3333 Audubon Nov.-Dec 95

Cedar River and other tributaries of Lake Washington. Last winter the run was down to an estimated 125. "If we don't do something, they'll be gone in a few generations," says Robert Everitt of the Washington Department of Fish and Wildlife.

The chief culprit in the decline may be another species, the California sea lion—and the sea lions may pay with their lives.

To reach their spawning grounds, the steelhead must swim up the fish ladder at Ballard Locks, on the Lake Washington Ship Canal. The sea lions know a good thing when they see one: Since the early 1980s they have congregated around the entrance to the ladder, eating as many as half the steelhead each year.

The state tried shooting the sea lions with rubber-tipped crossbow bolts, installing a net at the fish-ladder entrance, and detonating firecrackers underwater. Finally, in July 1994, it requested that the National Marine Fisheries Service (NMFS) approve "lethal removal" by injection.

The sea lions are protected under the Marine Mammal Protection Act. However, a 1994 amendment to the act allows the killing of animals known to be endangering salmon populations, and steelhead are members of the salmon family. To evaluate the conflict at the locks, the NMFS convened a task force of representatives of environmental organizations, universities, sport fishing organizations, Indian tribes, and government agencies such as the U.S. Army Corps of Engineers, which has jurisdiction over the locks. In November 1994 the task force recommended lethal removal, and the NMFS approved it in January. It was the first time permission had been given to kill marine mammals in the United States, though no sea lions were killed last winter.

But is this really a case of species versus species? Eight members of the task force—all six environmentalists and two of the four university representatives—don't think so. They say killing the sea lions would be pointless because others would take their place; they argue that the biggest problem is the design of the fish ladder. The steelhead, which can reach three feet in length, must find a narrow opening that varies between about one and four feet wide. Worse, the fish mill around the ladder's base for days with no place to hide, increasing their vulnerability.

California sea lions are preying on steelhead trout.

One way to provide cover would be to install an artificial kelp forest of Mylar strips at the base of the locks. According to the dissenters, the NMFS has been requesting such improvements for five years, but the Army Corps of Engineers has not responded. Task force member Donald Wynn of the corps says his organization has recently been seeking ways to improve the ladder.

The task force's recommendation was based largely on the fact that the steelhead's decline correlates with the arrival of significant numbers of sea lions at Ballard Locks. But two other factors also correlate with the run's decline: the general decrease in the productivity of the Pacific Ocean after El Niños in the 1980s, and degradation of spawning grounds in the Cedar River, where diversions and flood-control measures have reduced the surface area by more than half.

"[The task force] zeroed in on the easy way out," says dissenter Glenn VanBlaricom of the University of Washington. "But we would have to kill many sea lions, and I don't think the public will buy into that." —*Robin Meadows*

ECOSYSTEMS

Taking the Long View

OUTSIDE A CLUSTER of wood-frame laboratories and dormitories in Oregon's Andrews Experimental Forest, forest ecologist Mark Harmon and an assistant were making "cookies"—each about the diameter of a tire, fashioned with a howling chainsaw from the end of a log.

For a decade Harmon has been analyzing this wood chemically and physically, following the inexorable decay of each log. The work has yielded results already, including details about the role fungi play in cycling nutrients to the forest soil.

But the most startling aspect of the study might be how it defies a long-standing convention. While most scientists limit research projects to a few years, Harmon has designed his study to be continued by generations of scientists yet unborn: It will take two centuries for these logs to decompose completely.

The study is but one puzzle piece in an almost dizzying array of research going on here in the Andrews Forest and at a scattering of other sites in the United States that takes not only the (often very) long view, but also the (often very) holistic view. The Andrews, a 16,000-acre parcel of mainly old growth set aside for research in the Willamette National Forest, is one of 18 Long-Term Ecological Research (LTER) sites now sponsored by the National Science Foundation. Other locales range from the Chihuahuan Desert to the Kansas prairie, from a rainforest in Puerto Rico to the lake country of northern Wisconsin. Although their approaches vary, all the projects are attempting to use knowledge from an array of disciplines to help piece together the mystery of how entire ecosystems function over the sweep of time and space.

Critical discoveries have already emerged. Some were answers to specific questions (might the messy-looking jumble of sticks and logs in an old-growth-forest stream actually serve a biological purpose? Answer: yes, in spades). Others were pure serendipity (what caused the appearance of the Hanta virus in the American Southwest in 1993? Answer: weirdly, a weather system in the Pacific Ocean).

James Gosz, a University of New Mexico biologist who chairs the LTER coordinating committee, says that scientific tradition in the past discouraged efforts like these. "It just wasn't the way science was supported," he says. "Funding tightly-focused projects of one to three years has been the norm because the feeling was that you had to show results quickly. But ecological variables are often hugely dynamic. For example, if you study a plant population in a wet year you only get a snapshot, which could be completely different from a dry year. It's like trying to characterize children by knowing them for an hour."

The Andrews project is one of the oldest of the LTER efforts, having continued for more than two decades. Chemists, geologists, mammalogists, botanists, and even experts in satellite imaging have done research involving everything from injecting radioactive tracers into tree sap to boring into soils to study insect life, from monitoring rapid changes in tiny algae to measuring the slow movements of landforms over decades. The work has provided much of the scientific basis for the notion that old growth itself has biological value.

Other studies have generated equally important insights. At the Konza Prairie LTER site, in the Flint Hills of Kansas (see "What Good Is a Prairie?" page 36), research has shown that although burning prairie is critical for maintaining it, too-frequent burning of prairie refuges may actually reduce biological diversity.

And then there's the mystery of the Hanta virus, which broke out on and around the vast Navajo reservation in New Mexico in 1993. Once medical investigators had linked the virus to infected deer mice, they began to wonder if they were looking at the front end of a new epidemic. But data from the state's Sevilleta Desert LTER site showed that the region's seed-eating-mouse population had increased in response to an explosion of seed-bearing plants, itself an apparent response to an unusually wet spring brought on by an El Niño weather system thousands of miles away in the Pacific. The scientists' prediction: The disease would subside with El Niño. By the end of the year, it had done just that.

Why continue such studies? "On one level it's a frontier issue," says Fred Swanson, the geomorphologist who directs the Andrews project. "People are still out there on the scientific frontier, looking in some new places and finding interesting stuff. But the benefits can be practical and tangible. These are the ecosystems that feed us, provide our drinking water, give us aesthetic pleasure." In light of that, he says, "the time and the resources devoted to these studies are a pretty small price to pay." —*Jon R. Luoma*

ENVIROTECH

Cleaning Up With Horseradish

ACCORDING TO JERZY DEC, a research associate at Pennsylvania State University's Center for Bioremediation and Detoxification, *Armoracia rusticana*—the ubiquitous horseradish—could become an important tool in the cleanup of phenols, which are water and soil pollutants produced by a wide range of industries.

Minced horseradish plants added to contaminated water neutralizes pollution by virtue of enzymes that cause the phenols to form a stable bond with other chemicals generally present in industrial waste. The newly formed compounds, which are water insoluble, then precipitate out and are easily removed. The addition of hydrogen peroxide initiates the process, which can clear as much as 100 percent of the phenols from tainted water in just half an hour.

In a paper published last year in the journal *Biotechnology and Bioengineering,* Dec said the process represents a major improvement over other forms of organic remediation, which may require weeks or months to act. The process is also effective in contaminated soil, where it binds phenols to humus.

Hundreds of thousands of liters of phenol-containing wastewater are generated every day at a typical industrial site. And hundreds of tons of soil may be contaminated by spills or as the result of continuous emissions of toxins. Given the magnitude of the problem, says Dec, another advantage of horseradish is its cost-effectiveness. In one test, minced horseradish retained 100 percent of its neutralizing effect after being used 15 times; and supplies are plentiful. In fact, the plant itself is considered something of a problem. As gardeners know, it costs less to grow horseradish than to prevent its growth. —*Robert Frenay*

The Blackstone Now Runs Blue

By Ted Williams

How the Clean Water Act saved a river—and why the act itself must be preserved.

I WAS PAYING more attention to the river than to the dignitaries. They and it were babbling happily in front of Slater Mill in Pawtucket, Rhode Island, on the sticky morning of July 18, 1995. The speakers expressed great pride in the restoration of the mill, the restoration of the Blackstone River ecosystem, and their valley's contribution to our nation's manufacturing heritage. "It all started here," they kept explaining. What started here—the American industrial revolution—turned into the worst ecological disaster this continent has ever experienced.

The Blackstone rises under the streets of Worcester, Massachusetts, and flows 46 miles to Providence, Rhode Island. It was the first polluted river in America, and as far as I can determine, it's the only one whose headwater flow is mostly outfall from a regional sewage-treatment plant. Slater Mill—a cotton-spinning operation constructed in 1790 by Samuel Slater, Moses Brown, and William Almy—was the United States' first water-powered textile mill. The three fathers of our industrial revolution took it upon themselves to extinguish the river's prolific runs of salmon, shad, alewives, and blueback herring. Never before had Rhode Island permitted anyone to build a dam without providing fish passage. When enraged fishermen tore down the barrier, Slater and his associates, with the forces of law and order on their side, rebuilt it.

By the 1830s there was a mill dam for every mile of river, usurping the power of the Blackstone as it plunged 438 vertical feet to Narragansett Bay, a more precipitous drop than that of the Colorado through the Grand Canyon. In 1828 an elaborate canal-and-lock system had made landlocked Worcester a seaport, but such transportation was rendered obsolete 19 years later by the Providence and Worcester Railroad.

Before Slater Mill, "America's hardest-working river," as the Blackstone has been called, fed the people of Rhode Island and Massachusetts with protein. Once the dam was built, the river fed industry with power, and because there was no longer any protein to worry about, it doubled as a waste-removal system. Throughout the 19th century, buildings were constructed with their backs to the Blackstone so valley residents needn't gaze on it—and so they could more easily push their refuse into it. When they complained that their river was giving them asthma and tuberculosis, the framers of our manufacturing heritage attempted to overpower the dangerous vapors by burning coal tar. So foul was the Blackstone that textile mills had to find other sources of water for washing their wool.

The Clean Water Act, passed by Congress over a Nixon veto in 1972, changed all that. When I settled beside the Blackstone River in April 1970, a dog belonging to my insurance agent had recently died as a result of frolicking in it. Not altogether in jest he had publicly proposed that the Blackstone be piped underground to Narragansett Bay. Today my dog, who enjoys rolling in compost, actually cleanses himself in the Blackstone.

When I first walked beside the river 25 years ago, nobody I knew felt anything for it. Now even the industries that used to pollute it are proud of it. The Clean Water Act has transformed a river that was an ecological desert into an ecological magnet that is pulling new life into new habitat. You don't have to cut nature much slack; although the river is still very sick in its upper reaches, it now supports thriving populations of waterfowl, muskrat, otters, turtles, frogs, yellow perch, white perch, largemouth and smallmouth bass, black crappies, bullheads, pickerel, sunfish, and hatchery-bred trout. Now I live beside a Blackstone that two years ago called in an adult Atlantic salmon from its ocean wanderings, and in which blueback herring that were transplanted to test the feasibility of anadromous-fish restoration have successfully spawned.

"The process of restoring the waters of a stream to their original purity is not always good judgement or sound

The Blackstone River (right), flowing by a dam in South Grafton, Massachusetts, in August. Top: Industrial waste pouring into the Blackstone in 1970.