ch 3 - Empirical abundance distributions are more uneven than expected given their statistical baseline.

segue

Okay, so having dealt with things in a granular, mechanistic way, and taking a continental-scale look at ~~community~~ patterns biodiversity trends, we're now going to step into a somewhat wilder conceptual space and ~~start asking~~ get curious about what ~~all these~~ these kinds of ecological "patterns" are really telling us about ecology.

Define CS

To do this, we need to embrace a perspective that treats ecological systems as complex systems ~~akin~~ analogous to ~~the~~ systems in economics or physics, ~~etc~~ (just as examples). Specifically, by this we mean that ecological systems are made up of lots of subcomponents — individual organisms, species, etc — that interact through numerous pathways (predation, compet. etc.) often in ~~nonlinear~~ context dependent and nonlinear ways. This complexity can be a bit of a curse, in that it can make it overwhelmingly difficult to predict ~~in~~ specific details about ecological communities.

CS: emergent regularity

However, it can also be a source of leverage. ~~Because complex systems~~ The crux of complex~~ity~~ systems thinking is that ~~many~~ apparently highly complex systems often exhibit strikingly consistent emergent properties, ~~which can provide clues about the strong processes at play in a system~~ if we ~~step away~~ zoom out slightly and look at aggregate properties.

SADs: J-shaped = law ~~SAD~~

Probably the most compelling ~~example~~ instance of this in community ecology is the species abundance distribution, or SAD. The SAD is the frequency distribution of species' abundances in a community - 1 species w/ 10 individuals, 1 with 5, and so forth. When plotted as a rank-abundance curve, w/ rank on the x axis and abundance on the y, the SAD almost always shows a j-shaped, or "hollow curve", form, with a few very abundant species and a larger number of rare ones. Ecologists have been paying attention to this for generations; a J-shaped SAD is one of the most consistent phenomena in ecology and may be the closest thing to an ~~e~~ ecological "law."

ideally dodge McGill 2007 cul de sac, go → → → to stat. baseline....

math-bio interplay

So the SAD seems like a promising place to start if we want to use ~~[illegible]~~ emergent patterns in ecology to understand general ~~generative~~ processes shaping community structure. To do this, we ~~[illegible]~~ need to take another ~~a~~ lesson from complex systems science more widely and recognize that ~~the~~ emergent phenomena, like a J shaped SAD, derive from a combination of ubiquitous mathematical ~~constraints on the behavior of~~ or statistical constraints, and potentially more ~~specif~~ system-specific processes, for example competition or disturbance in an ecological context. To capture the signal of these sorts of ecological contributions to patterns like the SAD, we need to control or account for the statistical processes that also operate on these distributions ~~patterns~~.

~~[illegible] statistical distributions [illegible]~~

random expectation

Fortunately complex systems ~~[illegible]~~ scientists in other fields, and particularly statistical mechanics, have provided us with the conceptual tools for ~~[illegible]~~ this task. The key observation is that, ~~if~~ when we have many parts and many processes at play in a system, if no single process dominates the overall signal, ~~the emergent~~ numerous ~~relat~~ relatively weak processes will smooth or cancel each other out and produce emergent outcomes that look very similar to what would occur entirely at random. ~~with no strong~~ (You can think of this as similar to how normal distributions emerge through the central limit theorem — except depending on our system we ~~d~~ might expect some pattern other than the ~~b~~ normal to emerge.) ~~So~~ As a baseline, or a sort of null model, we expect the emergent properties of an ecological system to align with ~~the~~ ~~our~~ a ~~[illegible]~~ statistically determined random expectation. As it turns out, in the case of the SAD, the expectation is a J shape.

unf?

disruption

However, if there is an additional strong process at play — for example an ecological phenomenon like a disturbance event or niche dynamics — it may disrupt the statistically-determined pattern

Dev. cont'd.

and introduce deviations, even subtle ones, between what we observe in nature and what we would expect to see just due to ~~the statistical~~ mathematical constraints. These deviations ~~[illegible]~~ can ~~a~~ provide greater diagnostic power for ~~in~~ detecting ecological processes that contribute to phenomena like the J-shaped SAD. For example, if empirical SADs are consistently ~~[illegible]~~ more uneven than the ~~[illegible]~~ forms we'd expect to see at random, this may signal that dominating ecological processes promote ~~[illegible]~~ high unevenness; and we can evaluate potential theories based not just on how well they predict the overall J shape, but on how well they predict the deviations, which we take to be the specifically biological signal in this pattern.

Inference

~~Previous th~~

~~Previous work has shown~~

~~Previous work has shown that SADs are strongly affected by statistical constraints, for which that can & realistically [illegible] form is also the null expectation [illegible], but that empirical~~

To use deviations in this way in ecology, we need to develop ways to quantify them, and establish how widespread they are in empirical systems. To quantify deviations, we need a way to characterize the random expectation for the SAD, and measure how ~~[illegible]~~ unusual an empirical observation is compared to that expectation. And then we'd like to do this for a vast array of ecological systems to establish general ~~[illegible]~~ themes.

Gap-ish!!

Here, we combine combinatorics with ~~more traditional [illegible]~~ ecological summary metrics & a lot of data to quantify the prevalence and nature of deviations, ~~[illegible]~~ and explore how this varies ~~[illegible]~~ across broad gradients of system.

How we. Trash.