New Mathematical Model to Predict Ecological Invasion and Species Survival

March 10 2005

Researchers at Rensselaer Polytechnic Institute and University at Albany have proposed a new mathematical model that predicts the survival of invasive biological species upon introduction to an ecosystem. The model analyzes the struggle for space between clusters of invasive species and native species to predict which species will survive. According to Gyorgy Korniss, assistant professor of physics at Rensselaer Polytechnic Institute, a predictive understanding of the ecological invasion process should lead to better techniques in preventing the proliferation of invasive species such as milfoil. A submerged aquatic weed that invades lakes, ponds, and reservoirs, milfoil often restricts natural water flow, clogs water intakes, and eliminates native species from ecosystems.

“This new model explains what happens when invasive and resident species are competing for space and how the invasion process evolves over time,” said Korniss. “We have shown that it is possible to quantitatively predict the lifetime of invasive and native species based on analysis of the species’ cluster patterns.”

Korniss collaborates with Thomas Caraco, associate professor of biological sciences at University at Albany, on the project which has also benefited from contributions by Rensselaer graduate student Lauren O’Malley (physics), Rensselaer undergraduate student Joseph Yasi (computer science, physics), and UAlbany undergraduate student Andrew Allstadt (biology, computer science). The work was supported by the National Science Foundation (NSF). “Our collaboration offers students a perspective to better prepare them for scientific careers that increasingly require an integration of disciplines," said Caraco.

The research findings are reported today in the Journal of Theoretical Biology in a paper titled "Spatial Dynamics of Invasion: The Geometry of Introduced Species."

To approach this biological problem from a computational perspective, researchers applied statistical physics to complex ecosystems. The researchers predicted the invading species' population growth in time based on its spatially-distributed cluster patterns by applying the theory of nucleation. Nucleation theory has been used to explain growth processes such as crystal growth, magnetic domain formation, and DNA replication.

Korniss said that additional research will combine spatial elements of species growth with more complicated temporal elements. "The next step in our research is to further develop the model to explain how the change of seasons affects the probability of an invasive species' survival," he said.

Source: Rensselaer Polytechnic Institute