Stockton Professor Uses Computational Science to Understand How Ecosystems Function

Dr. Russell Manson Travels to Iceland to Collect Data

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Galloway Township, NJ- "How fast does a stream breathe," asked Dr. Russell Manson, associate professor of computational science at The Richard Stockton College of New Jersey.

This is not a trick question; it's one real life application of computational science. Manson, a Galloway Twp. resident, recently traveled to Iceland and utilized a combination of cutting-edge technology with mathematics to find answers that may help us better understand our world and solve problems never before thought answerable.

The rate at which the stream "breathes" -- a measure of how fast the living organisms within the ecosystem undertake their life processes such as eating, moving, and reproducing, is one such problem only computational science can answer, Manson said. Planet earth is home to many ecosystems – defined regions inhabited by animals, plants and microscopic life, he explained. A stream ecosystem is an innumerable collection of living, breathing creatures.

An organism's metabolism is comprised of all the chemical processes that allow the organism to survive. Manson said the rate of photosynthesis and respiration of stream-life is a measure of the stream's metabolism. The summation of the metabolisms of all the creatures living within the stream is the "stream's breath" and the answer to Manson's original question.

The Stockton professor's research will appear in the June volume of *Freshwater Biology*, a prestigious scientific journal, and was supported by the College's School of Natural Sciences and Mathematics.

Stream metabolism is important to scientists for a number of reasons. Manson explained, "It is becoming increasingly clear that freshwaters play a major role in the global carbon cycle. Stream ecosystem respiration (breathing) and gross primary productivity exert a significant

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control on organic carbon fluxes in networks of running fresh water. However, little is known about how changes in climate will influence these fluxes."

Some researchers are also searching for a scientific "holy grail;" a universal theory of living systems known as the metabolic theory of ecology. Manson said, "Our research contributes to this conversation but there is still a long way to go."

Measuring and adding up the individual metabolisms of each living organism within the stream is impossible, so the research team measured the dissolved oxygen level in the stream over a defined period. This method measures the total oxygen used by the ecosystem.

Manson explained, "One aspect of the metabolic theory of ecology hinges on the relationship between metabolism and temperature. We all know that temperature and metabolism are related. You only need to raise your metabolism by undertaking aerobic exercise and you feel your temperature rise also."

But comparing metabolism in different streams at different temperatures is fraught with difficulty. Manson said, "The complication is that stream metabolisms differ under varying latitude, altitude, temperature, sunlight and stream geology." Most streams carve through regions of varying elevation and are exposed to varying levels of sunlight. Experiments performed in the laboratory can control variables such as these, but the results are synthetic.

Manson and his research collaborator (Dr. Benoit Demars of the Hutton Institute, Scotland) got around this difficulty by conducting their field research in what they call a "natural laboratory." A series of twenty spring-fed streams, located in a watershed in a remote part of Iceland, is one of the few areas in the world in which all variables except for temperature are constant for experimental purposes.

While in Iceland, Manson and the international research team gathered dissolved oxygen and temperature values at one-minute intervals over a twenty-four hour period, as well as other variables from the streams. The raw data was analyzed by a mathematical formula known as a differential equation. The math model has the ability to compute the stream's metabolism under various climate conditions.

Manson's research is an environmental application of computational science, the process of solving scientific problems too large or complex to be solved by traditional mathematics. He plans to return to Iceland this August to involve his students in this hands-on research combining field work and mathematics.

In November of 2010, Manson presented Stockton's computational science curriculum to a panel of judges during an international supercomputing conference in New Orleans. The program, which includes an undergraduate, accelerated dual-degree and master's program, was given the Undergraduate Computational Engineering and Sciences Award, administered annually by the Krell Institute and funded by the United States Department of Energy.

During the College's winter 2010 commencement, the first two graduates of the undergraduate computational science program received their diplomas.

To download a high resolution photo of Dr. Manson in Iceland, please click here.

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