

Everything should be as simple  
as possible, but no simpler

- Albert Einstein

# Toward a Synthesis of the Newtonian and Darwinian Worldviews

John Harte, Physics Today,  
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- In terms of conventional physics, the grouse represents only a millionth of either the mass or the energy of an acre. Yet, subtract the grouse and the whole thing is dead – Aldo Leopold, *Sand County Almanac* (1948)
- In anything at all, perfection is finally attained not when there is no longer anything to add, but when there is no longer anything to take away – Antoine de Saint-Exupéry, *Wind, Sand and Stars* (1940)

PHYSICS	ECOLOGY
The more you look, the simpler it gets	The more you look, the more complex it gets
Primacy of initial conditions	Primacy of contingency and complex historical factors
Universal patterns; search for laws	Weak trends, reluctance to seek laws
Predictive (chaos and quantum mechanics notwithstanding)	Mostly descriptive, explanatory
Central role for the ideal systems (ideal gas, harmonic oscillator)	Disdain for caricatures of nature

The Earth system is rife with feedback, nonlinear synergies, thresholds, and irreversibilities that confound our intuition

- There is, in ESS [Earth System Science] a growing infatuation with ever more complex models. It's gotten to the point where some models look as inscrutable as nature itself.
- A “Fermi approach” based on models that capture the essence of the problem, but not all the details, might get us farther. We need to develop simple, mechanistic models.
- This Fermi approach to ESS will only be effective, of course, if decision makers can be weaned from their awe of computer-simulated complexity.

Particularity and contingency, which characterize the ecological sciences, and generality and simplicity, which characterize the physical sciences, are miscible, and indeed necessary, ingredients in the quest to understand humankind's home in the universe.

# The two rules of good modeling

- Clearly define the question to be answered with the model
- Make the model no more complex than necessary to answer the question