Background – key concepts

* Energetic compensation
  + Defined
  + Zero-sum dynamics
  + Niche and neutral
  + Functional redundancy leading to resilience
* Temporal shifts in species overlap
* Limiting similarity

Background – Portal history

* Portal is one of the most compelling empirical examples of EC
  + Low energetic compensation at the beginning of the study
  + Establishment of PB in 1996 leading to high EC
* Gradual and abrupt shifts in habitat and the rodent community
  + Multiple droughts and floods
  + From the 1970s to the 1990s, a transition from grassland to shrubland
    - Referenced in Thibault et al 2010 Redundant; Ernest et al 2008 Zero-sum, …
    - From Zero-sum: “the threefold increase in shrub density since 1977 resulted in a dramatic transition from open desert grassland to a mixture of grasses and shrubs, as well as dramatic changes in the composition of the rodent community. Several species abundant at the beginning of the study became either extinct or very rare, while other species colonized and/or increased dramatically in abundance (Valone et al 1995, Brown et al 1997, Thibault et al 2004)…Grassland-affiliated species declined significantly over time, whereas shrubland-affiliated species increased dramatically”.
    - Brown et al 1997 Reorganization of an arid ecosystem in response to recent climate change.
    - Valone et al 1995 Catastrophic decline of a desert rodent, DS: insights from a long-term study
    - Thibault et al 2004 Temporal dynamics in the structure and composition of a desert rodent community
  + Increase in small granivore proportional abundance/decline in kangaroo rat dominance
    - Described in Thibault et al 2010 Redundant; slightly predates PB arrival
    - Linked to grassland 🡪 shrubland transition, see above
    - Not just DS
  + Abrupt transitions in the rodent community composition
    - Changepoints: Decline of DS, gradual rise of small granivores, arrival of PB, decline of PB
    - Abrupt transitions might reflect delayed niche tracking triggered by low abundance
* The most recent set of changes
  + A precipitous decline in PB
  + Possibly triggered by the drought in 2010
  + Curiously, our data streams do not show an obvious habitat shift preceding the crash (except for the drought)
    - Shrub cover (either ~anecdotally~ or from transect data)
    - Precipitation anomaly
    - Mean, max, min temp anomalies
    - NDVI
    - Tend to show changes in the mid-1990s (if at all), but not in the 2000s.
    - Other ideas:
      * Precip variability
      * Regional-level climate change (would be documented external to our data streams)
      * Veg community composition
        + Seed size (following Valone – may not be possible)
        + Erodium?
        + Some kind of dimensionality reduction x clustering

Questions

* How has community composition of energy flux on the controls **and exclosures** changed following the 2010 drought?
* How has EC changed following the 2010 drought and decline of PB?
  + 1. Declines to pre-1996 levels
  + 2. Possibly buoyed by the habitat shift increasing their potential overlap with krats, other species of small granivore take over for PB
  + 3. Maybe the habitat shift *decreased* the overlap between smaller granivores and krats, and there is a decrease in compensation even compared to pre-1996
* How has the net effect of krat removal changed following the 2010 drought?
  + This is distinct from compensation because of shifting baselines across both control and exclosure plots

Answers to the questions

* PB has declined on all plots, but more so on controls. It is still present on exclosures.
* EC on exclosures has declined to comparable to pre-1996.
* The total energy use discrepancy is smaller, because Dipo is using less energy in general on controls.

Discussion nucleation points

Tight to the results:

* The shrubland shift doesn’t appear to have increased the capacity of other small granivores to exploit krat resources.
* EC is therefore pretty much fully contingent on PB’s arrival and persistence at the site as a dominant species.

Less tight:

* **It is not immediately obvious why PB declined**
* Presumably some combination of habitat changes modulating the competitive dynamic between PB, Dipo, and probably to a lesser extent, PP.
  + PB declined the most sharply on control plots: competes with krats
  + PB-krat turnover (referenced in Ernest and Brown 2001) in slightly different habitat types: PB may have slightly different environmental optima. If the site has moved away from those optima, PB might be unable to compete with krats, and less dominant even when it doesn’t have to compete with krats.
  + Declines on exclosures may be exacerbated by the exclosures being small islands of no-krat in a sea of krat. However, this isn’t sufficient to explain why they couldn’t come up from zero now, when they could before.
* **Something changed, that affected PB more than any of the other major long-term species.** 
  + It wasn’t the absolute amount of resources available to PB. Some other aspect of the niche got hit. I think.

Speculative but grounded:

* PB is the least core of major Portal core species.
* PB overlaps a lot with krats.

The widest of implications:

* EC is definitely (here) contingent on niche structure and sensitive to changing conditions that impact certain species.
* If there is a connection between PB being a krat ~substitute~, and PB being unable to persist at the site post-2010, that could mean that EC/functional compensation via colonization is inherently fragile.