Country | Current forest area (%) WCMC | Current forest area (%) FAO | Current forest area (%) average | GNI per capita ($) | Total protected area (%) | Net export of wildlife products |
| Myanmar | 51% | 51.1% | 51.05% | 1183 | 5.4% | -63 |
| Laos | 19.5% | 54.2% | 36.85% | 4570 | 18.8% | 6004 |
| Vietnam | 15.5% | 25.0% | 20.25% | 5030 | 4.2% | 150824 |
| Thailand | 33.5% | 19.3% | 26.40% | 13510 | 15.7% | 34264 |
| Cambodia | 65.5% | 52.4% | 58.95% | 2890 | 23.7% | 200 |
| Malaysia | 41.1% | 53.7% | 47.40% | 22460 | 30.6% | 778006 |
| Singapore | 0.3% | 0.3% | 0.30% | 76850 | 5.5% | 294812 |
| Indonesia | 50.3% | 52.5% | 51.40% | 9260 | 12.5% | 842275 |
| Brunei | 50.7% | 83.3% | 67.00% | 43971 | 56.2% | -500 |
| Philippines | 8.5% | 17.7% | 13.10% | 7820 | 7.8% | -282 |

1. 10 points: Based on the (limited) data from southeast Asia, is there evidence that investing in protected areas protects forest? Use the average current forest area from the WCMC and FAO estimates. Support your answer with a graph illustrating your analysis and a brief interpretation of the data.

At least based on this dataset visualized below, the evidence is quite convincing that countries protecting land also have a larger percentage of forest remaining. Some countries such as Myanmar even have a (relatively) large percentage of forest remaining when only a small amount is protected, although this is not the norm. In general, it seems that reducing forest loss requires more land to be protected. While this is a very logical statement, the extent of protected areas within most southeast Asian countries is low, and forest loss has been relatively extensive.

1. 10 points: Does investing in protected areas reduce the legal exportation of wildlife? Support your answer with a short paragraph including a graph below. Calculate net exports based on the data in the appendix, being careful to add exports (positive numbers) and subtract imports (negative numbers) for your estimate. Because the net exports vary so much among countries, use the log 10 transformation of the net export estimate for your analysis. Focus your analysis only on countries that are net exporters of wildlife products **(excludes Myanmar, Brunei, Philippines)**.

In general, it appears that increasing the extent of protected areas does not have an *overall* significant impact on reduction of wildlife exportation. As seen below, the extent of exportation is quite high no matter the amount of land protected; this is especially true in the case of Malaysia, which has the greatest extent of protected area of the net exporters, and also nearly the highest exportation of wildlife products. On the other hand, though, excluding Malaysia from the dataset may allow one to make the case that reduced protection of forested areas results in a clear, nearly linear increase of wildlife exportation. Therefore, while there are certain countries that stray from the trend, this data may indicate that protecting a larger extent of land has the potential to reduce exportation of wildlife. At the very least, there is certainly not a positive relationship between the extent of protected area and wildlife exportation.

1. 10 points: Now let’s focus on the economic data. Is there evidence that per capita income is predictably associated with forest loss? Include your graph and interpretation below.

When considering all of the data, there does not appear to be a specific trend suggesting that increased per capita income is associated with forest remaining in each of these countries. Of course, removing either Singapore or Brunei from the dataset influences the relationship. Given that when Singapore and Brunei are either included or excluded there is no relationship between per capita income and percent forest remaining, countries with higher per capita income likely do not have a predictable difference in forest loss from countries with lower per capita income.

1. 10 points: What is the relationship between per capita income and wildlife exports? Provide your graph below. In a paragraph or two, what do the data from southeast Asia suggest to you about conservation issues surrounding habitat loss and the wildlife trade? Do the two drivers of biodiversity loss appear to be driven by the same factors? Do they have the same solutions?

Based on the data below, there appears to be a clear association between per capita income and wildlife exports. In general, countries with higher GDIs appear to export more wildlife and wildlife products. Even excluding Singapore, which has an comparatively extreme GDI and high net exportation of wildlife products, there is a definite positive trend between per capita income and net exportation of wildlife. This relationship is likely a significant underestimation, too. There is likely far more exportation going on than indicated by these datasets, given the extent of illegal wildlife exploitation and trade that goes unreported.

Overall, the data from southeast Asia appear to suggest that the extent of forest remaining in the evaluated countries is dependent on preserving and protecting forested areas. Similarly, it seems that exportation of wildlife and wildlife products would, in general, decrease as the amount of protected forested area increases. This suggests that preservation of forested areas throughout southeast Asian countries is integral to mitigating these drivers of biodiversity loss (habitat loss, wildlife trade). Of course, this is increasingly difficult to implement as southeast Asian countries’ populations rapidly increase and as their conservation resources continue to dwindle.

Moreover, economic growth and growing population densities are both positively correlated with forest loss in these countries (Sodhi et al., 2004); this is substantiated by the data presented here. While there is not a clear relationship between per capita income and remaining forest in these countries, the aforementioned association between economic growth and forest loss clarifies that, in general, forest loss is associated with increasing economic growth. Also, countries with higher per capita income tend to export more wildlife products, which may go hand-in-hand with harvesting forests and reducing habitat. Both habitat loss and wildlife exploitation could be mitigated by ensuring that forest reserves are well-protected and continue to proliferate, but this must involve some combined effort of public education and economic incentives, as well.