

Population Ecology and People

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My work in CUNY's masters program in Liberal Studies involves what ecology and evolution can teach us about humanity's relationship to the rest of nature, especially in the context of present population and consumption crises. Taking a coevolutionary view, I argue that these crises result from cultural traits rather than our biologically evolved nature. By contrasting our current dynamics with those predicted by models from population ecology, we might be better able to identify and alter maladaptive cultural traits. This approach may prove fruitful in developing a new framework for dealing with a wide range of social issues, especially ecological degradation.

The distinction between r-strategists and K-strategists is problematic since many species, humans included, do not fall neatly into one category. It is useful, though, to note how we depart from K-strategists: level and rate of resource use, dispersal, mobility, geographic range, autotoxicity and population growth rate are all high like r-strategists. All but the last variable are results of or highly enhanced by modern technologies and economics, pursuits clearly unrelated to our biology. Perhaps our population growth rate is also a result of culture.

The alternative, that we biologically evolved as exponential growers, is unlikely. Such growth may be an evolutionary stable strategy for, e.g., species whose numbers cycle annually as harsh winters kill off most of a year's progeny. Were humans pursuing this strategy, though, our cycle would be hundreds of thousands of years long, a period related to no natural cycle for us. More importantly, given that a growing population increases social problems and ecosystemic degradation, it would be all the more difficult to defend this as a stable strategy for humans.

Ongoing exponential population growth can only be accomplished when resources are unlimited, a condition which does not occur in nature. Since our numbers are growing in such a way, a cultural explanation is once again indicated. Two cultural factors that would contribute to use of resources as if unlimited, thus enabling exponential growth, may themselves be integrally

related: growth-oriented economics and dominion over nature.

In logistic population growth, density dependence and carrying capacity (K) as stable equilibrium suggest that, as resources are depleted, birth rates will decline and death rates will rise. Key here is carrying capacity as mathematical reality, not just tree-hugger rhetoric to discourage industry. But to argue that our current population growth is not truly exponential but merely the exponential “leg” of a longer-term logistic curve destined to level around 10 billion in 2050, as did the *New York Times* in covering the birth of the 6 billionth baby, seems faulty on several counts.

One assumption of the logistic model is linear density dependence. Based on growth rate and time lag, though, dynamics may yield damped oscillations, a stable limit cycle or chaos. Since our growth rate and time lag are both large, we are unlikely to simply level off monotonically. We may overshoot K , or we may already have done so, and the greater the amplitude of our fluctuations the more our stability is threatened. The other assumption of the model is constant carrying capacity. More important than the density dependence issues, our growth economy seems to be the very definition of ever-increasing carrying capacity. This may be the heart of anthropogenic ecological degradation with exponential population growth, merely a special case of economic growth, occurring literally at the expense of other species. Again, with social and ecological ills growing along with our population, it is hard to believe that anything above our current numbers could represent a “natural,” stable equilibrium for our species.

The Lotka-Volterra models for competition and predation support the idea of human carrying capacity increasing to the detriment of others and, eventually, ourselves. Competition, at its heart, is a channeling of K from one species to another. Indeed, K itself is never an absolute, instead based on the relative strengths of the conversion efficiencies of a predator and its victims or, alternately, a species and its competitors.

Technoindustrial age humans, for whom commandeering global resources is the ultimate manifestation of interference competition, have a high conversion efficiency and growth rate with a low death rate. These factors yield various conclusions. Solving for equilibrium predator population, we find that high conversion efficiency means fewer people are needed to control other species' populations. Our large and growing numbers must then overcontrol our victims. Conversely, increasing food production, i.e., victim populations, as an attempt to fend off starvation simply ends up requiring greater numbers of predators, i.e., people, to control the victim populations. Thus, a food race escalates in much the same way as the nuclear arms race.

These conclusions are supported by the paradox of enrichment, in which low death rate combines with high conversion efficiency so that a predator overexploits a victim, drives it to extinction, then starves. Victim refuges can alleviate overexploitation, but humans programmatically seek and destroy such refuges. An extra bird in the hand now, though, means none in the bush later. Finally, the cycle rate between predator and victim populations slows as both prey growth rate and predator death rate decline. Thus, as we overexploit other species and decrease our own susceptibility toward death, the fluctuation cycle may slow to a rate too low for us to recognize, making us ever less able to acknowledge our connection to other species.

All of the above conclusions come from continuous time models of competition and predation, where coexistence is inherently difficult to achieve. Discrete time models generally give coexistence over a large range of population size pairings. But even here coexistence can be lost when one species is an ultracompetitor, which is precisely what modern humans seem to be.

While the above models bode ill for our future, they also seem to support my notion that our ecological problems are culturally generated. Thus, population ecology proves itself extremely useful in illuminating my research and pointing the way from pessimism to optimism.

A Conjectural Supplement - Not for Grading

Since the final paper was limited to three pages, I do not expect this section to be considered for grading purposes. However, I was sufficiently intrigued by how some additional topics we covered might apply to anthropogenic ecological degradation that I am adding this supplement in case you should also be interested.

To gain a sense of the what ecological equilibrium might look like at a global level, the basic McArthur-Wilson model of island biogeography can be scaled up so that the entire Earth becomes, in effect, the largest possible island. The variables in the formula for equilibrium number of species would be replaced by factors appropriate to the new scale to give us a formula for the global equilibrium number of species. Immigration becomes species generation through evolution while the number of species in the source pool becomes the number of species on the Earth at a given time. Extinction rate remains in the equation. A benefit of this application of the model is that, unlike the original model, evolution is now not only allowed but required.

The AMNH's Countdown to Extinction exhibit suggested that the global extinction rate is significantly higher now than it has been in the past. If global growth-oriented economics consistently overexploit other species, directly or indirectly, so as to yield a paradox of enrichment, it must at some point increase the global extinction rate to outweigh evolutionary generation. Biodiversity will necessarily decrease until growth economics goes extinct. It is extremely unlikely that growth-oriented people would be the last life form to go extinct, so global biodiversity would eventually be able to increase diversity to regain equilibrium after they disappeared. If there is hope for people as a species, then, it lies in reducing our impact on the global extinction rate.

The key, though, is not merely to keep endangered species from extinction, since the McArthur-Wilson model itself yields only an equilibrium volume of species. Preserving particular species does not address growth economics' systematic raising of the global extinction rate and thus the entire preservation/conservation movement is discredited as a method for maintaining biodiversity. The solution would appear to lie in converting our growth economy into an equilibrium economy, the steady-state economy described by Herman Daly and espoused by Garrett Hardin. Thus, extinction of growth economics need not go hand in hand with the extinction of *Homo sapiens*.

If the principles of population dynamics apply equally to humans as to other species, then perhaps solutions to population management "problems" might be applied equally without falling prey to the double standards of human exceptionalism. Bottom-up measures, which involve regulation of the inputs to a system, appear to yield much more stable solutions than top-down measures, which usually involve simply killing off either "overrepresented" species or the predators of "underrepresented" species. If the same holds true for humans, then top-down efforts such as birth control, euthanasia, infanticide, genocide and eugenics could never yield stable solutions to human overpopulation. On the other hand, if we can address the inputs to our economic system by focusing on equilibrium as opposed to growth, we are likely to produce a lasting positive effect on our population dynamics. Indeed, since resources are limited, growth is inherently unsustainable and must end at some point, as we have seen through the above analyses. It would seem preferable to take the bull by the horns and do the job ourselves rather than wait until we simply can grow no more. Finally, in an equilibrium economy, many issues in managing other species may cease to be problems, or at least cease to be viewed as problems.