Ch. 1 - Maintenance of community form through compensation breaks down over time in a desert rodent community.

segue

For the first chapters, we'll be taking a deep experimental, natural-history informed look at how ~~changes in species composition, the size structures, the competitive dynamics, species interactions, and~~ environmental ~~factors~~ modulate how ~~ecological communities~~ community-level properties respond to perturbations, and how and why these ~~changes in~~ responses change over time. This work is currently in rev. @ Ecol. preprint ↓ code: X

motivate from perturbation

As a field, ecology is v. ~~specifically, we're~~ interested in how community function ~~is~~ - such as the total biomass produced in a system, or the total amount of food resources ~~energy~~ being processed by a group of organisms as metabolic flux - will respond to the types of perturbations ~~we often see in~~ we often see in community dynamics, such as species loss, ~~changing species~~ species ~~or~~ mass mortality events, or climate change, ~~interactions, or shifts in environment~~. These are both questions about basic ecology, and about how we expect ecological systems to respond to global change ~~driver~~ in the Anthropocene.

how we #1

Here, we'll ~~use classic experimental food web systems~~ to focus on how community function is affected by the loss of ecologically significant species, and how this response changes over long periods of time. ~~How to changes in biodiversity species~~

Generally when species are lost from a community, whatever contributions they made to overall community function - their biomass, or their resource uptake - is also lost. So species loss, on its own, should automatically result in a decline in function. However, ~~if there are species~~ species ~~emerging in the community that are able to perform the same functions as the species that were lost, we see a phenomenon called compensation or compensatory dynamics~~, function may be

resilient to species loss if there are other species still present in the community that are able to "take up the slack" or compensate for the decline in function that was caused directly due to species loss. When we're talking about function measured in terms of resource use or standing biomass, this means that there are species remaining in the system that are able to exploit the resources that were made available due to the loss of some species. Once the original species are gone, those remaining species may increase in abundance to take advantage of these resources, and restore community-level function, in terms of biomass or energy use, to match what it was before those species were lost. This is called compensatory dynamics or compensation.

Compensation

One way for compensation to occur is for all species are identical, capable of using all the same resources equally well under whatever contexts — this is a scenario we refer to as complete "niche neutrality", and it is perhaps most strongly associated with theoretical dynamics. Or, compensation can occur in a niche structured system through what's called "functional redundancy." Functional redundancy is when there are subsets of species in a community that may not be identical in every respect, but share similar enough traits and environmental requirements that they can perform similar functions under some conditions.

FR

When we see compensation achieved through functional redundancy it's contingent on a few things. First, the right species, with the right traits, have to be present in the system. Second, they have to be capable of performing similar functions under the

interact dep.

contingency

particular set of environmental conditions being experienced in that system at that time. This is esp. relevant! because functionally redundant species within the assemblage are likely to be competitors, and one of the ways we see similar but nonidentical competitors coexist is for them to respond differently under different conditions.

Temporal dimension

Both of these contingencies in compensation through functional redundancy introduce an important temporal dimension to compensation. As the set of species over time, we can see the set of species available in an assemblage change due to colonization from the regional metacommunity. We can also see temporal fluctuations in environmental conditions modulate the amount of functional redundancy between similar, but not identical, competitors.

long term experiments

So there is solid theoretical logic for the expectation that the extent to which community function is robust to species loss should be context dependent and change over time, through either changes in species composition or through changes in the competitive dynamic within the same set of species. However, it's very difficult to evaluate these effects empirically, because observational data don't provide enough information to detect compensation & attribute it to specific processes. Experiments can give us that information, but experiments are time and labor intensive, and a short term (3-5 yr) experiment can't give us the temporal breadth to watch these dynamics change. So this is a moment where we're really looking for long-term experimental evidence to tell us how the response of community traits to species loss has changed over time and provide clues as to why it's changed that way.

Here we turn to the Portal Project
long term manip. of diverse rodents to study how community function responds to the loss of key species, kangaroo rats.

System of experimental plots. "Controls" w/ KR; "Excl" from which KR removed. Rodents censused monthly & trapped.
Compare fxn in EE v CC to see how KR removal affects it.
Long term (40 yr) monitoring reveals how these responses have Δ'd due to different types of Δs to community dynamics.

This site has experienced major transitions in rodent community composition & habitat over the years, w/ potential to affect compensation. Specifically, rodent community shifts ~1996, 2015; long term grass → shrub
~~[illegible]~~

We use the TS of the PP to examine ~~specifically~~ how these Δs modulate the ~~of~~ impact ~~resp~~ of spp. loss on fxn.

Stat. methods:
break TS into chunks
Calculate TER, compensation, PB, dipo
Compare time periods using GLS / autocorr.

Repeated shifts in TER response and impersation.

1st is PB arrival

2nd is PB decline

Repeated shifts in TER response and impairation.

1st is PB arrival

2nd is PB decline

RESULTS

1) 1996 shift:
   clear & compelling colonization

2) 2010 shift:
   sharp decline in compensation & TER
   assoc. w/ PB ↓.

Contrast

PB still present, so not avail.

Suggest Δ conditions.

3) Simultaneously, we find that —
   while compensation has reverted to pre-PB levels, TER has not.
   → Role for niche complimentarity.

DISCUSSION / WRAP UP

1) contingent over time, Δ spp & conditions
2) long term perspective — ~~degrees~~ sensitivity of community properties to species loss, modulated by metacommunity & environment; ~~boosts~~
3) increasingly contingent when we start thinking about global Δ.