Modeling Change

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Modeling Change

COOPERATORS CAN PROSPER: POPULATION MODEL RESOLVES THE TRAGEDY OF THE COMMONS

Social conflicts naturally arise within populations, particularly around the use and management of common resources. The tragedy of the commons is a social dilemma that members of any group face: whether to cooperate for the benefit of the group (and thus each individual) or to act out of self-interest. Cooperation has typically been more challenging to explain.

In the March issue of *Proceedings: Biological Sciences*, Timothy Killingback of the College of William and Mary, Jonas Bieri of the University of Basel, and Thomas Flatt of Brown University present a population-based model that depicts the evolution and maintenance of cooperation under simple conditions. The mechanism depends solely on the group structure of a population and does not invoke any of the other mechanisms traditionally used to explain cooperation, such as kin selection or reciprocity (for example, "if you cheat, I cheat; if you cooperate, I cooperate").

In the public goods game the modelers use, cooperation does not emerge if the population is assumed to be well mixed. Individual self-interest—that is, investing nothing in a public good—always pays off. But if individuals are assumed to interact only within local groups instead of with the entire population, and all other conditions of the game still apply, then cooperation becomes the advantageous choice and investment in public goods is maximized.

The mechanism, explain the authors, is simple: Reproduction in groups, along with limited dispersal between groups, results in variations in group size, "and for groups of sufficiently small size, the public goods game is no longer a social dilemma." Variants of the model show that cooperation does not evolve when groups can be any size or dispersal values exceed a certain range.

Applications for the model, which does not require individuals in a population to have any particular traits or abilities, may span the whole range of biological complexity, from genes and viruses to humans.

OVER 100,000 VOLUNTEERS SIMULATE CLIMATE CHANGE

Global climate models have been getting more sophisticated as computing power has increased. To make the most accurate predictions possible, models must incorporate as much of the global climate system as possible, a trend that has led recently toward assembly of multiple models. Utilizing the computers of more than 100,000 public volunteers, a group of UK scientists has created a "perturbed physics" ensemble, an ensemble of ensembles, to perturb key characteristics of model simulations one at a time (see climate*prediction*.net, or CPDN, at *www.climateprediction.net*).

Participants run three 15-year simulations using selected parameter values and initial conditions. The first simulation is a calibration, used to calculate natural climate variability, which is then incorporated into the second and third phases, "control" and "double CO_2" (carbon dioxide). These experimental phases calculate climate change over two 15-year spans using preindustrial CO_2 emissions levels and twice those levels, respectively.

The model predicts climate sensitivity, that is, the change in annual surface temperature, averaged globally, in response to a doubling of atmospheric CO_2. In their latest analysis of the CPDN results, Claudio Piani and colleagues at the University of Oxford have arrived at a climate sensitivity estimate of 3.3 Kelvin (K), or 3.3 degrees Celsius (see the December 2005 issue of *Geophysical Research Letters*). They also calculated a probability density function, which determined the possible range of values (the 5th and 95th percentiles) to be 2.2 K and 6.8 K, respectively.

People wishing to participate in the climate study, which the BBC is engaged in promoting, can not only contribute spare capacity on their computers but also track the results of their simulations using visualization software developed for CPDN by Numerical Algorithms Group. (See *http://boinc.berkeley.edu/* for more on distributed computing projects.)

*Glacier National Park's receding glaciers are caught in their disappearing act at a new USGS Web site featuring repeat photographs (*http://nrmsc.usgs.gov/repeatphoto/*). This view of Shepard Glacier was photographed in 1913 (top) by W. C. Alden and in 2005 (bottom) by Blase Reardon. Photographs courtesy of Glacier National Park Archives and USGS.*

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