



## Joel E. Cohen, Ph.D., Dr.P.H.

ABBY ROCKEFELLER MAUZÉ PROFESSOR, LABORATORY OF POPULATIONS

**The Laboratory of Populations studies the health of human and non-human populations quantitatively, including births, deaths, and migration; Chagas disease; COVID-19; farms, fisheries, forests, wildlife, food webs, and weather; and cellular and molecular populations. The lab's research uses mathematical, statistical, and computational tools, existing and newly developed, in collaborations that cross disciplinary, institutional, and national boundaries.**

The human species is a node in a network of feeding relationships, known as a "food web," with thousands of other species. Species that humans eat are conventionally studied as part of agriculture, agroforestry, or fisheries. Species that eat humans, which are often the agents or vectors of infectious diseases, are studied in epidemiology and human microbiome research. Humans, the species humans eat, and the species that eat humans are nodes in a global food web, studied in ecology. The global food web includes many species not directly linked to humans by feeding and strongly interacts with the physical and chemical environment.

Cohen and his colleagues aim to offer insights that can help manage local and global food webs for the well-being of humans and other species. They combine the perspectives of demography, agriculture, epidemiology, ecology, and environmental sciences. Their work uses concrete problems to develop new concepts for understanding populations and aims to crystallize these concepts into mathematical, statistical, and computational tools applicable to scientific and practical problems.

For example, Cohen and colleagues study Chagas disease (also called American trypanosomiasis), an insect-borne chronic infectious disease that affects children in Latin America and eventually kills many young adults in their prime years of work and family rearing. No vaccine is currently available to prevent infection because the affected people are poor and commercial incentives to develop a vaccine are weak. The drugs available for treatment are toxic. Cohen collaborates with Argentine colleagues who conduct field studies of Chagas disease to understand the ecology of disease transmission in poor rural villages in northwest Argentina. Based on data from these field studies, they develop mathematical models of the relations among humans; domestic animals like dogs, cats, chickens, and goats; the insects that transmit infection; and the trypanosome that causes disease. Their findings lead to specific recommendations of low-technology, low-cost interventions to prevent infection of people at risk.

Cohen's lab also views weather events as a population. Cohen and colleagues showed that severe tornado outbreaks became more common during the last half century. Both the average and variance of tornadoes per outbreak increased, and the variance increased more than four times as fast as the mean. Hence outbreaks with an extreme number of tornadoes have become more likely. The relationship between the average and variance in this case follows a power law known in population ecology as Taylor's law.

This same power-law relation of variance to mean occurs under other names in other fields of science, and has provided insights into many systems. Cohen and colleagues have studied Taylor's law theoretically and empirically in COVID-19, bacteria, trees, fish, voles, humans, and other species, including the insects that transmit Chagas disease, and are exploring its practical applications to sampling, projection, and management.

### EDUCATION

A.B. in applied mathematics, 1965  
A.M. in applied mathematics, 1967  
Ph.D. in applied mathematics, 1970  
M.P.H., 1970  
Dr.P.H., 1973  
Harvard University

### POSITIONS

Assistant Professor, 1971–1972  
Associate Professor, 1972–1975  
Harvard University  
Professor, 1975–  
The Rockefeller University  
Professor, 1995–  
Columbia University

### AWARDS

MacArthur Fellow, 1981  
Fred L. Soper Award, Pan American Health and Education Foundation, 1997  
Tyler Prize, University of Southern California, 1999  
Golden Goose Award, American Association for the Advancement of Science, 2015

### HONORARY SOCIETIES

National Academy of Sciences  
American Academy of Arts and Sciences  
American Philosophical Society  
Council on Foreign Relations  
Fellow, American Association for the Advancement of Science

### SELECTED PUBLICATIONS

Sela, U. et al. Quantifying how much host, pathogen, and other factors affect human protective adaptive immune responses. *Front. Immunol.* 15, 1–9 (2024).  
Cohen, J. E. Integer sequences with regularly varying counting functions have power-law variance functions. *Integers* 23, 1–19 (2023).  
Gürtler, R.E. et al. Controlling the abundance of invasive exotic wild boar (*Sus scrofa*) improves palm-tree conservation in north-eastern Argentina. *Eur. J. Wildl. Res.* 69, 1–15 (2023).  
Cohen, J. E. et al. COVID-19 cases and deaths in the United States follow Taylor's law for heavy-tailed distributions with infinite variance. *Proc. Natl. Acad. Sci. U.S.A.* 119, e2209234119 (2022).  
Yang, Y. et al. Temporal and spatial Taylor's law: application to Japanese subnational mortality rates. *J. R. Stat. Soc. A* 1–28 (2022).