**Notes on use of detrended LRR**

* LRR may not work well for data with high variance – likely due to the fact that the LRR with a positive control response ratio dampens the overall effect.
  + Subtracting correction from both sides of response (LRR\_N – LRR\_Control x LRR\_P – LRR\_Control) appears to constrain the relationship to a 1-1 line, even if there is no temporal trend, but just random noise.
  + Have looked at the math (very surface-level) to understand why this might be the case, but it’s challenging to work through – log of a ratio of random variables seems to be a pain to deal with for any kind of closed-form expression. If we wanted to explore this response in more detail, I think we’d need to conduct a simulation study.

**The “signal” of a trade-off**

* Whether using the PerMANOVA approach to answer this question or some variety of a log-response ratio, I think it might be good to take a step back and evaluate what the signal of a tradeoff might be.
* As of now, we’ve been focusing on looking for positively correlated / negatively correlated species responses to nutrient enrichment at the community scale. Positively correlated responses indicate that there is no tradeoff in nutrient enrichment, negatively correlated responses indicate that there is.
* While in theory the single tradeoff axis makes sense, I think it’s important to remember that this change is realized in a community context, rather than on a species basis. I don’t think we’re interpreting the results of a tradeoff in species resource use directly, but rather, what communities look like after species interactions have played out under different nutrient supply levels.
* While species themselves may exist on a set of resource use tradeoff axes, I don’t think we should expect to see the negatively sloped, linear relationship we have been looking for. A consistent, negatively sloped relationship can only really occur when there is a nutrient use tradeoff that results in inverted species responses to different nutrient addition; i.e. all species that respond positively to nitrogen enrichment respond negatively to phosphorous, with relatively similar magnitudes.
* However, we know that nutrient addition causes decreases in species richness / reduction in SAD evenness. While it’s possible that the species which are lost under N enrichment are entirely different than those lost under P enrichment, I think this is unlikely. Instead, I would predict that we see a lot of similar species being lost, with a shift in what becomes dominant
* If this is the case, I think what we should really be looking for is a “diamond” pattern of species responses to different nutrient addition treatments. When comparing two different nutrient addition treatments, I think we can divide species responses into 4 main categories:
  + **Uniform decreasers:** With most fertilization treatments, nutrient enrichment reduces plant diversity – increasing the abundance of a few species comes at the expense of the many. These are the many. Whether these species are better colonizers, rely on temporal mechanisms of coexistence, etc., a majority of species responses to nutrient enrichment should be negative, regardless of nutrient identity.
  + **Uniform increasers:** Species that increase in response to both added nutrients. Can occur in situations where there are too few species to produce a consistent tradeoff, multiple nutrient limitation of a dominant species, etc.
  + **Conditional increasers:** *These* are the species that I think are most interesting. If there are nutrient use tradeoffs, this is the primary axis on which they will be distributed, and is particularly relevant to our desire to understand how multiple nutrient limitation controls patterns of diversity loss.
* **The broader the “width” of the diamond, the greater influence we see of these conditional increasers.**



**How would we quantify?**

I think there are a number of different ways in which we could quantify this tradeoff, some which are more individually-focused versus more community focused. I think both are valid, and together provide a bit of a hybrid between some of the methods we initially discussed and those that were a focus during the Nutrient Network meeting.

I would argue that we really need both a community-level focus, and to delve into the individual-level data to understand what is going on.

At the community scale:

* If the sets of species that change in response to nutrient enrichment are distinct between treatment types, and species respond positively to both treatments, we should see:
  + Significant compositional differences in both treatment 1 and treatment 2
  + Vectors of compositional change that are not significantly correlated
    - Measure multivariate angle of change between communities?

At the individual scale, provided we see these differences, we could then ask what species are driving this relationship, i.e.:

* What species fall along the major tradeoff axis? What species show the highest affinity towards N treatments vs. P treatments? If we were to project species responses to the trade-off surface, where would they lie?
  + What species have the highest P-affinities? N-affinities? K-affinities?
  + Other ways to measure this? Indicator species analysis?
* Would be able to use existing code from PerMANOVA / LRR analysis.

