HANDLING THE COMPLEXITY OF PLEISTOCENE EXTINCTION:

SECOND ORDER PREDATION, 22 YEARS AND COUNTING

Elin Whitney-Smith, PhD

Retired: Netalyst, Inc. Washington DC 20003
Correspondence: elin@quaternary.net

The second order predation hypothesis (2-OP) of Pleistocene extinctions (Whitney-Smith, 2000), is based on the Pleistocene Extinctions Model (PEM), a system dynamics model describing the interaction of predators, prey, and vegetation. PEM provides a level playing field to test various extinction hypotheses. (Figure below).

The 2-OP hypothesis predicted:

1. Humans compete with existing predators, reducing the per-capita availability of herbivores.
2. Predators, facing scarcity, prey on humans.
3. Humans, to reduce competition or retaliate, establish a predator extermination policy (beyond biological need).

2-OP predicted that predator decline preceded herbivore extinctions.

4. Humans don't control herbivore populations as well as predators did, so herbivore populations increase – boom.

The prediction of herbivore booms was unique and counterintuitive.

5. Herbivores overgraze/over-browse, denuding the environment. Proboscideans knock over trees, turning mixed parkland into grassland.

Prior to 2-OP, large scale changes in vegetation were seen as a consequence of climate change, not of anthropogenic action.

6. Herbivore populations collapse – bust.
7. In the denuded environment, ruminants – highly efficient animals - and smaller animals – that can reproduce on less food – are selectively favored. Megaherbivores, cecal digestors, horses, sloths etc. go extinct.
8. Humans step-up predator extermination to no avail. Relict groups establish new life ways.

Recently reported evidence confirms key 2-OP predictions and raises new questions about the complexity of the extinctions process.

Predator decline preceding prey decline is confirmed by

- Stewart et al, 2021's findings that Sabre-tooth cat populations declined before proboscidean populations.
- Puma DNA studies indicating a past population bottleneck (Culver, et al. 2000).

Herbivores booms, as a part of the extinction process, are supported by

- Multi-animal death assemblages, dating to the end of the Bølling-Allerød, indicating a large but collapsing herbivore population – boom/bust cycling (Widga, et al., 2017).
- FAUNMAP (Graham, et al., 1996) data showing some herbivore species increasing at the same time others were decreasing.

Environmental exhaustion as a proximal cause of herbivore decline is supported by evidence of extreme inter-herbivore competition at the end of the Pleistocene:

- Schwartz-Narbonne et al (2015) found that, during the Pleistocene, Mammoths, among herbivores, had a distinctive amino acid ^{15}N signature, suggesting niche separation. France et al. (2007) found Mammoths and other herbivores to have a definite, if unexpected niche overlap suggesting competition just pre-extinction (after10,000 BP).

In 2000, 2-OP seemed counterintuitive. It posited a small change in predator populations with large impact on prey populations and vegetation. In recent years, trophic cascades have been found repeatedly:

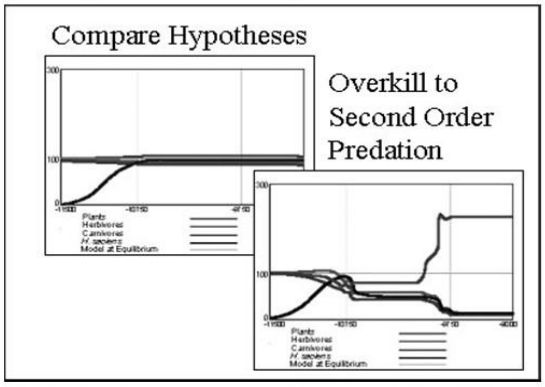
- Reduction of lions in African National Parks triggered biodiversity-reducing cascades, by decreasing populations of megaherbivores (Kerley et al 2007).
- Reintroduction of wolves to Yellowstone increased biodiversity, a consequence of direct predation and fear, changing herbivore behavior, thus decreasing habitat destruction. (Ripple, 2004).

The confirmation of 2-OP's counterintuitive predictions demonstrates the value of a model-based approach to developing and testing extinction hypotheses. This also provides a basis for increased conversations amongst various disciplines and a way to test non-traditional theories.

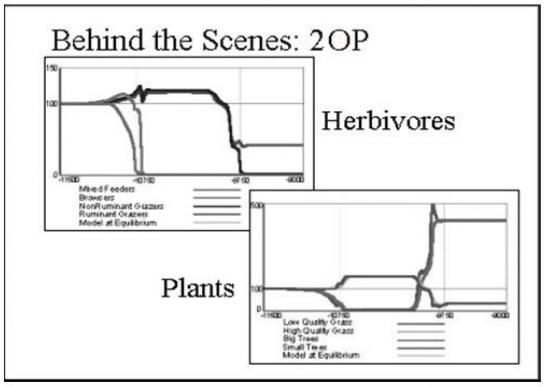
Figure 1:

Task: Create a model where carnivore and *H.sapiens* populations are limited by herbivore populations, herbivore populations are limited by plant populations and plant populations are limited by land mass.

Values: Predator hunting values based on food need of 20 lbs/pound/year, *H.sapiens* hunt herbivores based on half predator food needs. Far more hunted food than has been observed in modern H/G. *H.sapiens* hunt carnivores 1.25%/ pound/year. Climate change is derived and is a 13% reduction in the ability of land to support plants.

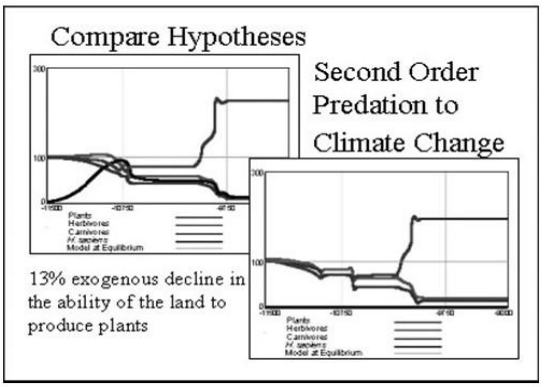


Task: Use the same assumptions model Overkill (OK) and Second Order Predation (2 OP)

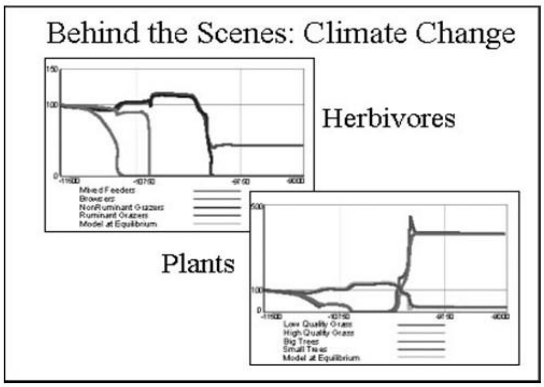


Task: Look at what is happening to herbivores and plants with 2 OP

2 OP is the one to beat

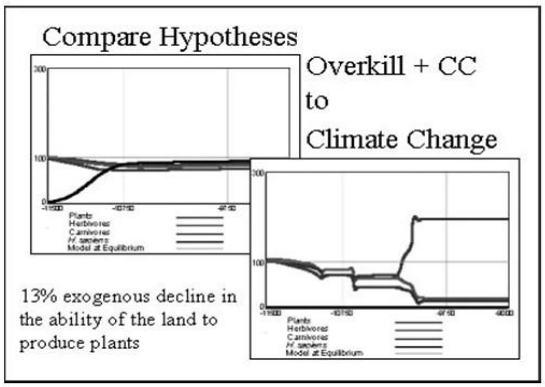


Task: Create a model with enough climate change (CC) to cause extinction—13%

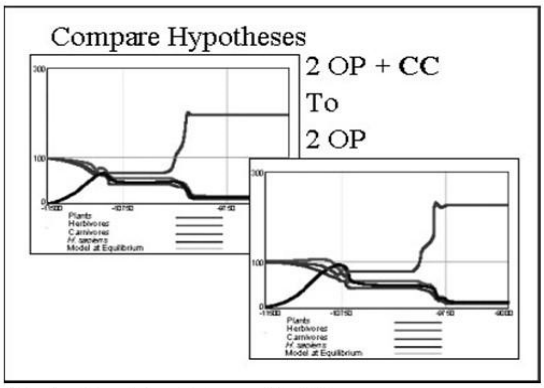


Task: Look at what is happening to herbivores and plants with 13% CC

Exogenous CC compares well with 2 OP



Task: Combine OK with CC.
Result: OK mitigates CC



Task: Combine 2 Op with CC
Result: 2 Op extinction occurs sooner

2 Op + CC is most consistent with rapid extinction and is consistent with ruminant grazer survival and non–ruminant extinction