RACKED BY FEVER, SHAKEN BY CHILLS AND WITH AN APPETITE ONLY FOR SLEEP, FLU SUFFERERS TAKE TO THEIR BEDS FOR RECOVERY. WITH OR WITHOUT MEDICATION, MOST WILL IMPROVE, SHAKING OFF ILLNESS IN A WEEK OR TWO. ABSENT SEVERE IMPAIRMENT, THE HUMAN IMMUNE SYSTEM IS ROBUST. NOT SO ECOSYSTEMS, WHICH SOME ACTIVISTS CONSIDER IRREPARABLY HARMED BY RESOURCE DEPLETION, HABITAT DESTRUCTION, POLLUTION, AND GENERAL, ONGOING NEGLECT.

BUT ARE RIVERS AND BAYS DOOMED TO SUCH BLEAK FATES?
Perhaps not, according to initial findings from a pair of Old Dominion University-led studies commissioned by the U.S. Navy Office of Naval Research Harbor Processes Program, and conducted in and near the Elizabeth River. There are hints that natural systems might have a rough equivalent of immune-system response, at least with respect to the short-term effects of otherwise potentially toxic metals. Some native microorganisms might be able to release compounds that bind to and neutralize certain metallic toxins, significantly reducing damaging concentrations.

“Portions of the Elizabeth River are among the most polluted waterways in the United States. The total concentrations of some metals are very high,” says John Donat, Old Dominion associate professor of chemistry and biochemistry and a leader of one of the investigations. “However, the concentrations of the metals’ toxic forms appear to be below or just approaching levels that kill phytoplankton, the single-celled plants at the base of aquatic food chains. The amazing thing is the toxic-form concentrations are not as high as we would have expected from the magnitude of the total concentrations.”

Donat and Andrew Gordon, chair of Old Dominion’s Department of Biological Sciences and leader of the other ongoing river study, emphasize their results are preliminary and may change seasonally. But the initial findings are intriguing enough to suggest if indeed some natural resistance is present, it may be possible to identify and then encourage proliferation of beneficial microorganisms.

“The question is how close the Elizabeth River system is to its biological limits,” Gordon says. “If we can understand what the compounds are, good and bad, and how they interact, it could lead to techniques to purify effluent before it enters the waterway. Maybe we could even figure out ways to boost the natural defenses.”

Researchers use this metal grid to hold plastic bottles containing Elizabeth River water samples. Each sample contains a different chemical treatment. By mooring the rack and samples to the river bottom with a weight, they can incubate the samples under natural conditions of light and temperature to determine how the river’s microorganisms respond.

A FOCAL POINT FOR RESEARCH

As with any complex system, the interrelation of ecology, chemistry, biology, toxicology and human influence that affects and harms an estuary is difficult to clearly identify. One factor that appears to directly impair the Elizabeth’s health is the large number of Navy ships that transit the Elizabeth and are moored in it. Antifouling paint used on ship hulls contains organism-damaging copper compounds that leach into surrounding waters; spills of sewage, trash and a variety of pollutants can also occur. The critical issues are the degree to which toxins persist and are released into the water table, or are entombed in bottom sediments, or are flushed out to the coastal ocean.

“These metals concentrations don’t go away,” says David Burdige, an associate professor in the Old Dominion Department of Ocean, Earth and Atmospheric Sciences. Burdige is examining the role sediments play in toxins interactions and transport. “Once you put something in, it stays in. What we hope is that the metals in the sediments can be sequestered in phases that are non-reactive.”

Should a hurricane or other large storm sufficiently disturb metals-laden sediment, disinterring toxic varieties, the river system could face irreparable harm. The right kinds of poisons might explode up through the food chain in destructive, devastating ways. “There’s a huge reservoir of toxins bound up organically. If they were to be released, the results would be catastrophic,” Gordon points out. “It’s a very delicate balance. That’s why we want and need to understand the mechanisms.”

Take copper, generally considered so harmless to humans that many water-carrying pipes are made from the metal. Sensitivity on the part of marine creatures is another matter. Approximately 1 percent of the copper in most natural waters exists in potentially toxic inorganic forms.
Ingested even in minuscule amounts, it can fatally disrupt basic cellular mechanisms. Organically bound forms of copper account for the remaining 99 percent. Scientists believe certain microorganisms are able to metabolize and convert inorganic copper into the more benign organic forms.

“It’s not the total concentration of copper that’s the problem,” Gordon explains. “It’s the concentrations of the different forms of copper, or what’s known as its ‘speciation,’ that influence bioavailability and toxicity. We’re trying to get at the processes that affect copper’s bioavailability and its specific toxicity.”

In a field study conducted in July 1999, surface water was collected at six points along a track running from the mouth of the Chesapeake Bay down through the Elizabeth River. Bottom water samples and sediment cores also were culled from two of the six sites. Water samples were double-bagged in plastic zip-lock bags and returned to a University “clean lab.” Within six hours of collection, filtered water samples were frozen and stored until analysis began. Today, at the laboratory, the team continues to study how metals and dissolved organics migrate in and out of river sediments, to better understand how they are affected by sediment processes.

Researchers also secured river water by means of two dozen, two-liter plastic bottles moored on a stainless-steel frame oriented horizontally and submerged in the Elizabeth to a depth of three feet. Some of the bottles contained water dosed with copper, to study its effects on native microorganisms. Several of the bottles remain untreated, while the remainder contained a variety of inhibiting agents that scientists believe will affect how copper is metabolized by the microscopic river creatures.

“This is an experiment in progress,” Gordon says. “We had conflicting results in the first incubation. Regardless of what happens, we’ll continue the research through the seasonal cycles. We expect to see differences, both at our two sites and at different times of the year.”

Because of its location and infrastructure, the University has become a regional focal point for river-related studies. Old Dominion’s proximity to the Elizabeth provides a major advantage to researchers. Not only are study sites easily accessible, but state-of-the-art analysis is quickly available. As experiments continue through the end of calendar year 2001, researchers from the National Marine Fisheries Service in Beaufort, N.C.; Woods Hole Oceanographic Institution in Mass.; Cornell University in N.Y.; and the Naval Research Laboratory in Arlington, Va., are all expected to join Old Dominion scientists in their investigations.