Fuentes, M. 2014. On sustainability of human ecological niche construction. *Ecology and Society* **19**(4): 38. http://dx.doi.org/10.5751/ES-07132-190438

Response to Isbell and Loreau. 2014. "Sustainability of Human Ecological Niche Construction"

On sustainability of human ecological niche construction

Marcelino Fuentes [1]

Key Words: *agriculture; human health; niche theory*

Isbell and Loreau (2014) use a simple Lotka-Volterra consumer-resource model to make predictions about human populational 'sustainability.' Their model allows for human manipulation of interactions with plant and animal resources and pathogens. They predict that the extensification of agriculture will lead to large fluctuations in the abundance of humans and our resources, that shifting to a completely vegetarian diet does not increase human carrying capacity, that health improvements will make it difficult to sustain livestock production, and that agricultural improvements will increase human pathogen abundance and can easily destabilize human population dynamics. I show that these predictions do not hold when some realism is added to their model.

In their model, Isbell and Loreau allow humans to tweak the parameters of the Lotka-Volterra equations, such as the equilibrium abundance of resource plants in the absence of human consumption, the nutritional quality of plants, or the harvesting efficiency. However, they leave out the most important manipulation, which gave rise to agriculture and animal farming. Humans spare a fraction of resource individuals or propagules from consumption and assign them to reproduction. This changes the dynamics of both resource and human populations.

The Lotka-Volterra equation for a resource population is dN/dt = rN(1 - N/K) - cNH, where N is the abundance of the resource population, H the abundance of humans, and cNH the number of individuals or biomass harvested and consumed by humans. By contrast, in farming dN/dt, the change in the number of reproducing organisms, is not a function of consumption and is thus unrelated to cNH. Instead, dN/dt is the result of planned reproduction, which includes, for example, the harvesting and planting of seeds for the purpose of producing the next generation of plants.

Whatever is consumed by humans is simply a byproduct of a population of reproducing organisms that are not consumed by humans. This is a donor-controlled system similar to those consisting of scavengers and their resources. Scavenging does not affect the supply of carcasses. Moreover, farmers manipulate the reproducing population to optimize effort and food supply. So, farming is a donor-controlled system in which the donor control is planned and purposefully executed by the consumer. This applies to human farmers and to nomadic humans that own livestock, as well as to termites, ants, and other strongly territorial organisms that practice rudimentary farming.

The incentive for sacrificing short-term consumption for long-term production is made possible by the most extreme form of territoriality found in any species, the institution of private property. Private property allows each farmer to reap the benefits of planning the reproduction of his plants and animals. The Lotka-Volterra model used by Isbell and Loreau applies to resource populations that are not under private property, such as those subjected to bushmeat hunting or open-seas fishing.

Consumers in Lotka-Volterra systems destabilize resource populations, whereas consumers in purely donor-controlled interactions, for example, scavengers, do not affect stability. However, farmers tend to stabilize the farmed populations by purposefully counteracting exogenous perturbations. Contrary to what happens in consumer-controlled Lotka-Volterra systems, farming by consumers makes resource populations more stable than they would be in the absence of human consumers.

Human-pathogen interactions are also largely manipulated by humans. Isbell and Loreau acknowledge that humans have increased the mortality of pathogens. Increases in the food supply per capita make people better inmunologically defended against pathogens. Also, advances in efficiency allow people to satisfy their food requirements with less time and effort spent in farming activities. Part of the newly available time is then devoted to manipulate the environment to reduce disease incidence. Improved water sanitation, hygiene, clothing, and food manipulation are examples of environmental manipulations that increase the mortality and decrease the infectious potential of pathogens. So, contrary to the model of Isbell and Loreau, improvements in agriculture allow for decreased numbers of pathogens and for larger numbers of human consumers both in the short and the long term. The same applies to livestock. Improvements in agriculture allow for more livestock and fewer livestock pathogens.

Finally, humans control their own reproduction by means of artificial contraception. Food availability and pathogen incidence limit human population growth, but human choice aided by contraception sets reproduction well below this limit. Reproductive self-control effectively decouples human population dynamics from food consumption and pathogen attack.

Human population dynamics and human interactions with resources and consumers largely depend on human goals and our capacity to manipulate our environment to achieve those goals. The Lotka-Volterra model of Isbell and Loreau does not capture the population dynamics of humans and their resources and pathogens because it does not incorporate human choices.

What kind of model would include both human choices and biophysical constraints? I suggest that the classical supply and

[1]Universidade da Coruña

demand model of economics is a better starting point than the model of Lotka and Volterra. The demand for food, children, and defense against pathogens reflects human desires. The supply of those goods reflects the costs of producing them given biophysical constraints such as the availability of arable land, phosphates, energy, antibiotics, and human labor. The laws of supply and demand then predict the equilibrium quantities and prices of the different goods.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/7132

LITERATURE CITED

Isbell, F., and M. Loreau. 2014. Sustainability of human ecological niche construction. *Ecology and Society* 19(1): 45. http://dx.doi.org/10.5751/ES-06395-190145