Annotated Bibliography: Plant communities and soil respiration

Metcalfe, Fisher, Wardle (2011)

**Keywords: soil carbon dioxide efflux, plant traits, plant range expansions, plant diversity, plant productivity**

*Title:* Plant communities as drivers of soil respiration: pathways, mechanisms, and significance for global change

*Introduction (Metcalfe, 2011):* A big topic right now in research is how climate change is affecting the environment and more specifically the ecological factors of an ecosystem. This article is a review of how plant communities affect soil CO2 efflux (R). Many of the articles aren’t specifically studies of plant communities but still have information that can be applied. This will highlight future research that is needed to build and effective model for carbon cycling. Three topics are discussed in this article: plant traits, plant invasions and range expansion, and plant diversity.

*Plant traits and soil respiration (Metcalfe, 2011):*

1. *Effects on aboveground litter quantity and quality:* Fast growing plants allocate resources as efficiently as possible. They produce more litter, have more nitrogen, and have less carbon in the nitrogen carbon ratio. Because of this ratio, the plants are broken down fast and have a high respiration rate. At a large scale, the relationship between (R) and plant productivity in biomes is positive but this isn’t always the case at smaller scales. This relationship has implications on climate change. Rising CO2 levels and N deposition increases plant productivity. Higher plant productivity will facilitate the growth of fast growing plant populations. The quick decomposition and increased respiration could cause greater effects on climate change. Keeping this in mind, different species were tested for decomposition rates to account for the differences in (R) in biomes. However, the decomposition rates of species was not significant in accounting for the differences in respiration between biomes. Herbivores and macrofauna can affect (R) of an area through excretion, mixing, and breaking up litter, both increasing (R) and incorporating litter into soil quacking resulting in higher productivity.
2. *Effects on plant allocation belowground:* As the age and size of a plant increases, the rate of photosynthesis and TBCF (total belowground carbon flux) decreases. However, as a site becomes more fertile or the amount of water is increased, photosynthesis increases as TBCF decreases. The TBCF differs greatly between species of plant and the anatomy and physiology of the particular plants. Therefore, a shift in the plant community due to climate change (such as rainforest to savanna) can have a significant impact on (R). In cold areas the TBCF is contributed to mycorrhizae which aren’t broken down as easily. The type of mycorrhizae can differentiate the two kinds of plants. Similarly, root herbivores prefer conditions that correlate more closely with fast growing plants. These herbivores can speed up the process of decomposition, increasing respiration for the soil food web.
3. *Effects on microclimate and soil structure:* The physical environment plays a large role in (R) as well because the conditions for microbial activity can be optimized at certain temperatures and moisture levels. An example is in the rainforest. The canopies can let in only low amounts of light causing the ground to be cooler and moister. This can also cause CO2 to build up.

*Plant invasions and range expansions (Metcalfe, 2011):* One species can play a huge role in an ecosystem’s (R) rate. When plants are invasive, their productivity increases, greatly increasing (R). When those invasive plants are removed, productivity, litterfall, and (R) all decrease. In the case of fire, invaders (either trees in grassland, or grasses in woodlands) can increase the chance of fires.

*Plant species and diversity (Metcalfe, 2011):* With diversity consistently decreasing, scientists are given the opportunity to study the effect less diversity has on an ecosystem. However, many of these projects aren’t showing much in regards to (R). However, single species-based projects are showing results. Researchers are concluding that the species make-up (or dominant species type) is the driver of (R) and diversity is secondary and with special circumstances.

*Towards model integration of species effects (Metcalfe, 2011):*

1. *Modeling plant trait effects:* Many of the models take all fundamental aspects of plant traits into account but fail to recognize complexities. Examples of this complexities include a plant’s acclimation to temperature change and microbes’ acclimation and rate of decomposition in warmer climates. Furthermore, many models take biotic factors into account but fail to include circulation of CO2. This gives inaccurate estimates of carbon cycling.
2. *Modeling effects of plant invasions and diversity:* Few models take into account the increased productivity of invasive plants as compared to native plants. The quick solution would be to place invasive plants in their own functional types. However, more functional types increase the likelihood that the model will sow faster growing plants outcompeting slower growing plants. There are still many issues to work out with carbon cycling models.

*Conclusion (Metcalfe, 2011):* (R) can be affected by a large range of factors. There are still many areas of research that need to be explored.

-How underground carbon is distributed among the roots, fungi, and microbes. Each has a different rate of respiration.

-The link between plants and the ecosystem. How do environmental changes effect plants and vice versa?

-Biotic interactions such as fire or other disturbances and their effect on CO2 emmissions.

-How invasive species or the extinction of species effect the ecosystem and more specifically (R).

-Creating models that are broader spatially and in time scales. This will involve understanding seasonal variation