

VIMS Leads Long-Term Ecological Research Program in Antarctica

Scientists define an ecosystem as a collection of species—animals, plants, and microbes—that have adapted over millions of years to function together. What happens when these finely balanced systems face natural or human-induced change? How does migration of new species in and out of the system affect the food web? Do some species die out as others replace them?

These are the kinds of questions biological oceanographer Dr. Hugh Ducklow and others are asking as they continue their ecosystem studies in Antarctica. Ducklow, Glucksman Professor in VIMS' Department of Biological Sciences, will for the next six years be lead investigator for the Long-Term Ecological Research (LTER) site at Palmer Station, one of three permanent U.S. research outposts in Antarctica. The Palmer LTER site is one of 24 sites funded for long-term studies through the National Science Foundation (NSF). Ducklow will coordinate research with scientists from the Scripps Institute of Oceanography, U.C. Santa Barbara, Columbia University, and the Montana-based Polar Oceans Research Group.

"This is an outstanding opportunity for our students to work with scientists and students from leading marine research centers all over the country," says Ducklow. The collaborating scientists will share the six-year grant totaling \$4.2 million.

NSF established the LTER program in 1980, as a unique program for studying the fundamental nature of ecosystems and their response to disturbances. "This is a very innovative approach to research," says Ducklow. "Most grants provide funding for two to three years, then you start over with another proposal. By having support and sites available for long-term study, scientists can better explore the interaction between humans and ecosystems." LTER sites also provide an accumulation of data and knowledge to help build new research and to support infrastructure. Only 24 institutes in the U.S. host LTER programs, at sites that include desert, forest, coastal, grassland, prairie, everglade, and both Arctic and Antarctic ecosystems.

Dr. Polly Penhale, with NSF's Office of Polar Programs, notes that "the polar regions play a critical role in

global processes on Earth. In order to understand global and regional changes in the biosphere, it is critical to collect long-term data that can be used to gain an understanding at both temporal and spatial scales."

Comparative studies with other LTER sites in the U.S. will lead to a greater understanding of the structure and function of ecosystems. "The Antarctic ecosystem is simpler than the Chesapeake Bay system," Ducklow explains. "In an area of lower temperatures there are fewer species and it is possible for us to observe changes earlier." Global warming is occurring more rapidly in the Antarctic than anywhere else on the planet. Winter temperatures have warmed by 5 degrees C in the past 50 years. In this environment, scientists have an opportunity to see changes occurring. "By studying this system, we not only gain a better understanding of changes in the Antarctic ecosystem, but also knowledge that will help to anticipate changes that may take many decades to centuries to occur in a system like Chesapeake Bay."

Scientists don't know how changing ecosystems will work. A new

Data and Models Help State Manage Shellfish-growing Waters

By Carl Hershner

Closure of shellfish-growing waters because of elevated bacterial levels is a common, long-standing problem in Virginia. The Commonwealth is now engaged in efforts to improve these conditions by reducing controllable sources of bacteria entering tidal waters. This activity is part of the water-quality management program operated by Virginia's Department of Environmental Quality (DEQ).

Remediation of contaminated water involves development of total maximum daily load models, or TMDLs. These models do just what the name implies—calculate the total maximum daily load of bacteria that can be allowed to enter a water body without violating water-quality standards. Once regulators know these limits, they must figure out where excessive bacterial loads originate.

VIMS currently plays an important role in DEQ's effort to develop TMDLs for condemned shellfish-



Dr. Hugh Ducklow leads a program that studies how Antarctic ecosystems are responding to global change.

collection of species in a system may not be as well adapted to living together and the system may be in transition for many years. For instance, the Adelie penguin is at the top of the food web in Antarctica. During the past 25 years their populations have decreased by 50-75%. Ducklow and colleagues are examining the abundance of phytoplankton and krill to determine if inadequate nutrition is contributing to the penguins' population decline. The scientists also note that other species of penguins are moving in and adapting to the warmer climate fairly well. Says Penhale, "Whether

these changes signal global change with implications for the Earth as a whole or simply indicate a regional cycle in temperature is unclear. Long-term data collection and analysis is the key to answering such questions."

LTER places a high priority on education at all levels, notes Ducklow. "With this new award we'll be able to train a new generation of graduate students, extend to undergraduates at William & Mary and elsewhere a unique opportunity to visit Antarctica, and bring the polar ecosystem into Virginia classrooms from kindergarten up."

growing waters. Scientists in the Center for Coastal Resources Management (CCRM) and the Physical Sciences Department are working on projects to create databases and models that will facilitate Virginia's efforts to develop shellfish TMDLs. CCRM scientists have created an extensive database of near-shore shellfish waters using geographic information systems (GIS). The database contains digital maps of the small coastal watersheds that feed each of the 276 condemned shellfish areas in Virginia. The CCRM staff has also converted shoreline surveys into a computer-based system that allows regulators quick access to much of the information necessary to develop a TMDL. These surveys are conducted by the Department of Health's Division of Shellfish Sanitation.

Scientists in VIMS' Physical Sciences department have developed models that link watershed, hydrody-

namic, and water-quality parameters to generate TMDLs. These models take information in the computer database and quickly calculate both the required limits on bacterial loads and various ways to achieve those limits. The output is a number of management options that can be considered by DEQ and local residents in efforts to "clean up" affected areas.

Both of these projects are nearing completion. VIMS scientists are now working with DEQ staff to plan for the actual development of TMDLs for all the condemned shellfish-growing waters in the Commonwealth. The Institute will assist DEQ by using its expertise to develop and analyze models for each of the affected shellfish-growing areas. The effort, which will require several years to complete, is an outstanding example of the Institute using its expertise to solve very practical problems for the Commonwealth.