**Some of the best questions posed by students in preparation for the BIOL 416 2022 course seminars**

1. In the article on ecosystem carbon sequestration following abandonment of agriculture (Foote and Grogan, 2010), there were brief discussions about how different types of farming practices can affect the soil’s carbon sequestration ability. In class, we have discussed sustainable farming practices. Mitigating the impact of our farming practices on the environments they use will become more important the more that we are able to reduce the amount of land we use for agriculture, because we want the land we’re “returning to nature” to be as useful as possible as quickly as possible for us to receive maximal benefits from this re-naturing process. I’m imagining we might have ‘transitional farming’ practices that bridge land between high-output agriculture and high-sequestration-potential re-naturalized land, e.g. by growing crops that serve as high carbon sinks.

Leading to my question: If, as the article concludes, “trees rather than soils are the main sink,” is it possible that we could more effectively use abandoned agricultural land to offset our carbon emissions via **targeted cultivation** of highly effective carbon sink tree species, rather than by simply ‘abandoning’ the land to nature?

1. Most of the marginal fields studied were abandoned at least 20 years ago, after undergoing moderate agriculture practices (more time and energy intensive, slower pace, less intensive tilling (relying on human and animal power), and slower paced) from the late 1800s to the 1990s. The study also mentions that agricultural sites which suffered more C depletion, due to modern agriculture (mechanization, faster pace, more intensive use), represent a greater potential for C sequestration.  Would more recently abandoned marginal fields, having experienced greater agricultural intensity with modern practices and hence greater C depletion, represent a greater potential for C sequestration?
2. On the map of sampling locations in Foote and Grogan (2010), I noticed that all the Luvisol sampling sites are clustered around Lake Ontario, while the sampling sites for the other two soil types are around 20-50 km North of there. I know proximity to large water bodies can generally influence local climate (by mediating land temperatures and by lake-effect precipitation, etc.). Could these climatic variations significantly affect the processes of C depletion and regeneration (through influence on soil moisture/temperature, plants, etc.) specifically in the Luvisol sites, giving rise to a confounding factor, or would these effects be negligeable at this scale?
3. The Chapin textbook chapter 3 describes how physical weathering breaks up rock, exposing surface area for chemical weathering to occur, and I am wondering how the impacts of climate change might interact with these processes. For instance, increased precipitation and extreme weather events (such as rapid cycles of wetting-drying and freeze-thaw) might accelerate physical weathering, and warming might accelerate chemical weathering (since chemical reaction rates increase with temperature).

My question is this: Since chemical weathering consumes CO2 (indirectly, via carbonic acid), could weathering be an increasingly significant carbon sink in a warming world? Could this be considered ‘beneficial’, or would these changes negatively impact ecosystems in other ways, offsetting the benefits?

Diagram

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1. The location of different types of biomes may be predicted by temperature and precipitation.  Soil texture is affected by weathering which is promoted in warm climates and wet conditions.   As water and temperature affect both soil textures and biome distribution, are there predictable soil textures we may expect to find in each biome?
2. The use of fertilizers in agriculture is becoming widely recognized as problematic due to nutrient pollution from run off excess phosphorus. There is growing research into alternative phosphorus inputs such as Phosphate Solubilizing Microorganisms (PSMs) which can make insoluble soil phosphates available to plants. Are these efforts worthwhile or are they just temporary fixes that distract us from the root of the problem? PSMs don’t change the fact that we aren’t replacing the nutrients that harvested crops remove. If we continue as we are even the phosphorus made available by PSMs will eventually be depleted.
3. Bacteria can live for extended periods of time in an inactive state. Is this ability a key component of the formation and maintenance of bacterial consortiums?

Most bacteria are immobile and dependant on the substrates found around them. Over time the substrates located in their immediate environment will vary. This will cause fluctuations in the demand for which enzymes are needed to break down molecules. In consortiums different types of bacteria are each responsible for producing different enzymes. It seems that it would be useful (and maybe necessary) for the function of the consortium, to inactivate bacterium that are not currently needed and reactivate bacteria that produce enzymes relevant to the immediate substrate.

1. The Chapin textbook Chapter 7 outlines how fragmentation of litter by animals allows microbial decomposition by piercing protective barriers and increasing surface area. It later goes on to describe how fungi are able to penetrate the cuticle of dead plants themselves to gain access to the interior. This leads me to my question of whether fungi are at all reliant on decomposers to fragment litter, or if they are self-sufficient in their decomposition? If they are self-sufficient, do fungi and animal decomposers have any significant direct interactions in the soil (besides the death of either party), or purely indirect ones? Going one step further, could this explain why we still see some decomposition activity in very nutrient- and water-poor soils – there are different classes of decomposers that do not rely on one another, and are able to survive varying conditions?
2. Decomposition rates in mountain ecosystems are lower due to harsh climatic conditions at high altitudes, such as low temperature and high precipitation (which leads to waterlogging, thereby creating anaerobic conditions that inhibit decomposition), as well as decreased litter quality, all of which reduce microbial decomposition activity. Given that reduced decomposition rates permit the accumulation of organic C, could high altitude environments be considered C sinks? If so, how might climate warming, which thaws the permafrost and improves drainage as well as the environment for decomposition but also leads to nutrient loss from runoff after snowmelt which can inhibit microbial decomposition activity, affect the potential for high altitudes to serve as C sinks?
3. “Microbial enzyme activity and respiration increase  exponentially  with  short-term  increases in  temperature…[o]ver days to weeks, microbes may acclimate to higher temperatures”. How can this inform our predictions about climate change’s influence on microbial activity and soil production? Will this require an alteration to farming practices i.e. the timing/cycles of nutrient addition? Could global alteration to temperature cycles cause a bottom-up effect, altering microbial activity, vegetation, and ultimately high animals and whole ecosystems? We could go one step further and ask which is more pressing/has broader effects in terms of climate change: top-down controls (e.g. the loss of keystone species and higher flora/fauna) or bottom-up controls.
4. In the rhizosphere, decomposition is controlled by plant carbohydrate status more than it is controlled by the soil physical environment. Therefore, plant carbohydrate status plays a bigger role in fine-rooted grasslands, where the rhizosphere includes almost all the soil. Could this make decomposition in fine-rooted grasslands more sensitive to low water levels? Generally, bacteria can function at lower water levels than plant roots, so decomposition continues despite lack of plant activity. This might not be the case for grassland bacteria if they are reliant on carbon input from plant roots. As the occurrence of drought increases with global warming how might this impact decomposition?
5. Anthropogenic disruption of natural environments has altered the resources and niches available in them, and often eliminated or reduced populations of native species who previously provided important ecosystem services. If invasive species can inhabit these new niches and unlock their resources, they may also be able to replace the ecosystem services lost with the decline or elimination of ecologically similar native populations.

And if so, should we *stop* trying to eliminate these ‘beneficial’ invasive species and instead try to mitigate their harmful effects as a compromise for their benefits? Or is it better to enter the much *tougher* fight to restore threatened and endangered native species to levels sufficient to fulfill their necessary ecosystem services?

1. Controlling or eradicating non-native invasive species by manipulating soil nutrient availability poses risks to native species that are not being targeted, which could disrupt ecosystem processes and thus prove more harmful than good. Alternatively, gene drive methods have been proposed for eradicating invasive species. Gene drives involve a class of genes called homing endonucleases that, when inherited in one copy (heterozygosity), duplicate themselves on the complementary chromosome. In theory, these genes will be inherited by all of an individual’s offspring, thereby spreading rapidly in the population. If a gene drive construct that caused sterility were introduced into an invasive population, how might the potential risks of this method (e.g. the gene construct spreading into non-invasive populations of the same species) compare in severity to those associated with manipulating soil nutrient availability?
2. As the population of Africa grows, more food will be necessary to feed this population and jobs will need to be available to allow for economic growth and to provide meaningful work. However, increased production in agriculture and other industries often results in the reduction of forest area, decreasing the suitable habitats available for forest elephants. Thus, SDG 15.7 may be at odds with other SDGs related to economic growth and food security.

How should African countries balance food security and job creation necessary for their increasing populations with the conservation of habitats necessary for the survival of biota, including the forest elephants? What strategies could be employed to facilitate economic growth and food security while also protecting species and their habitats?

1. Zoonotic diseases like COVID-19 spread into the human populations through poaching and negative interactions with wildlife. What COVID has shown us is that that something that happens in one part of the world can have profound impacts that can be felt globally. It highlights that human health, environmental health and animal health are all so very intrinsically linked through their dynamic interactions. This understanding further cemented by our previous learnings in this course about the many interactions and systems present within ecosystems; disruptions on one scale can have impacts that can be felt on many different levels in both directions. While article explores the impacts anthropogenic actions have on elephants, what about the reverse? What are the consequences that a declining elephant population (caused by humans) have on humans and human health,both locally and globally?
2. Urbanization is a major threat to existing biodiversity, but can also introduce new niches and resources that promote adaptation, speciation, and immigration, potentially increasing biodiversity via human commensals and species that use urban areas as ‘staging grounds’ for dispersal. Consequently, two parts to my question:

Are there existing methods for quantifying the relative value of one type of biodiversity vs another? Since biodiversity is not ‘intrinsically’ good but rather is good for the services and stability it provides.

If we *do* find a way to measure relative values of diversity, should urban-enhanced biodiversity be considered 'worse’ than other forms of biodiversity? What unique services does increasing biodiversity *within* cities provide?

1. Gamfeldt et al. discuss how the birch species showed the strongest positive relationship with soil carbon storage in this study. Additionally, it is mentioned that forests and their soils store ~45% of all terrestrial carbon, and therefore can act as a sink for anthropogenic carbon emissions.

Considering the strong positive correlation between carbon storage and birch biomass, if birch biomass was increased in these boreal and temperate forests, would carbon storage increase to a larger degree than it did in this study (11% increase) when all the tree species biomass were increased?

If so, could creating monocrop forests of birch be a tactic used by climate scientists to create “mega-powered” carbon sink forests? Or would the lack of tree biodiversity in these monocrop forests lead to a tradeoff in ecosystem services that negatively affect the carbon storage ability of the soil indirectly, because, as the study briefly mentioned, “some ecosystem services may come at the cost of others”?

1. With the effects of climate change, we are seeing the ranges of species native the south expanding as warming temperatures allow them to survive further north. This is of course something of special concern in Canada due to our unique forest ecosystems. Species that may damage forest ecosystems may become more prevalent as their range expands. However, an additional consequence of climate change is an increased frequency of forest fires as we see in Western Canada. So, my question: how does deforestation and tree diversity decline compare between wildfires and insect attack? And the authors write that forest resistance to herbivory can be improved by choosing composition of mixed forests; can a similar effect be achieved regarding damage by wildfire?
2. Some forest diversity studies have found that insect herbivory is affected by the interaction between tree diversity and local climate, suggesting that the relationship between tree diversity and forest productivity depends critically on environmental context. If this is true, then how will a changing climate modulate tree diversity-herbivory relationships, and will this necessitate alterations in forest management practices? Further, given the significant variation in current climate and projected future changes in climate across the globe, how can we arrive at a definition of “sustainable” forest management practices that isconsistent on an international scale?
3. As outlined by the article, mountain species’ ranges are both shifting upwards and are being contracted by the upward shift of lower range limits due to climate change and intensive human activity in low ranges. Species’ ranges are also used as a proxy for extinction risk.

What can be done for the species which are reaching the mountain peak and no longer have anywhere to go?

Should these species be prioritized as they face the highest extinction risk and/or realistically would *in situ* conservation strategies even be useful when the species' largest threats are not disturbed environments but climate change (external pressures) as a whole?

1. In their discussion section, the researchers discuss the possible transport methods between the different plant species. Biotic vectors are known carriers of seeds and the researchers discusses this as being one of the likely causes of the range shifts. This had me thinking about how these interactions could affect further range shifts in both plant animal species. Specifically for biotic mediated seed dispersal, if animals are carrying seeds further up the mountain and this causes the shift of another animal species up the mountain to graze on the plant species, could this lead to a positive-feedback loop of continuous range shifts?
2. In the context of your question, “Does SDG 15.3 harmfully facilitate disguising economic interests as environmental interests?” I found the term “ecosystem services” to be very interesting. When I first started reading the article, I assumed ecosystem services had a meaning similar to the term ecological benefits. The inclusion of the word ‘ecosystem’ led me to believe that this term involved environmental benefit and not just human benefit. By definition the word ‘ecosystem’, involves interconnectedness and interaction between all aspects of the biotic and abiotic environment. However, the term “ecosystem services” paints humans as being separate from the ecosystem, in a position to take, but not give. I’m curious if the term “ecosystem services” was intentional crafted to disguise human pillaging of the natural environment, and if the term “ecosystem services” is able to glide by public scrutiny due to the positive associations surrounding the word ecosystem?
3. This paper mentions the ‘ecological benefits’ of reduced desertification of Hongsibu, citing a less ‘fragile ecological environment’ and ‘the formation of a better microclimate environment’. However, the authors failed to define or expand upon either of these terms/sentences. How was the ecosystem previously ‘fragile’? What microclimate are they referencing, how would it be ‘better’, and for whom would it be better? They also used the observed reduction in sandstorms and dusty days as an example of how the ecology of the environment has changed for the better - this clearly demonstrates the paper’s massive anthropogenic focus, which actively diminishes the ecological value of desert areas for biological diversity and ecosystem health/functioning/processes. No mention is made as to the species this environment supports, and their ecological requirements that rely on a functioning desert system (e.g. temperature, available space/range, etc.). Do you think the SDG goals were designed with a similar anthropogenic lens? As deserts tend to be less biologically diverse/abundant than areas such as rainforests, and the human population continues to expand and require greater resources, does it make economic sense to prioritize *human interests* in these less diverse/abundant desert environments and *ecological interests* in tropical environments? What balance/trade-offs should be struck between balancing human and ecological interests?

1. The main article selected for this discussion of SDG 15.7 presents a very anthropogenically-centered view of the issue of poaching and trafficking. For example, the paper states, “there are strong concerns about illegal hunting activities, such as poaching… because of safety concerns and loss of valuable resources”. Do you think this same anthropogenic perspective was taken in the development of SDG 15.7? What benefits **and/or** consequences would come from approaching a complex issue such as poaching and trafficking, which involves many ecological, cultural, and socioeconomic nuances, with a primarily anthropogenic stance? Would you recommend that the UN’s current approach to SDG 15.7 be altered – why or why not?

This paper also assesses 67 reported incidences of white-tailed deer being poached in Iowa, USA, over a 9 year period (equating to ~7.5 instances of poaching per year). Do you think the narrow scope of this paper (limited in geography, sample number, affected species) is representative of SDG 15.7, without the use of additional supporting literature?

1. The article discusses how hot spot maps can be used to increase the efficiency of poaching regulation by focusing efforts on peak times and locations. If this practice becomes public knowledge, could poaching activity shift to avoid detection, reducing the effectiveness of this strategy? Presumably, popular locations (such as valleys and forests) won’t change since this preference is influences the high probability of finding deer. However it seems likely that more arbitrary elements, such as the day of the week, could shift.

1. Ecosystem management involves trade-offs between ecosystem services; enhancing one service often comes at the expense of another. I feel this also applies globally, in the context of the SDGs, because some SDGs seem to conflict with others. For example, Goal 2 (end hunger and achieve food security) would conflict with Goal 15 (promote biodiversity and sustainable use of ecosystems) if the best way to alleviate hunger in a certain region was to convert forest to monoculture cropland. Further, it could be argued that most corporations align with Goal 8 (economic growth), even if their practices are wildly unsustainable in the environmental and social context. It seems as though the UN must narrow down the SDGs by choosing which ones to prioritize, in order to provide any sort of actionable framework.

On the other hand, the valuation of ecosystem services requires ecological information that is often site-specific, meaning that local and traditional ecological knowledge plays an important role. In this sense, perhaps it is valuable to have multiple SDGs, so that the local knowledge of each region can be used within the SDG framework. What right does the UN have to choose which SDGs are important, on behalf of the world, when they cannot speak to local-scale ecological and social needs?

My question is - ***is it even possible to provide a framework that simultaneously has enough flexibility to accommodate local differences while also being rigid enough to prevent contradictions and corporate exploitation?*** How might these issues be reconciled in a modified version of the SDG framework?