

Trieste, 2022

Understanding the Human Place in Ecosystems from the Archaeological Record

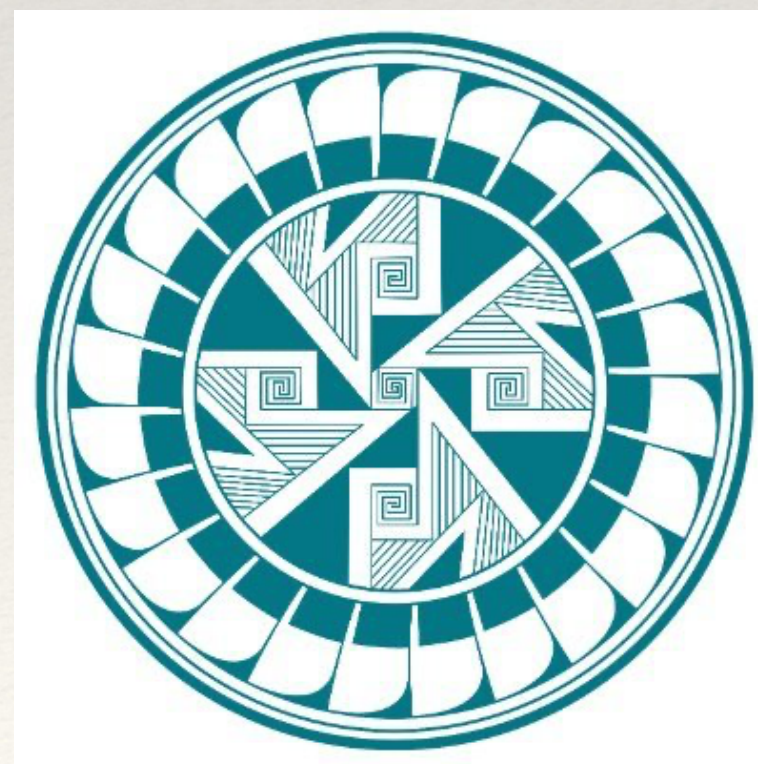
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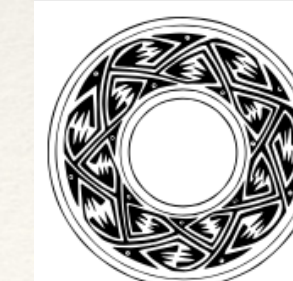
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AUSTRALIAN RESEARCH COUNCIL
**Centre of Excellence for Australian
Biodiversity and Heritage**



THE
RESEARCH INSTITUTE AT
(ROW) (ANYON)



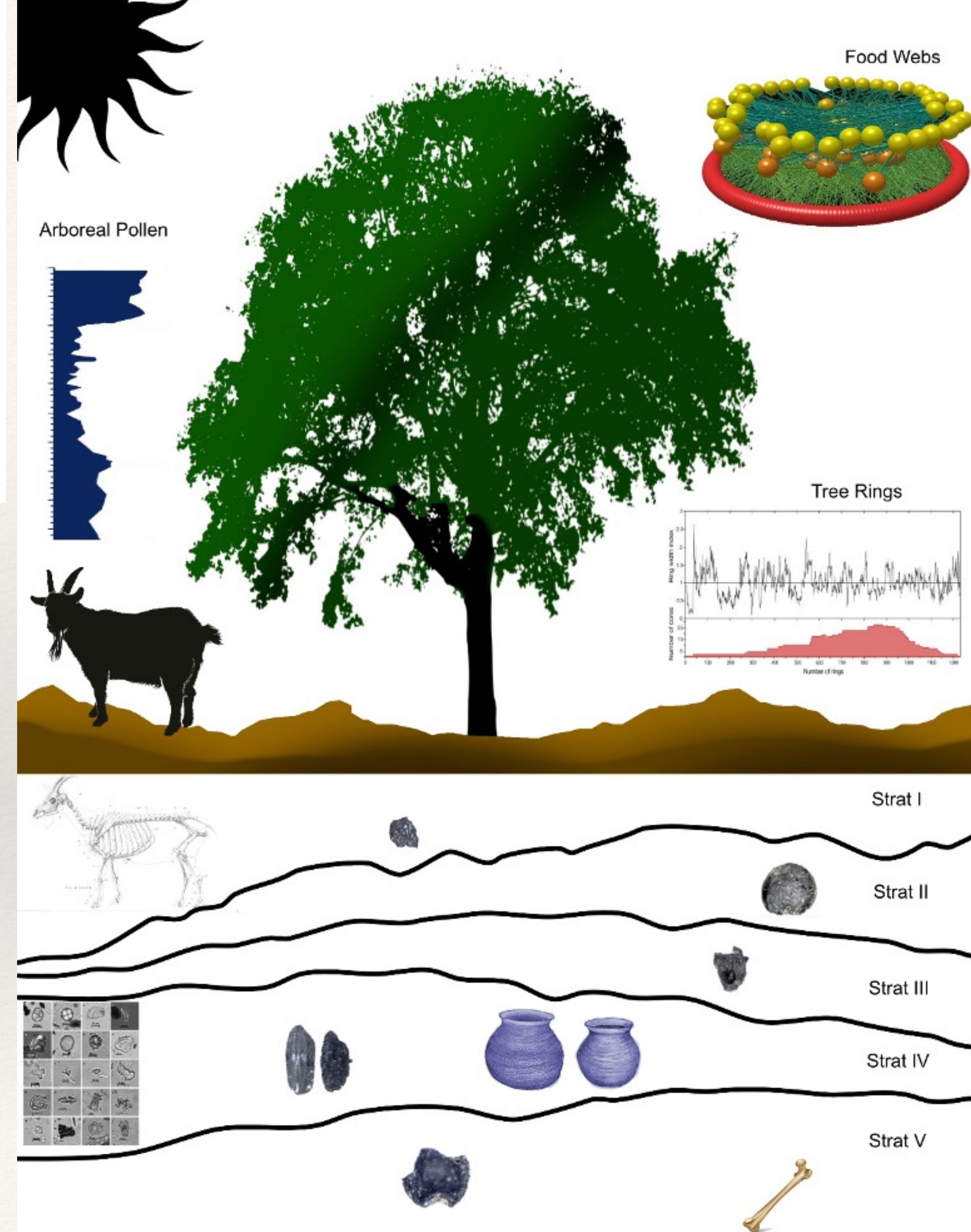
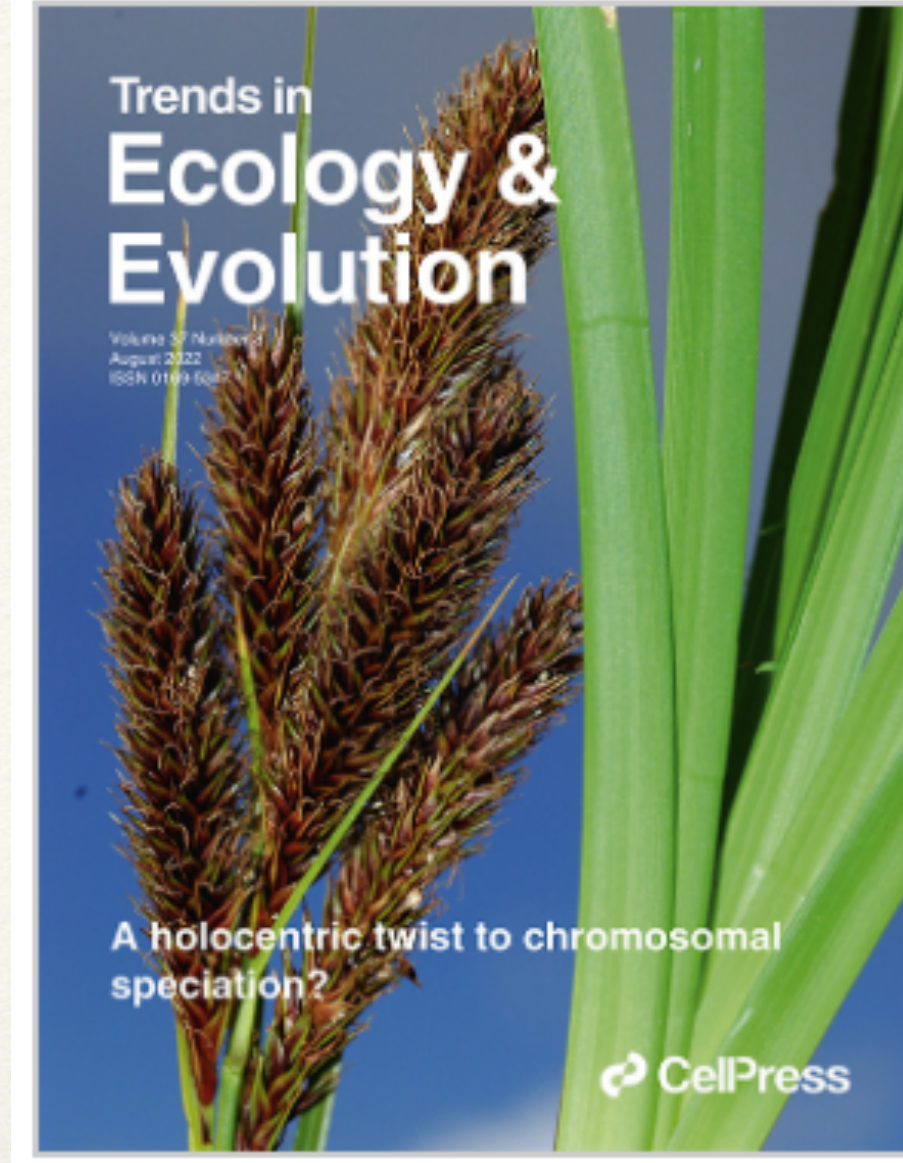
Qui suis-je?

- ❖ Ph.D. in Anthropology (Washington State University) and Ph.D. in Environmental Science (Université de Franche-Comté)
- ❖ Combine fieldwork (ethnographic and archaeology) with computational modeling and analysis
- ❖ Currently prof of social-environmental modeling in Department of Environment and Society at Utah State University and Fellow at Santa Fe Institute

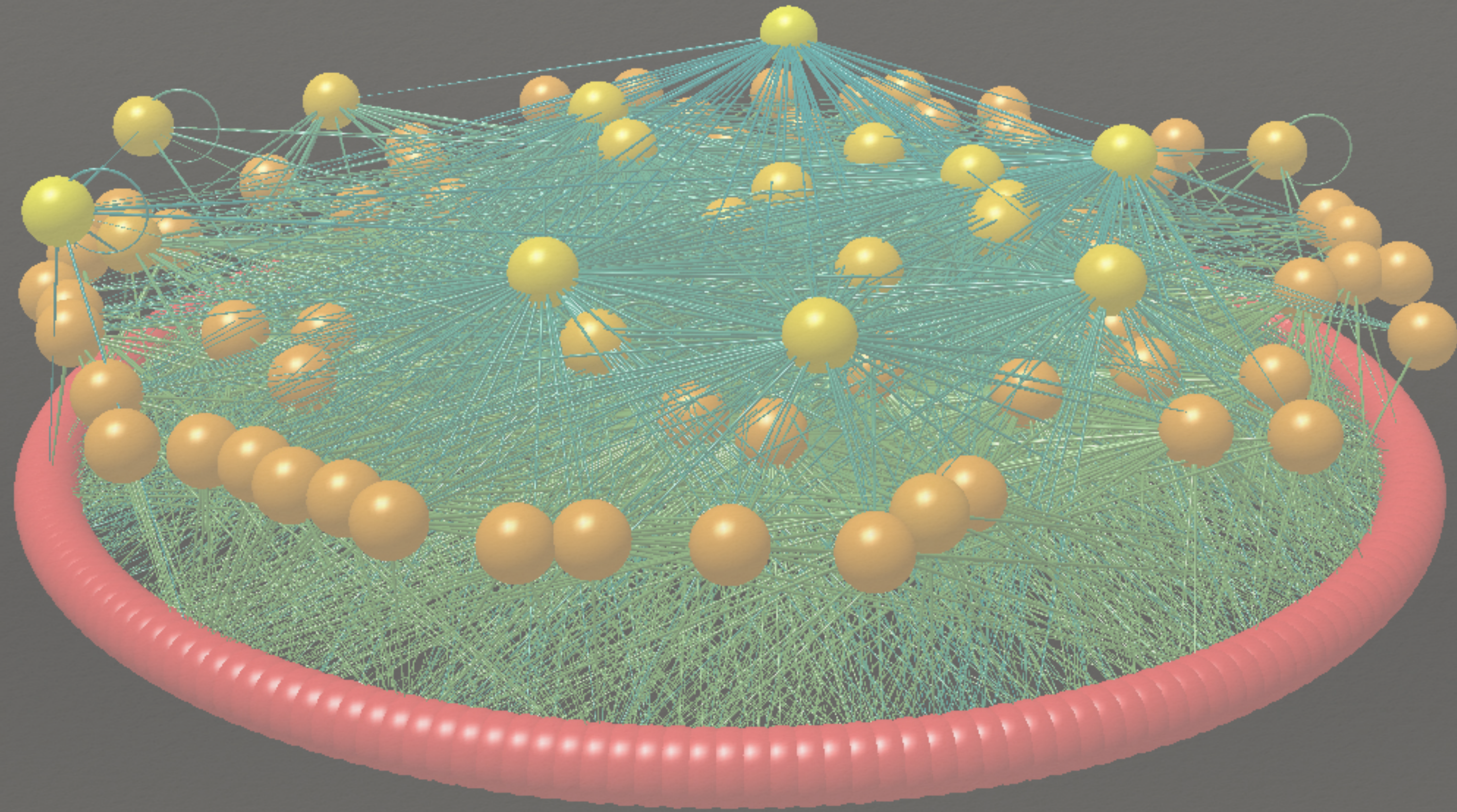


Towards a Science of Archaeoecology

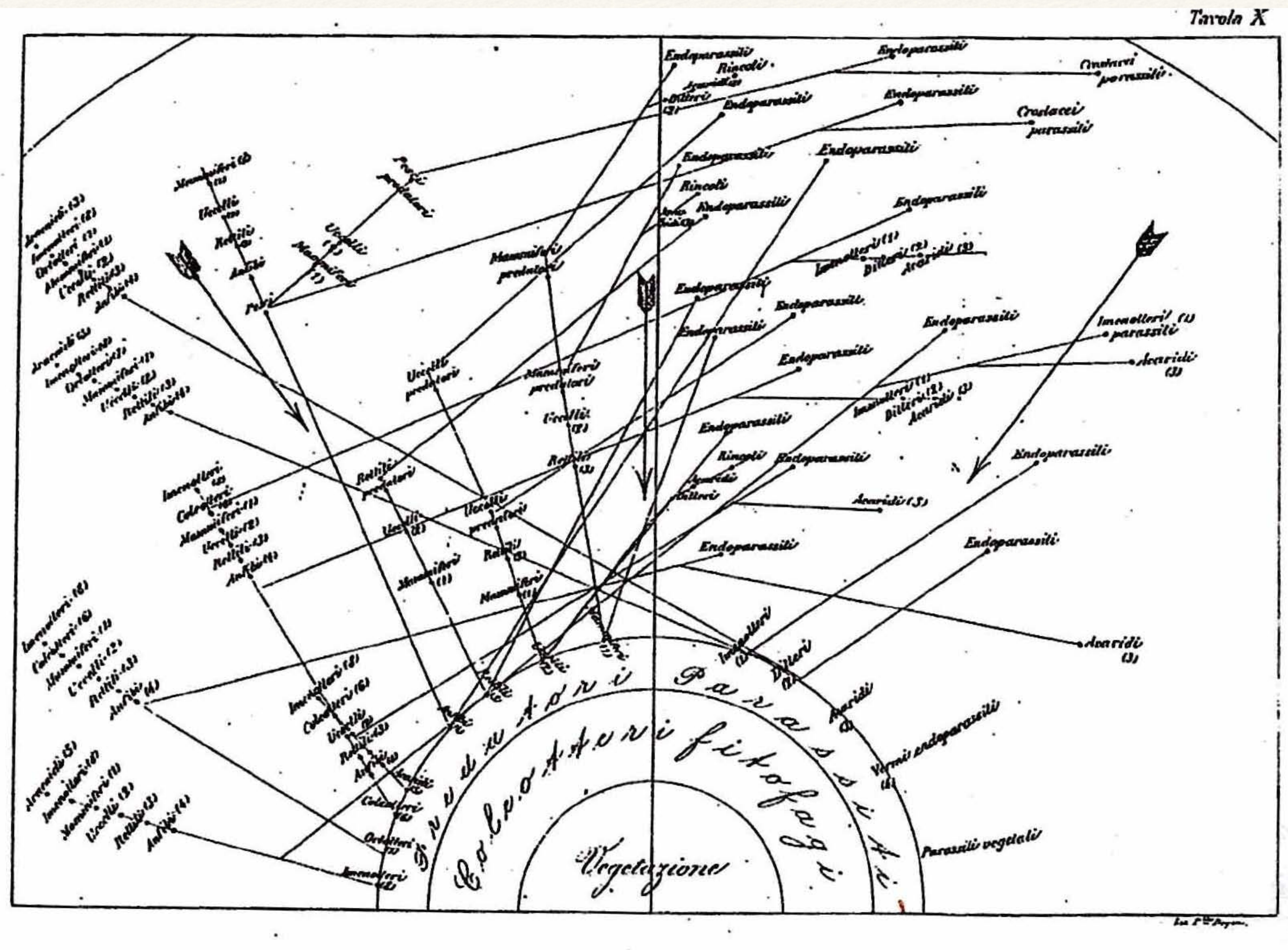
- ❖ Forthcoming paper in Trends in Ecology and Evolution proposes the field of Archaeoecology
- ❖ Combining archaeology with ecological and paleoecological approaches
- ❖ Archaeoecology can help us look at completed experiments with sustainability in the past



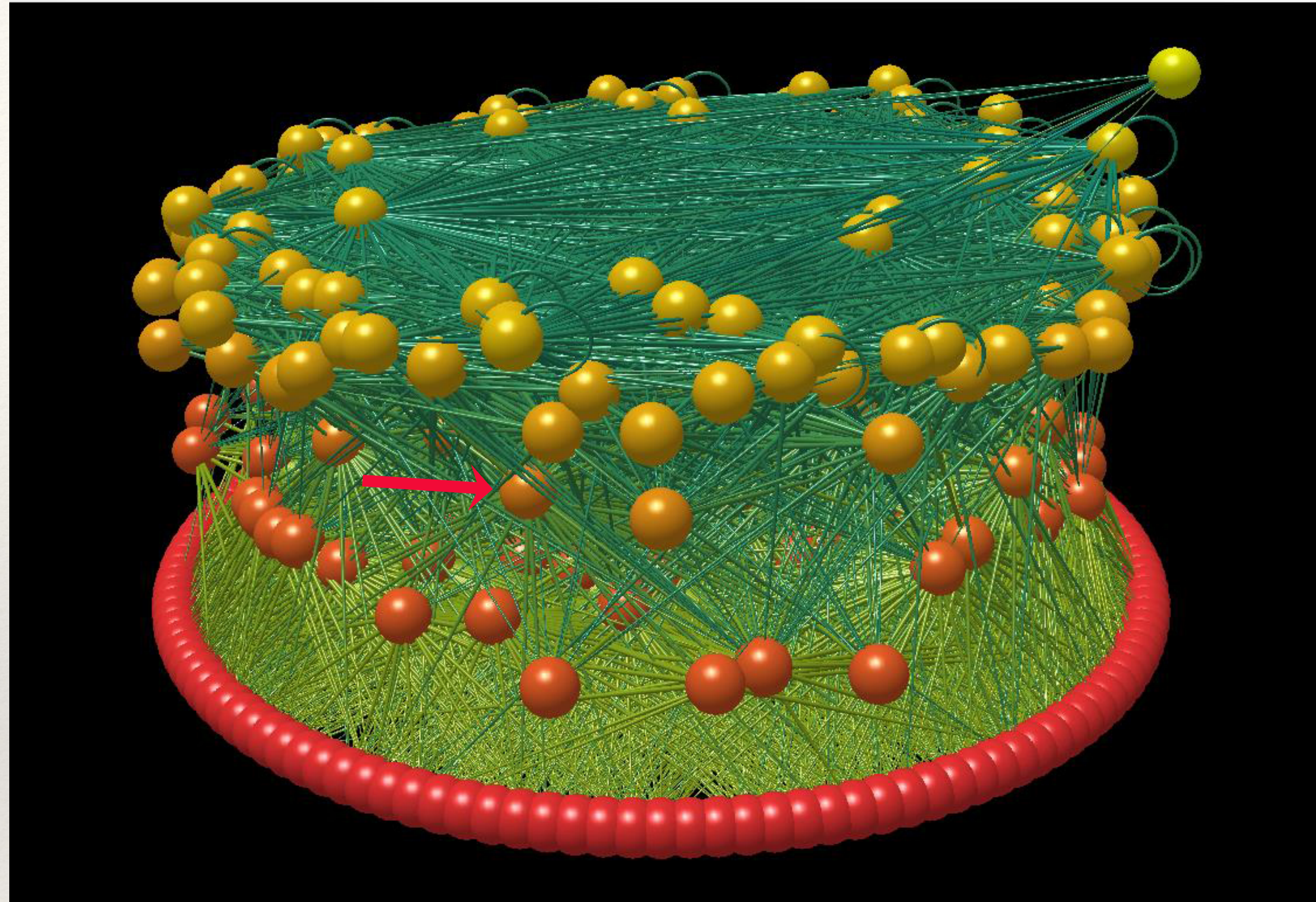
Humans in Food Webs



THE FIRST FOOD WEB



A MODERN FOOD WEB

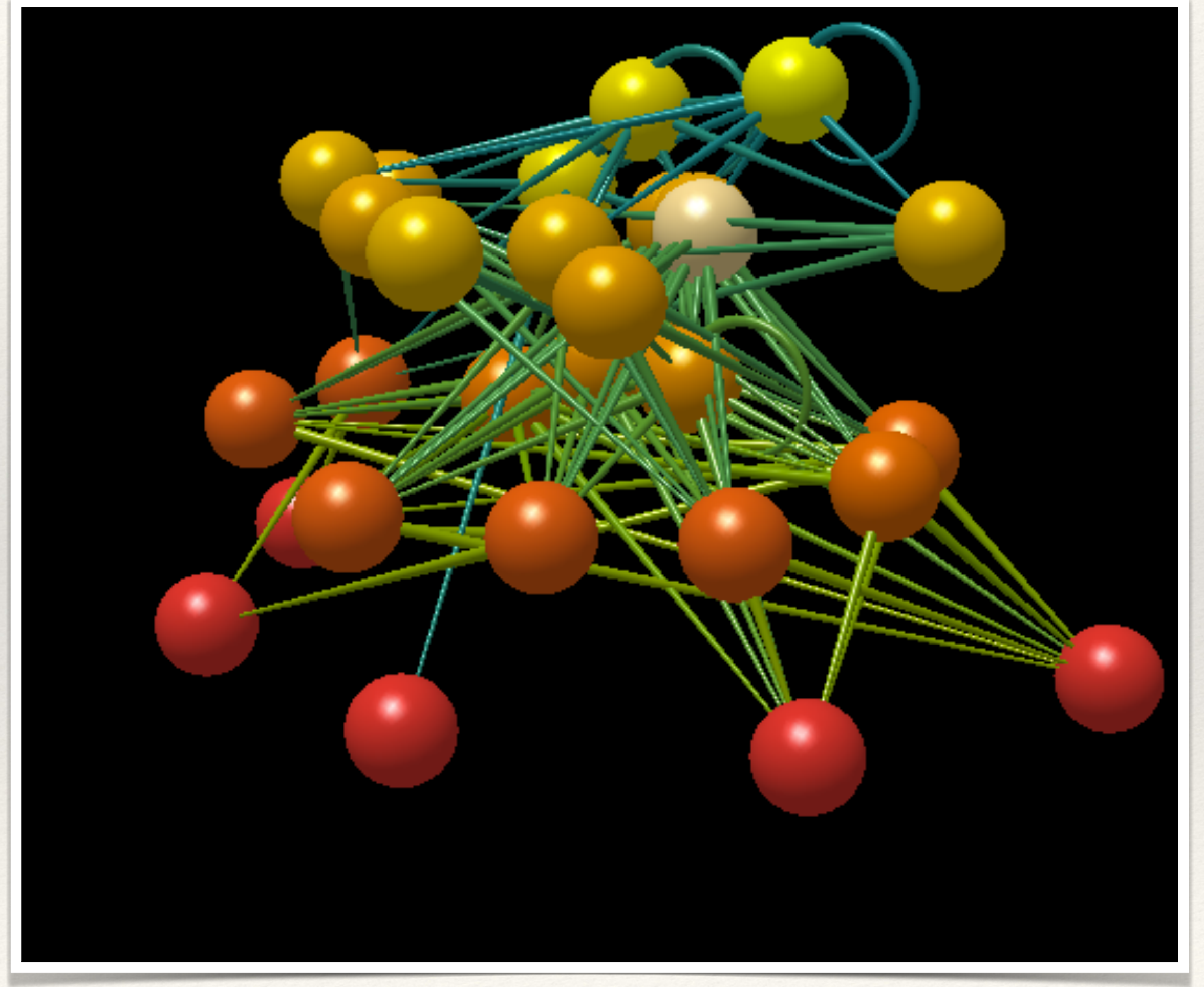


Lorenzo Camerano, 1880
 “On the equilibrium of living beings by means of reciprocal destruction”
 “Dell'equilibrio dei viventi mercede' la reciproca distruzione”

Stefani Crabtree, 2017

Humans in Food Webs

- ❖ If food webs can tell us the structure of an ecosystem, why not include humans?
- ❖ We know we can exert large pressures on an ecosystem
- ❖ Could we see these archaeologically to understand when ecosystems with humans are stable and when they unravel?



Food Webs of People

- ❖ How I built these food webs
 - ❖ Begin with the human aspect—interviews with elders, follow studies, ethnographies to get idea of what people ate
 - ❖ Compile known taxa radiating out from the human portion
 - ❖ Connect to every taxa I can identify in the study areas



Online Field Guide to The Reptiles and Amphibians of Arizona

REPTILES and AMPHIBIANS of ARIZONA



Choose an Archaeology
Program

Travel with
Us

Site Reports & Databases

Publishing the results of our fieldwork and laboratory analyses is fundamental to meeting our professional and ethical obligations as archaeologists (see [Archaeological Ethics and Law](#)).



National Park Service

Find a Park

Discover History ▾

Explore Nature ▾

Get Involved ▾

Mesa Verde

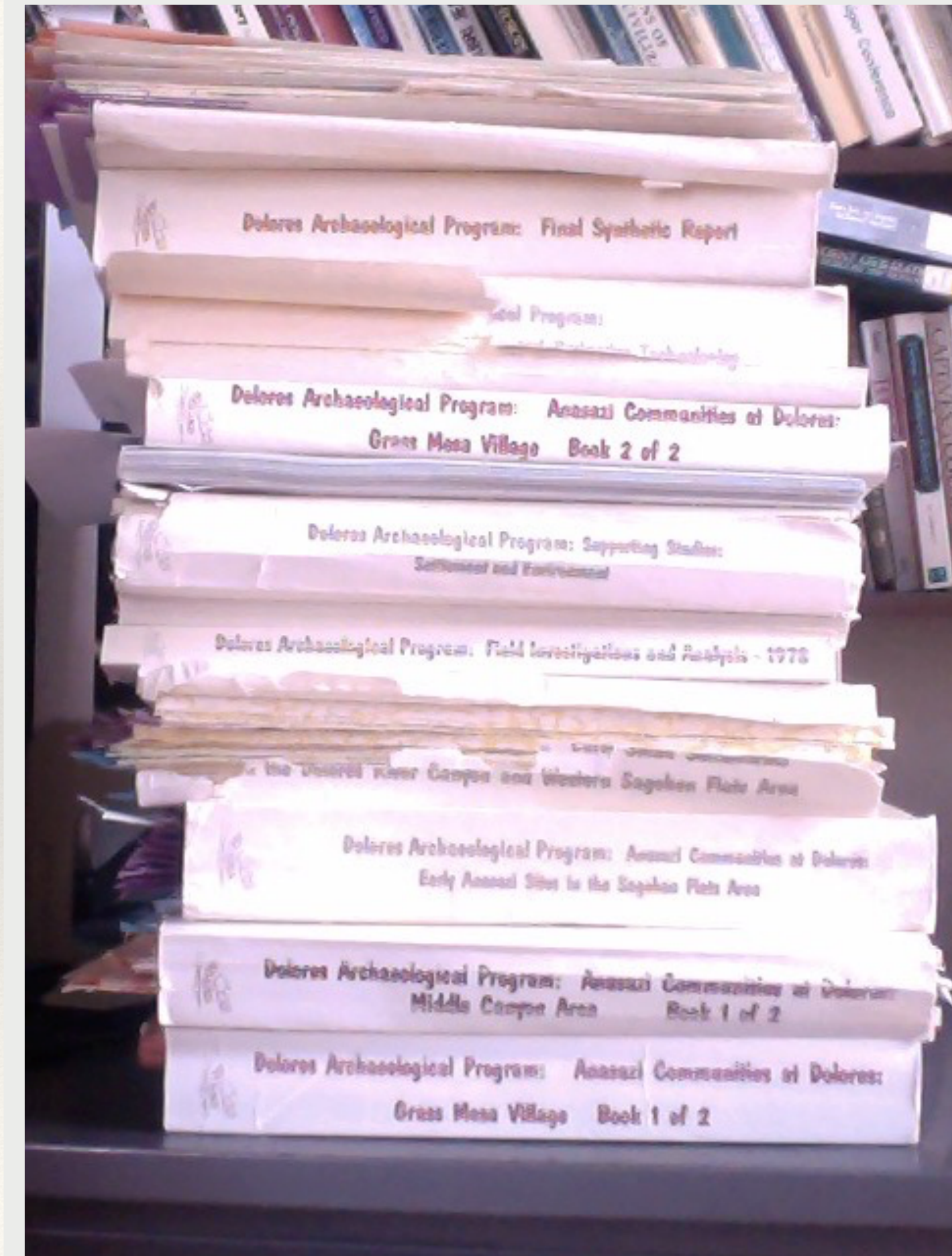
National Park
Colorado

Explore This Park

Park Home

Plan Your Visit

Animals



American Southwest



Western Desert of Australia



American Southwest



Western Desert of Australia



The Martu

- ❖ Until 1964 Indigenous Martu lived a traditional existence in the Western Desert of Australia
- ❖ In 1964 the government removed them to cattle stations and missions
- ❖ Between the 1960s and the 1980s several animals went extinct



Mala, the rufous hare-wallaby (*Lagorchestes hirsutus*), formerly ubiquitous across the arid zone, extinct on the mainland by 1970's.

The Martu



Food Webs of Martu

- ❖ Paradoxically, it seems *people* were keeping animals in this vulnerable region alive
- ❖ People in Australia since ~60kya, in Western Desert since ~30kya
- ❖ Long-term coevolution between people and ecosystems

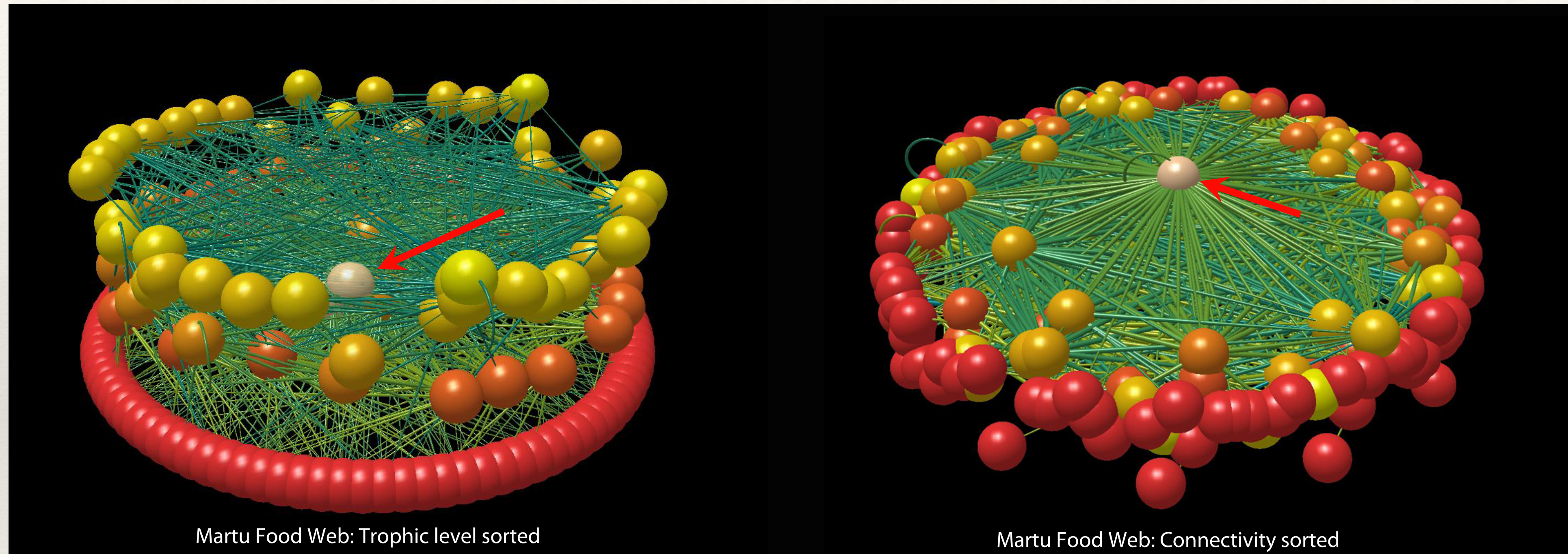


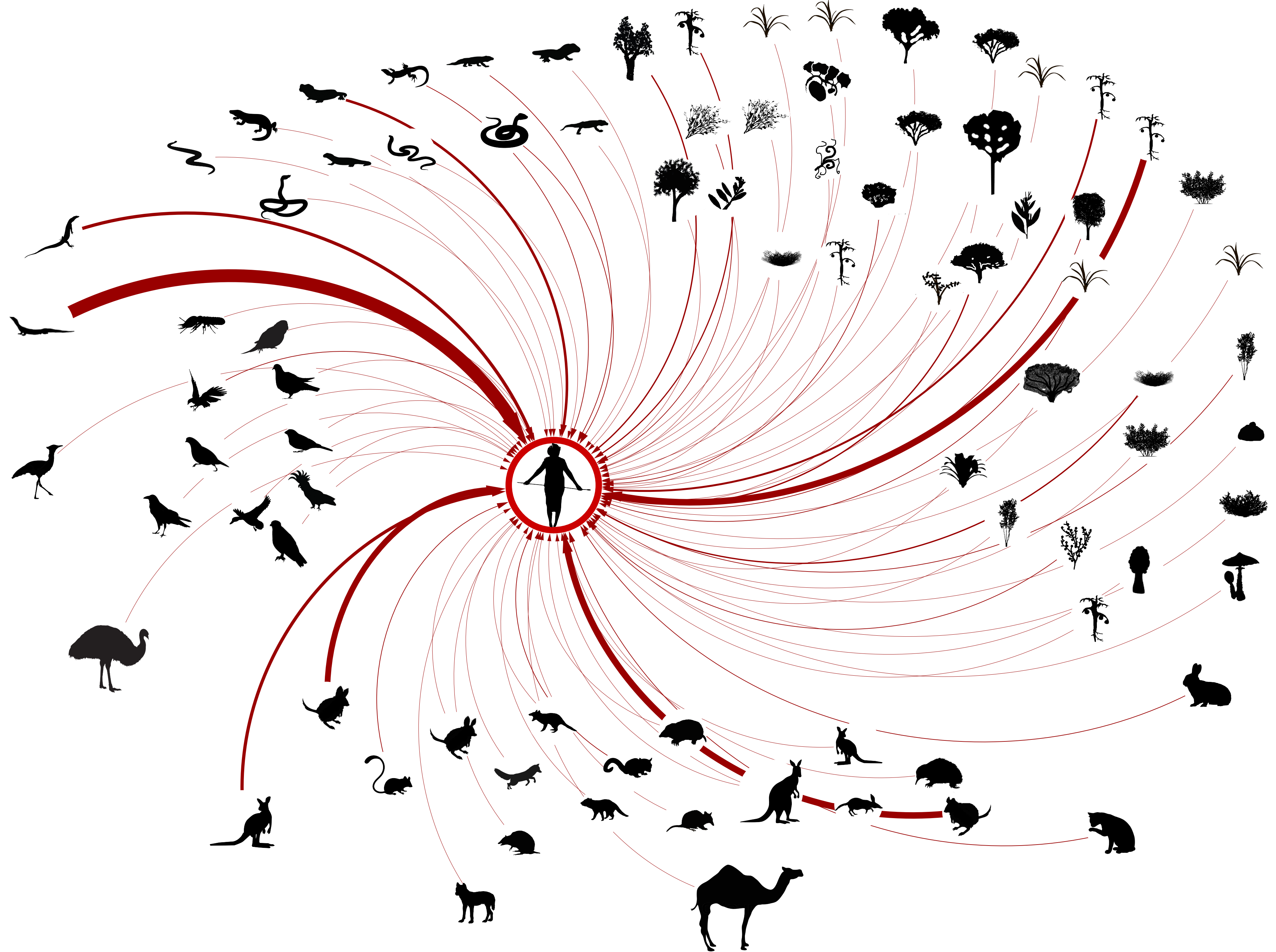
Food Webs of Martu

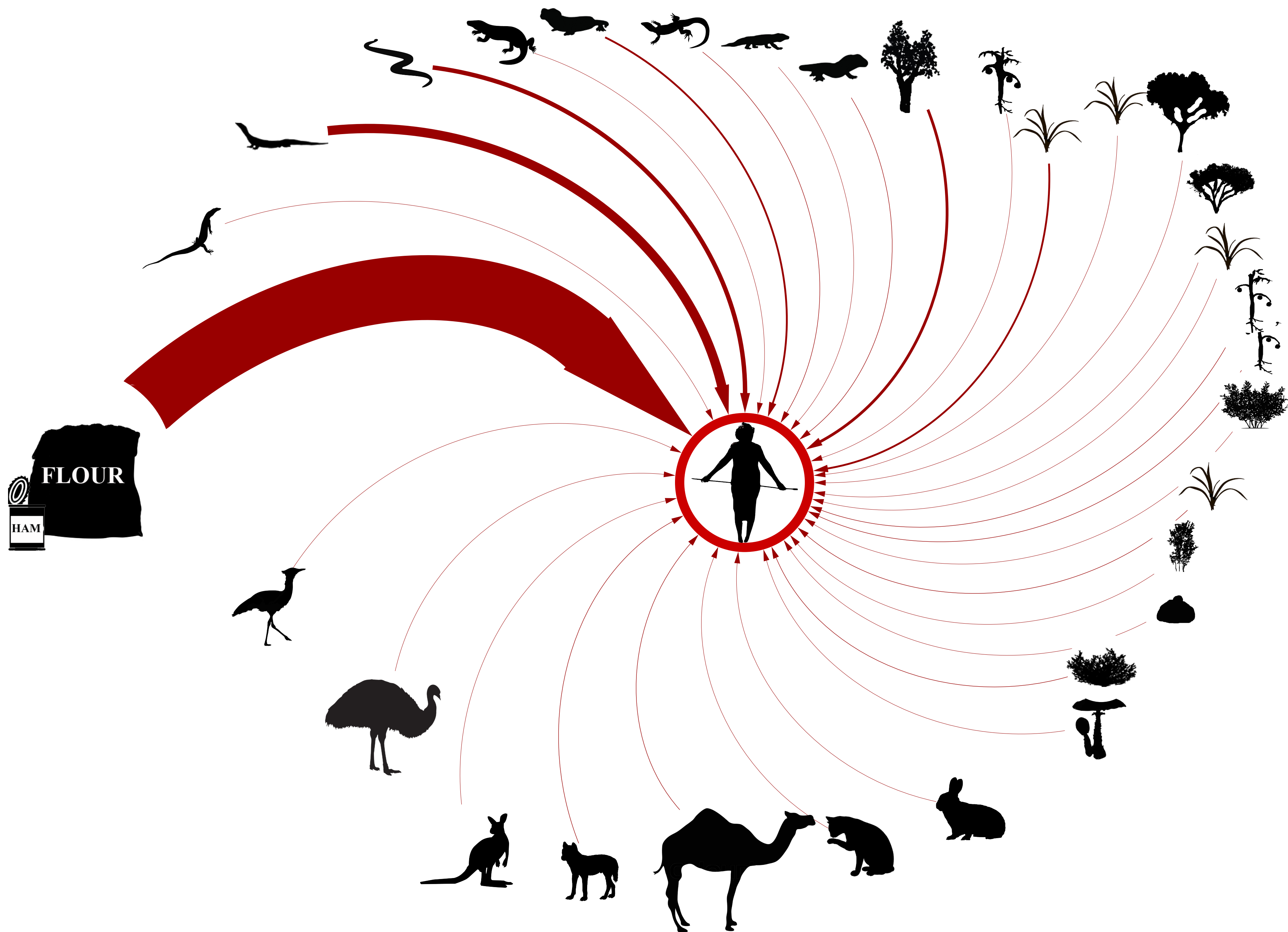
- ❖ Work by several colleagues suggests certain animals prefer certain fire recovery stages
- ❖ If you remove Indigenous burning you get less diverse ecosystems
- ❖ Can we model the pre-1964 and modern food webs?



Modeling the Recent Past







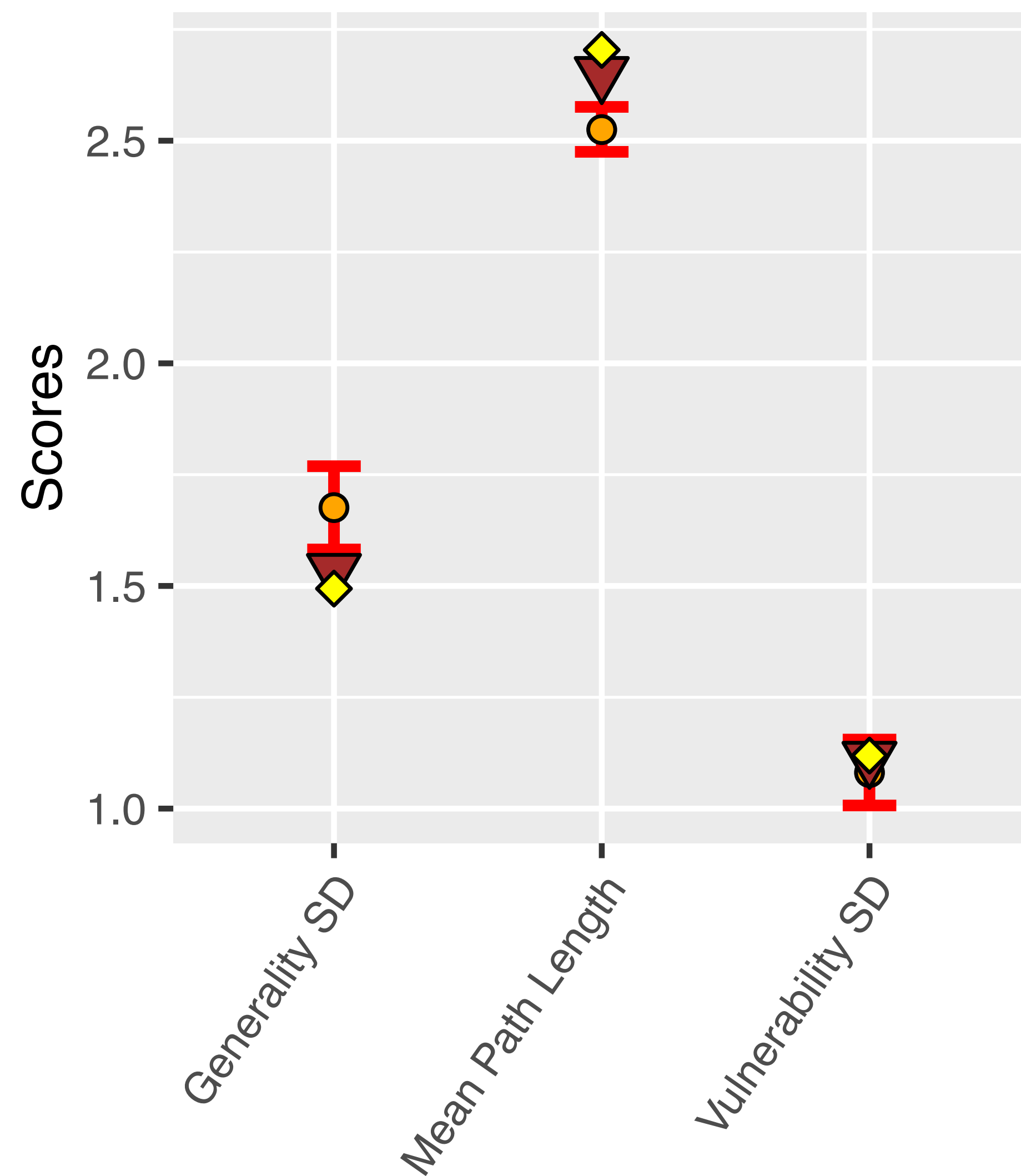
Modeling the Recent Past

- ❖ While we see a change in the food web, is this normal?
- ❖ I employed Niche Models to examine how changes are statistically meaningful
- ❖ Simulates food webs with similar number of links and edges to look at what “random” extinctions would look like
- ❖ Helps determine structure and stability

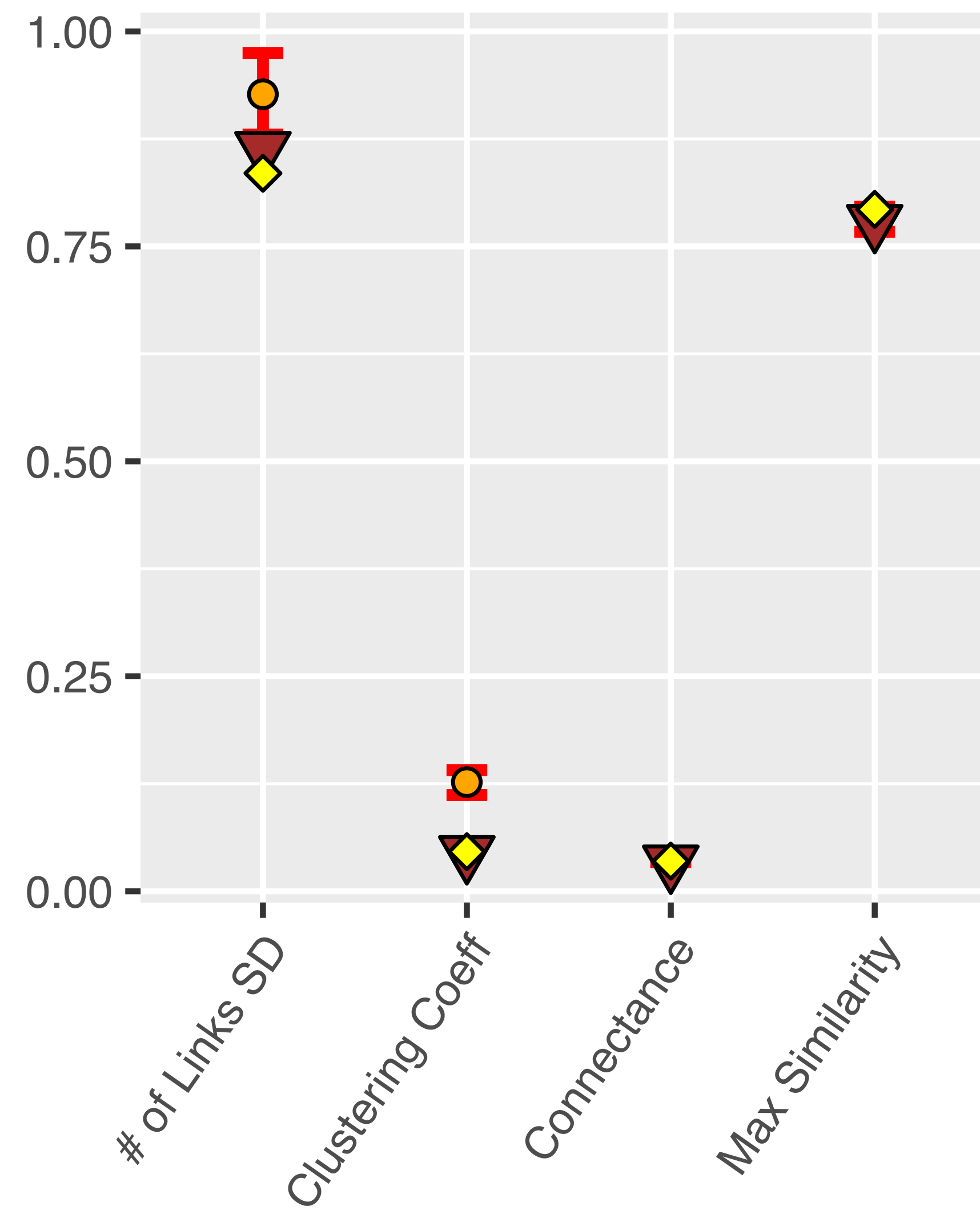


Niche Modeling of Martu Food Webs

Path, Generality, and Vulnerability



Connectivity Statistics



Modeling the Recent Past

- ❖ Martu are “knitters” of ecosystems
- ❖ They dampen predators, like large snakes and goanna
- ❖ They make patchy environments
- ❖ Their presence kept that food web together





Indigenous

Court of Summary Jurisdiction (2013). *Aboriginal Areas Protection Authority v OM (Manganesse) Ltd* (2013) NTMC 019, Court of Summary Jurisdiction, Darwin.

CRA (Coastal Risk Australia) (2021). Coastal Risk Australia, CRA, <https://coastalrisk.com.au/home>.

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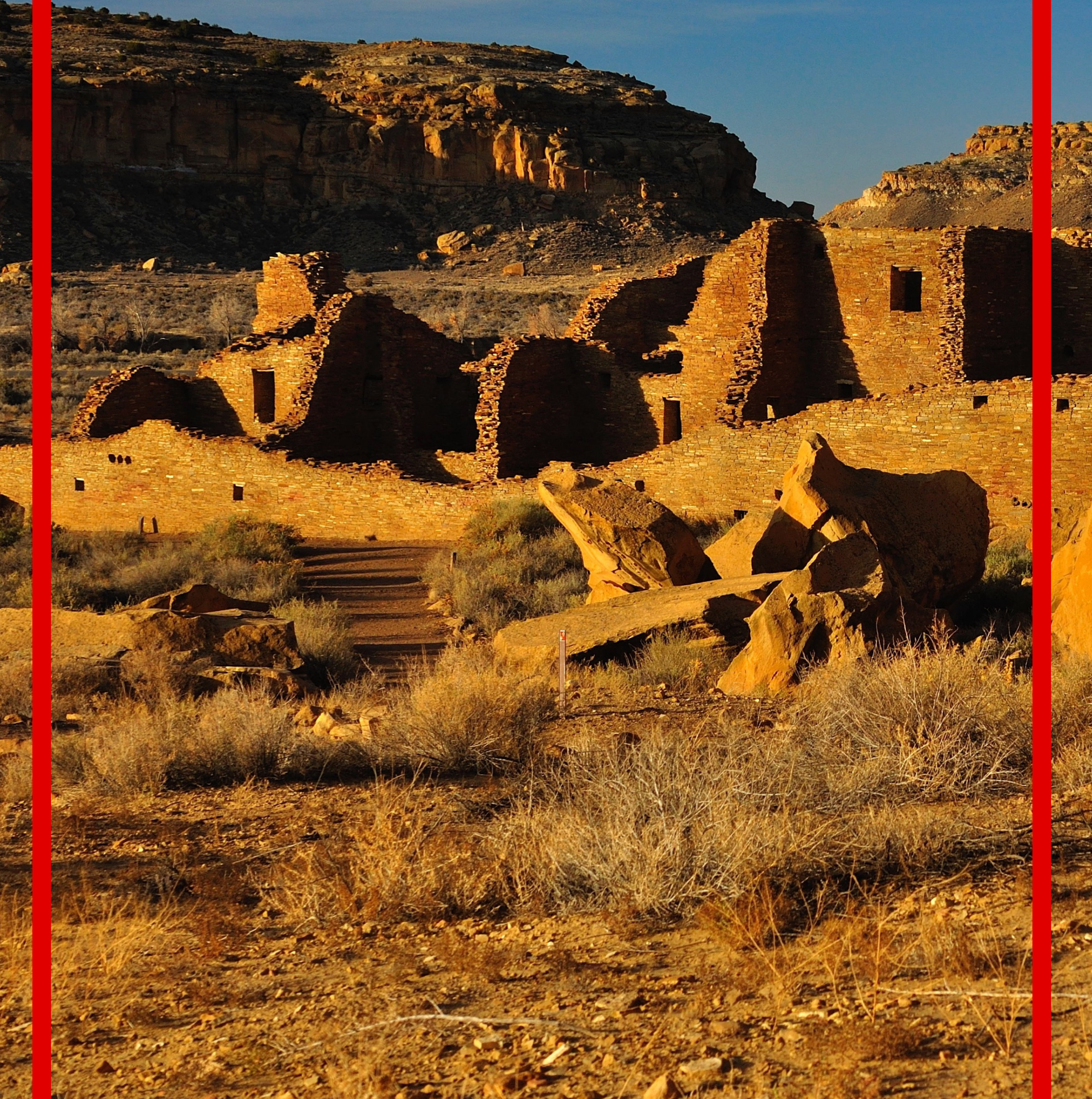
[education/programs/young-indigenous-womens-stem-academy/about-the-academy](https://www.csiro.au/en/education/programs/young-indigenous-womens-stem-academy/about-the-academy).

CSIRO (Commonwealth Scientific and Industrial Research Organisation) (2021d). Indigenous ecosystem services for the northern Great Barrier Reef, CSIRO, Canberra, <https://www.csiro.au/en/research/indigenous-science/managing-country/gbr-ecosystem-services>.

CSIRO (2021e). Indigenous STEM Education Project, CSIRO, Canberra, <https://www.csiro.au/en/education/Programs/Indigenous-STEM-Education-Project>.

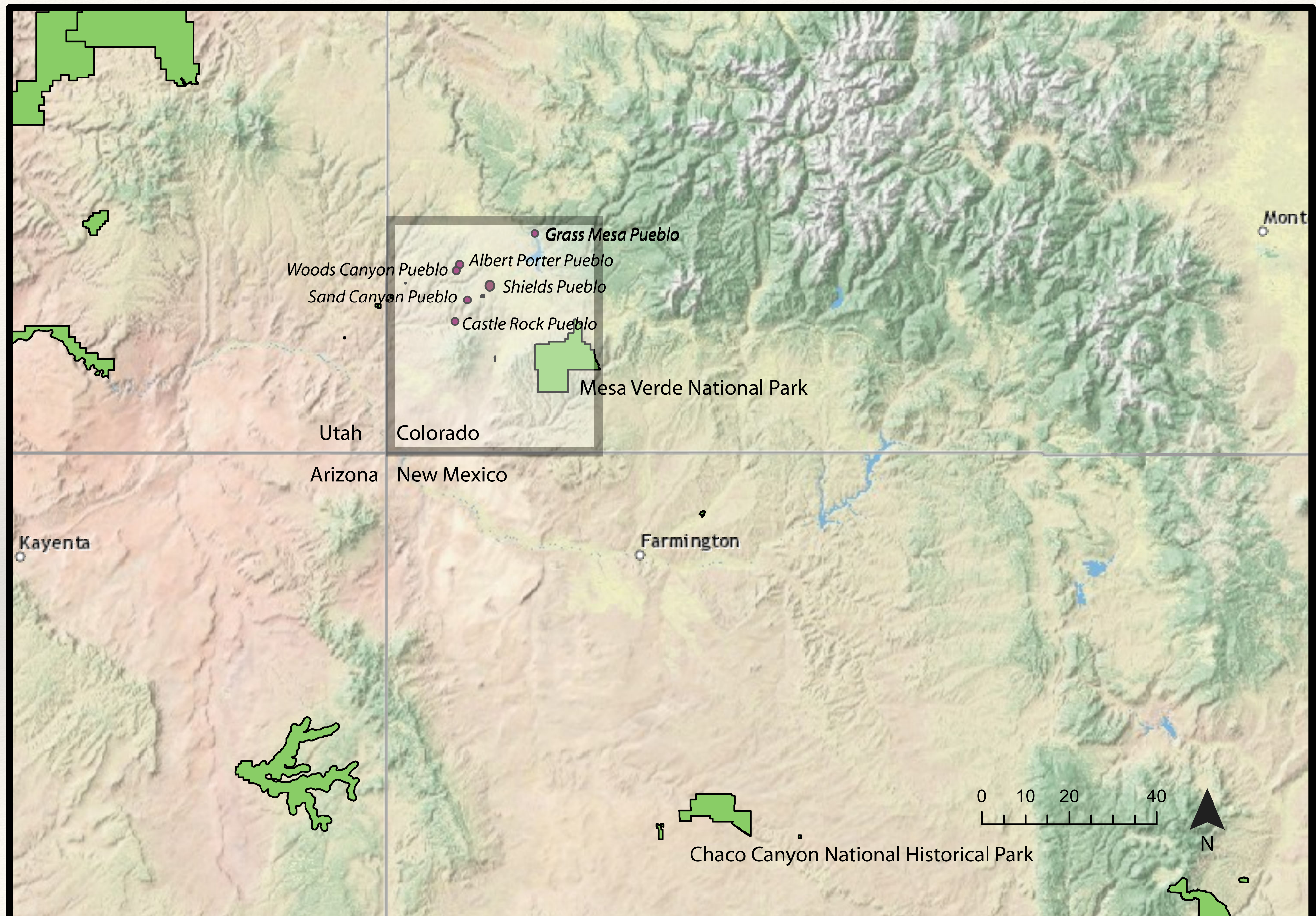
Cumpston Z (2020a). *Cities are Country: illuminating Aboriginal perspectives of biodiversity in urban environments*, research synthesis. Report prepared by the Clean Air and Urban Landscapes Hub, Melbourne.

American Southwest



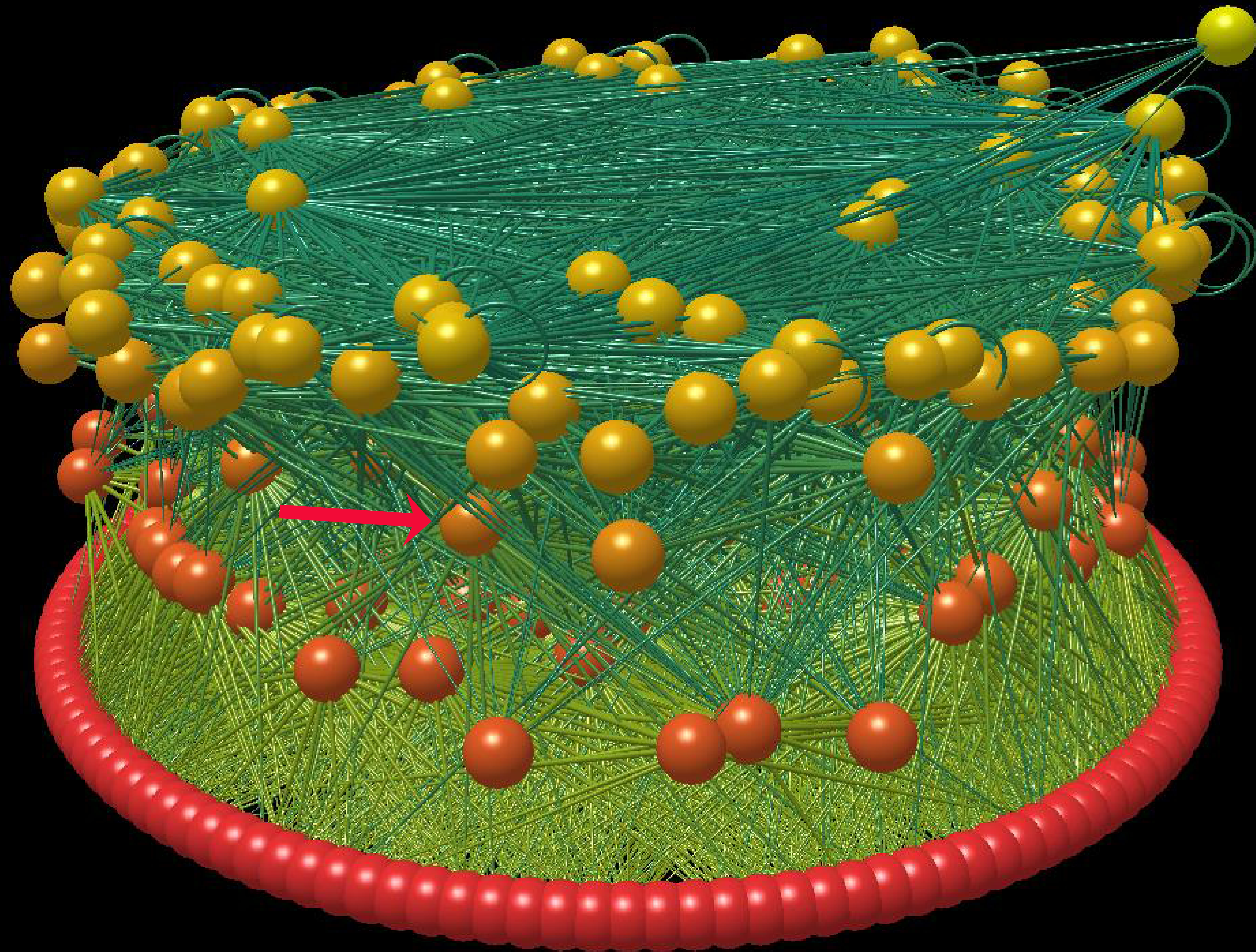
Western Desert of Australia

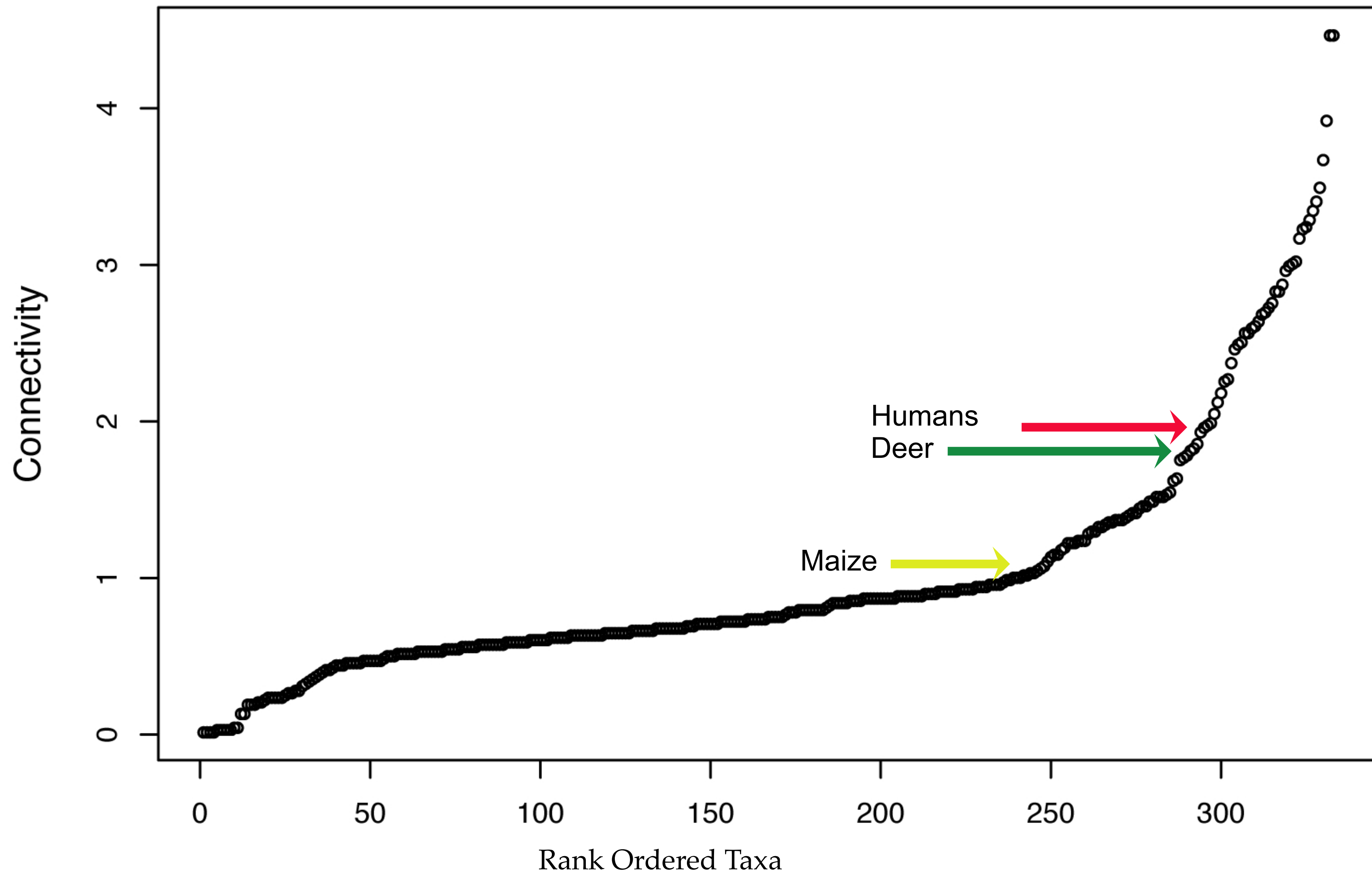


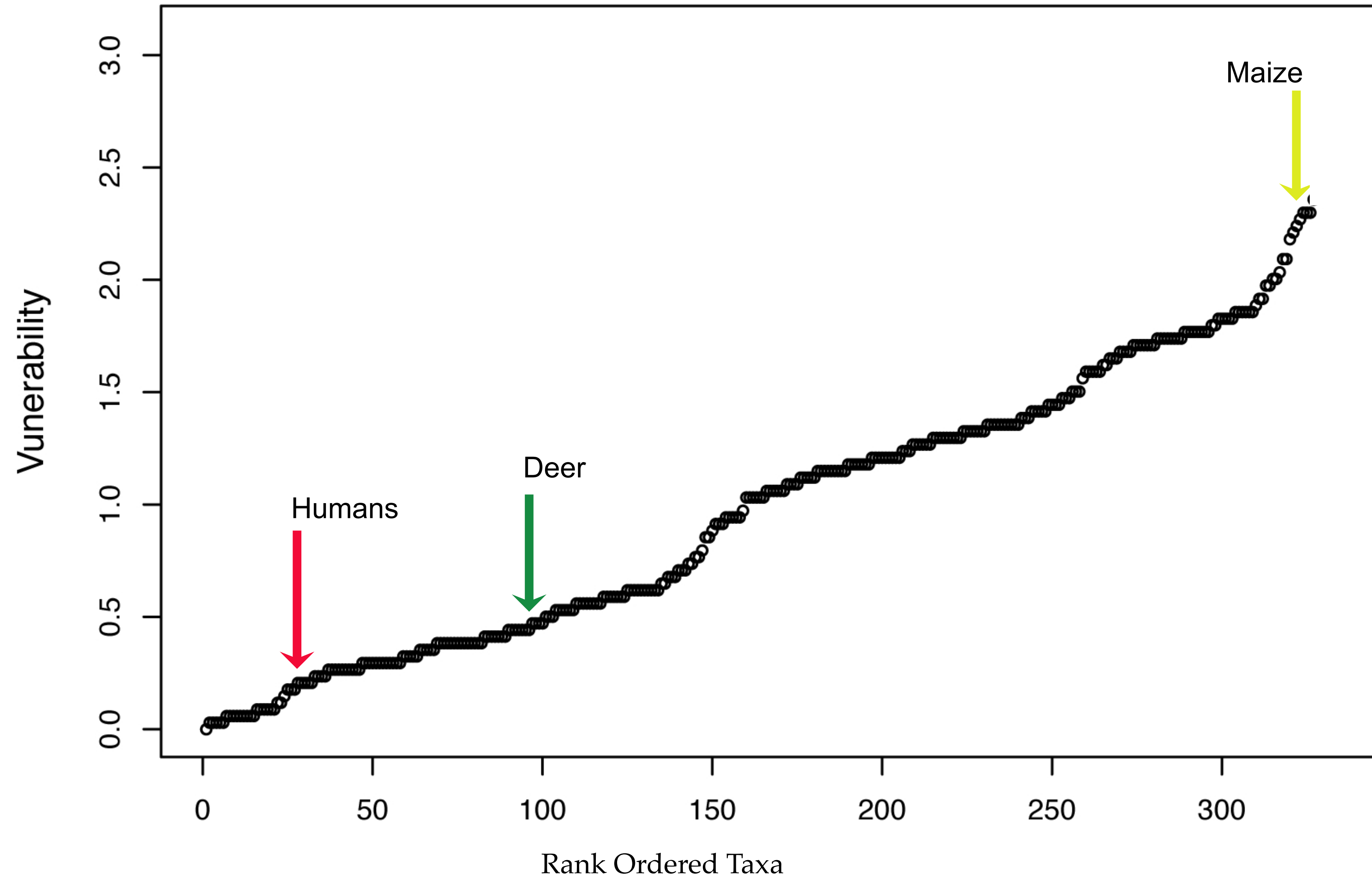


- When the Wetherill brothers came upon Mesa Verde in the late 1800s they saw completely abandoned stone dwellings.
- Where did they go? Why did they leave?
- The “Great Drought?” Hostile invaders?
- My approach: looking at food webs through the 700 year occupation to examine how the ecosystem changed over time to help inform discussions of abandonment





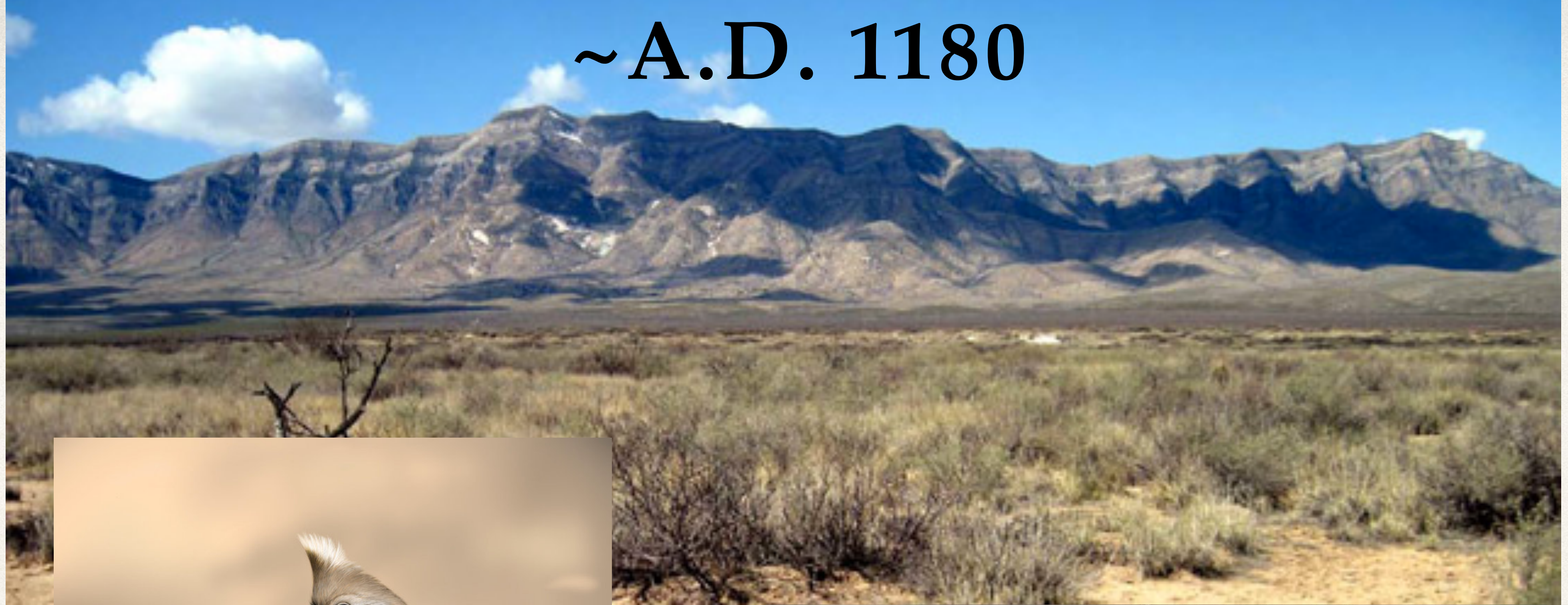




~A.D. 750



~A.D. 1180



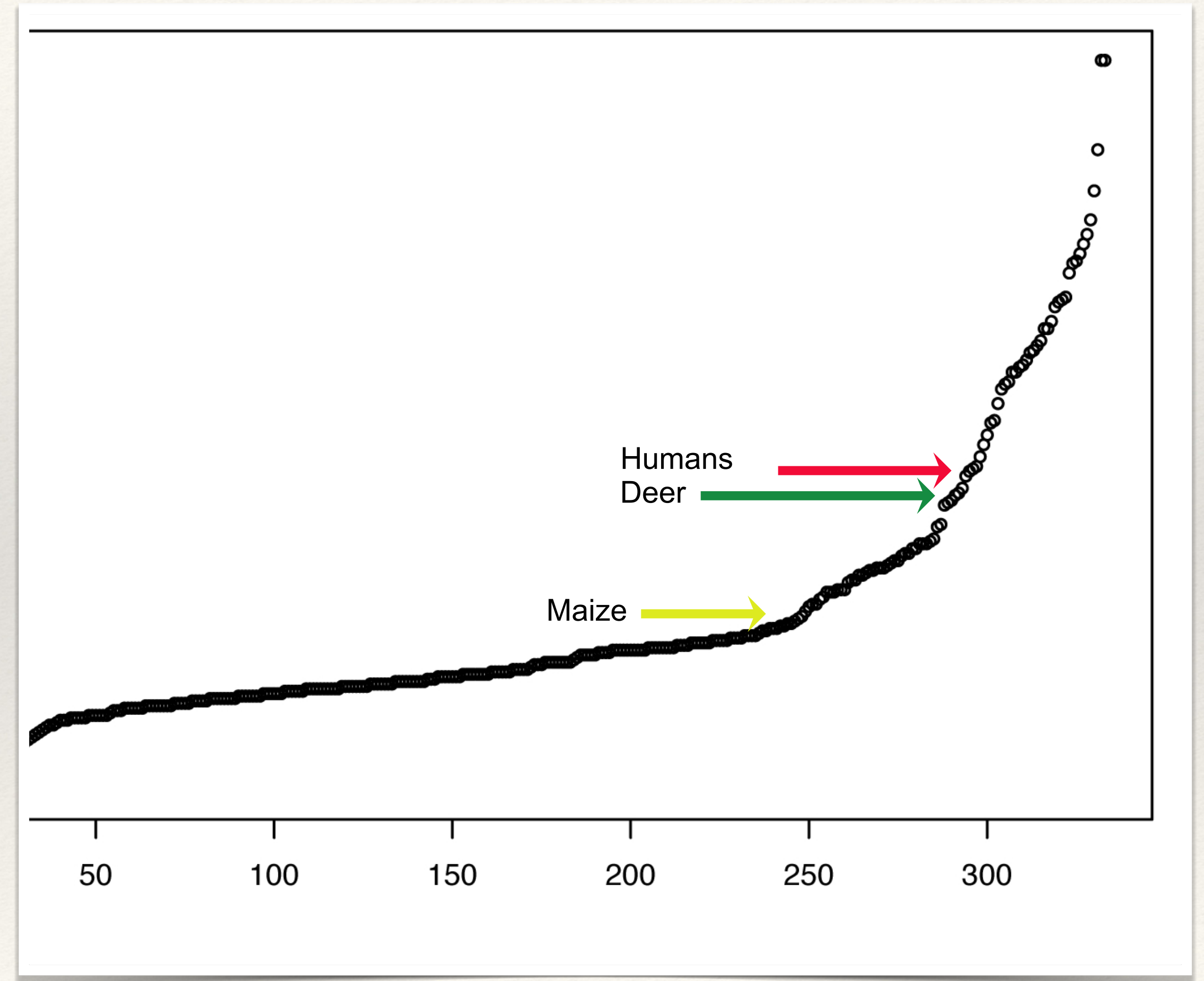
Cascading Consequences

- ❖ Clearing the landscape of trees for arable farmland decreases habitat for other animals and increases soil erosion.
- ❖ People would have to go farther afield for wild resources.



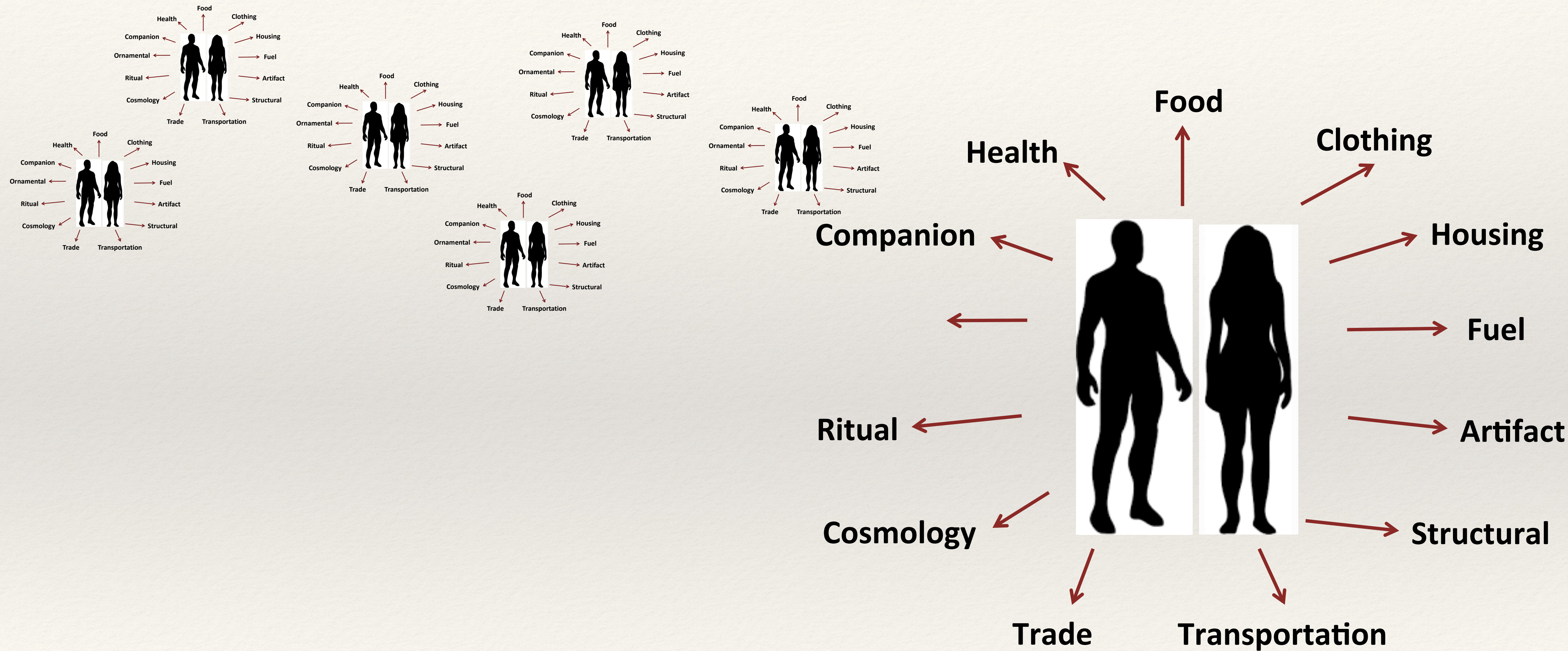
Cascading Consequences

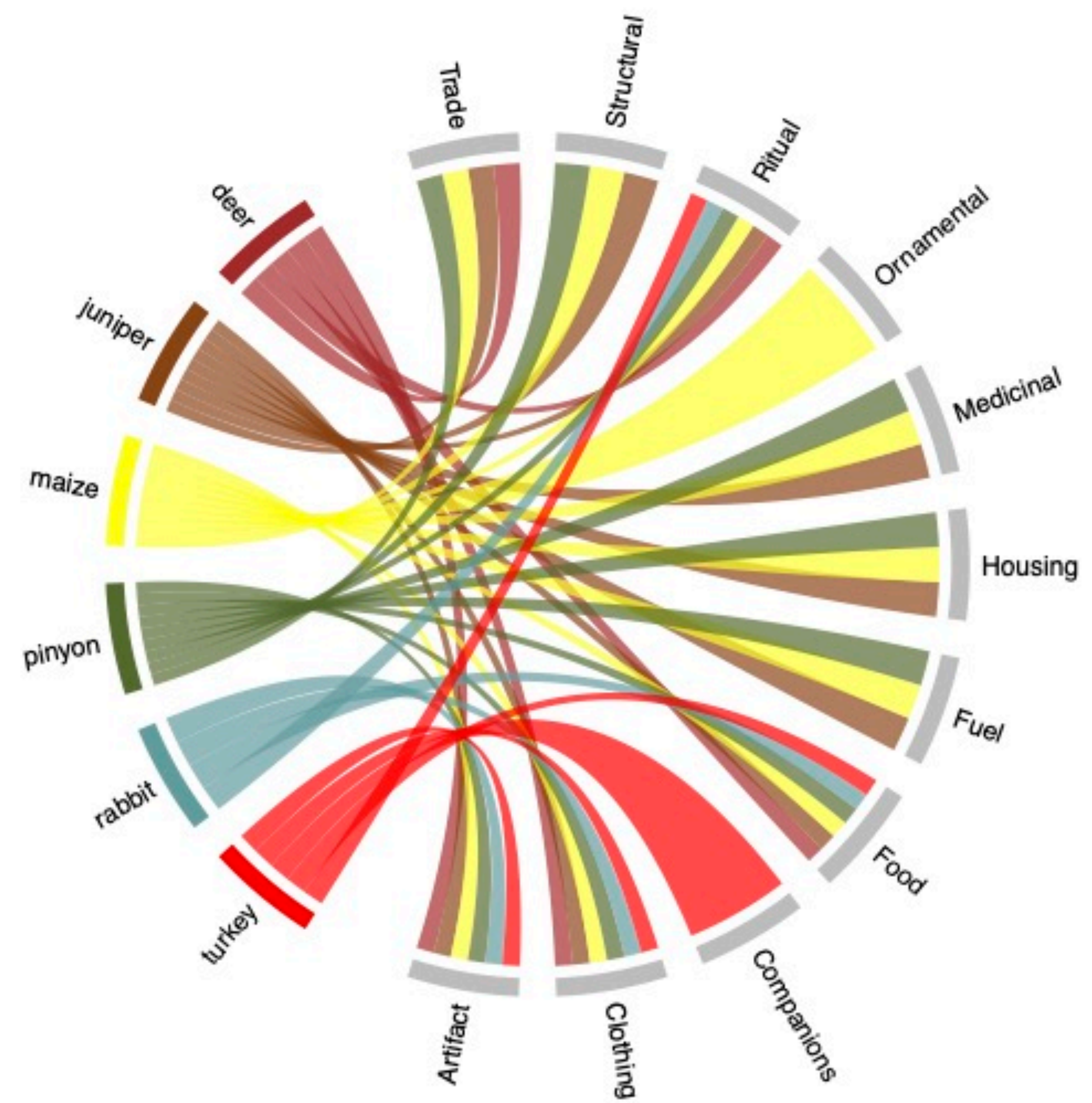
- ❖ Populations reached 27,000 in our region by the early 1200s (Schwindt et al. 2016).
- ❖ The ability to switch prey reliably would only be present in low density populations.
- ❖ But what could uses beyond food tell us?



Human Interactions with Other Species

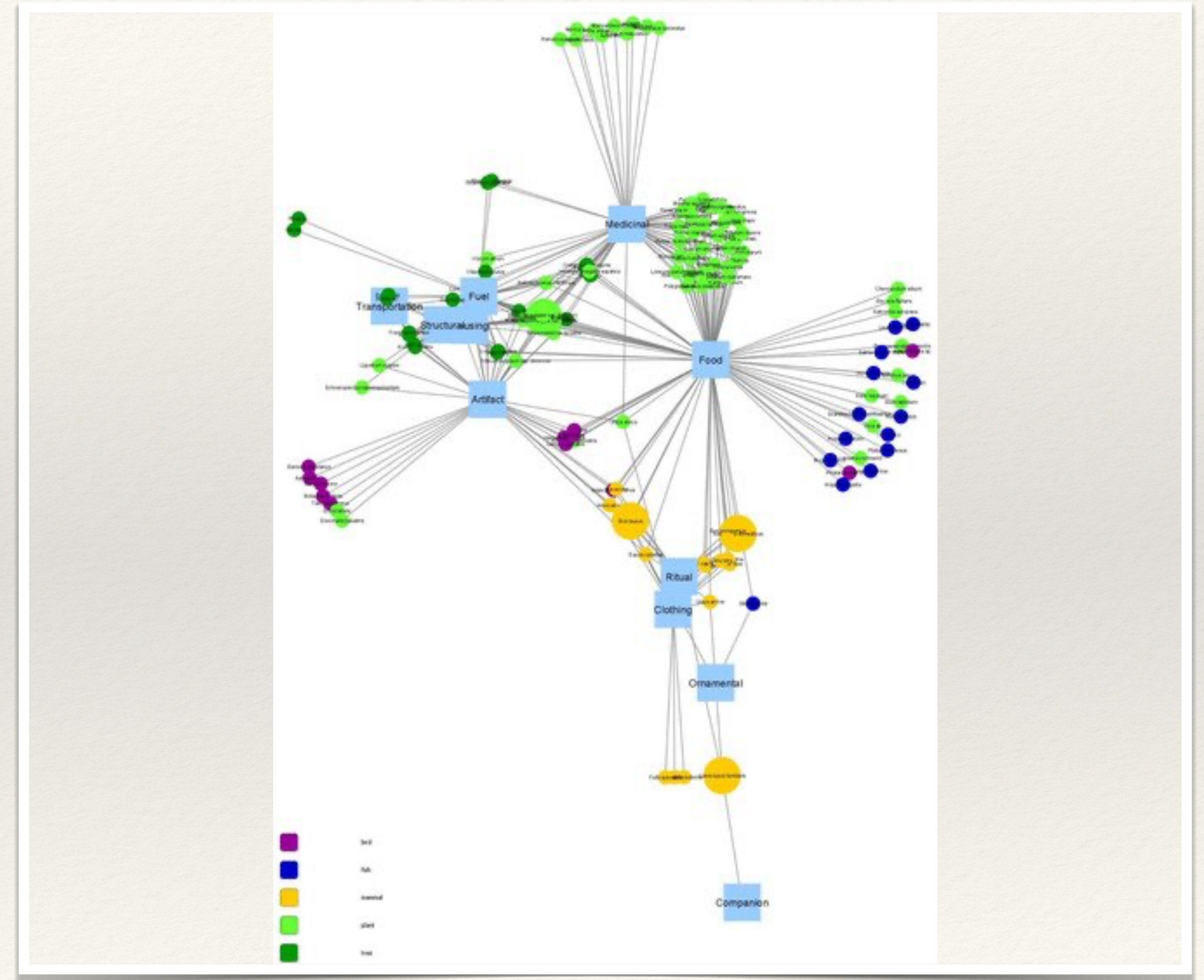
our next step: Human-centered interaction networks through space and time in relation to constraints & opportunities of ecology, environment & culture

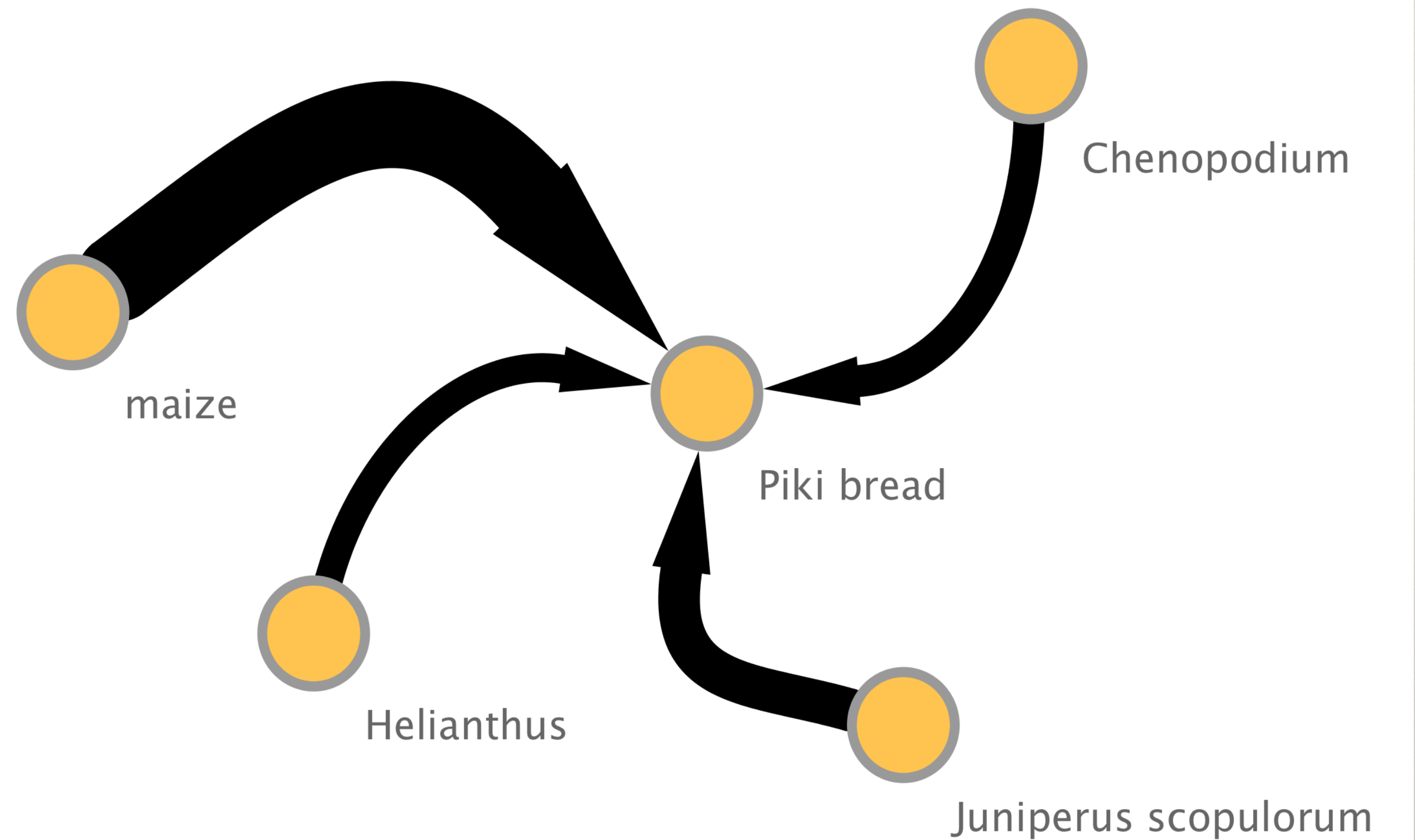




Beyond food webs

- ❖ Using network analysis to look at ‘importance’ of taxa, how many things they are used in, if their uses change, etc





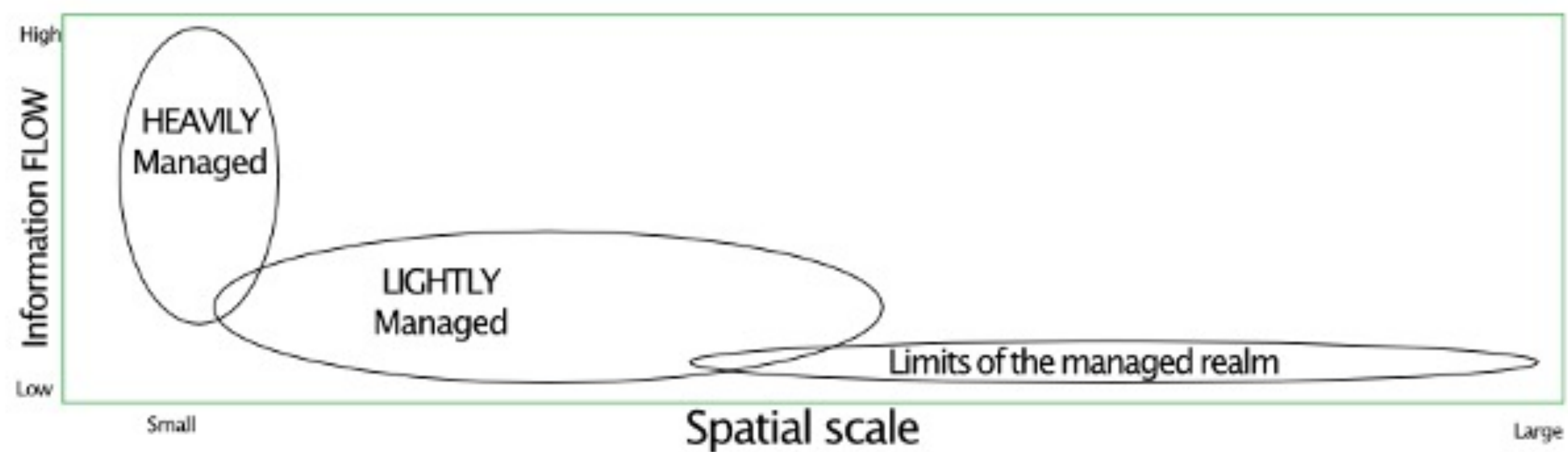
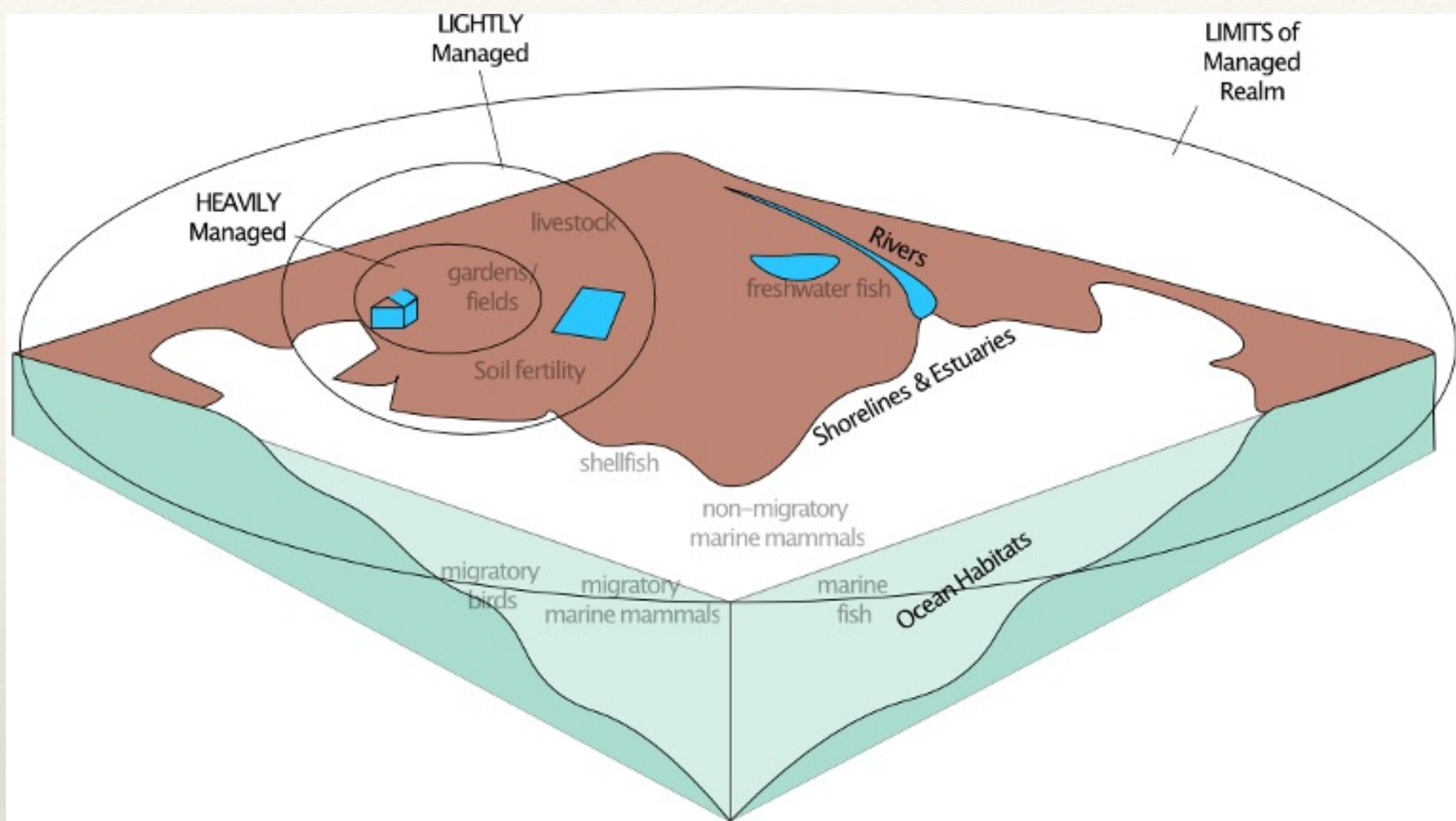
Maize: Main ingredient for bread

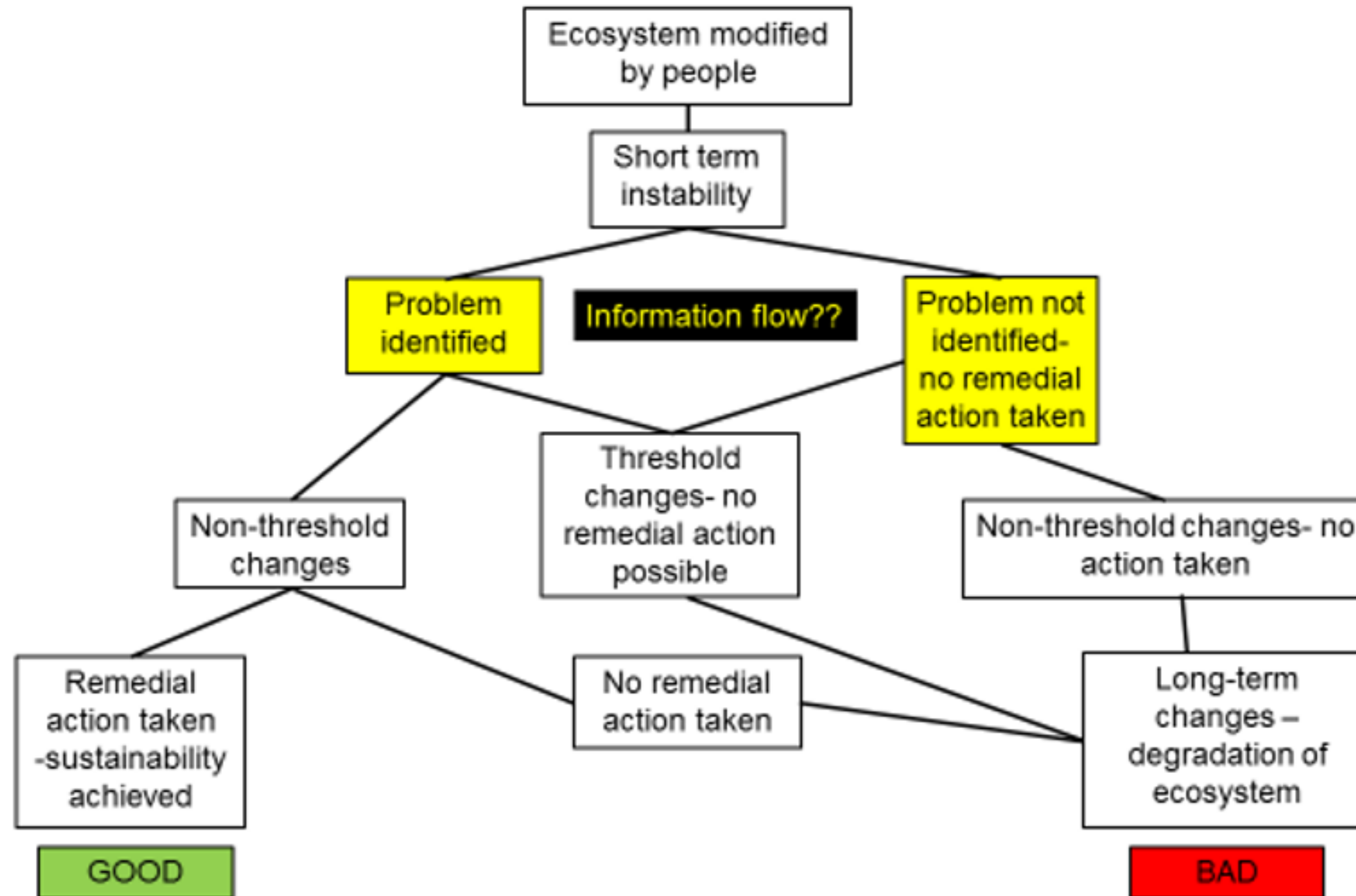
Chenopodium: Purple dye for bread

Helianthus: A hood over piki stone to lock in moisture

Juniperus scopulorum: Fuel to cook; ash as ingredient for bread







A Conceptual Mathematical Model

- ❖ Can we perceive our environments and act accordingly?
- ❖ Newly accepted paper to Global Environmental Change uses a conceptual formal model to look at this.



$$In_w = ((In_t(\lambda))\eta_p)\eta_a$$

or :

$$\begin{aligned} In_t(\lambda) &= In_a \\ (In_a)\eta_p &= In_u \\ (In_u)\eta_a &= In_w \end{aligned}$$

where:

In_t = total information

In_a = available information

In_u = usable information

In_w = wielded information

λ = losses of information due to perceptual limitations ($\lambda_{1...n}$)

η_p = cost of processing *available information* to become *usable information*

η_a = cost of actioning *usable information* to become *wielded information*

To sum up

- ❖ Humans impact ecosystems, but it isn't uniformly bad
- ❖ We can look to 'experiments with the past' to understand what has worked and what has failed
- ❖ Archaeoecology and modeling methods can be useful for understanding the human place in ecosystems



Thanks...

- ❖ ICTP for the invitation
- ❖ NSF grants Nos BCS-0119981 and CNH-0816400
- ❖ The Australian Research Council
- ❖ The Coalition for Archaeological Synthesis
- ❖ The Chateaubriand Fellowship Program and The Agence Nationale de Recherche (ANR)

