New Roots

You may not dine on curly-dock pancakes or gamma grass on the cob anytime soon. But a Kansas plant geneticist hopes these and other prairie plants will one day replace corn, wheat and soybeans in America's farm fields.

Wesley Jackson, director of the privately operated Land Institute in Salina, Kansas, is trying to develop perennial crops that would not have to be plowed under and replanted every year. He says this would save energy and protect soil from erosion. And he says several native plant varieties are higher in nutritional value than many of today's crops.

According to Jackson, plants like eastern gamma grass, a high-protein relative of corn, take nitrogen from the air to make their own fertilizer. Others, such as Maximillian sunflowers, produce natural pesticides. Jackson thinks several varieties could be planted together in a field to share their beneficial characteristics and reduce the need for synthetic fertilizers and pesticides.

Critics claim these kinds of plants cannot meet the demands of the modern agricultural market. They say it isn't possible to get a high seed-yield out of perennials because the plants need to reserve their energy for the next year's growth. So only annual plants, like corn and wheat, can afford to put most of their energy into seed production.

But Jackson disagrees. He points out that plants like curly-dock, a member of the buckwheat family, are more productive than many common farm crops. He says by breeding them for certain characteristics, scientists could make other prairie perennials more productive as well.

Jackson says change will come slowly. He hopes to persuade some farmers to grow his prairie plants on land easily eroded by row crops. He believes these farmers would save soil and energy and still get a good return on their investment.

Plant Partnerships

Next to weeding, the biggest headache for home gardeners is protecting vegetables from insects and other animal pests.

Lawn and garden centers usually prescribe chemicals to get rid of pests, but many people prefer not to use them. Instead, they try a rather old-fashioned alternative. It's called companion planting, and the idea behind it is to plant together two or more crops that benefit each other.

Jerry Minnich of Madison, Wisconsin, has written several books on gardening. He says some plants help keep pests away from other plants. For instance, marigolds grown next to virtually any vegetable crop discourage pests. People used to think the flowers' pungent odor was responsible, but recent research has shown another factor to be important: Marigold roots produce three compounds that filter into the soil and kill several common plant parasites.

The effect of marigolds is scientifically confirmed. But generations of gardeners also swear by a host of other unconfirmed crop companions. The herbs rosemary and summer savory reportedly repel beetles from bean plants. Mint is said to keep away the cabbage butterfly. Chives and garlic are believed to drive aphids away from peas and lettuce.

But companion plants don't just protect each other from pests. Minnich says deep-rooted plants help break up the soil for weaker-rooted plants. And tall plants like broccoli help shade low-growing crops like lettuce from the withering heat of the summer sun.

It is still not understood how some plants benefit neighboring plants. But plenty of people are convinced that companion planting keeps gardens healthier without the use of a lot of chemicals.

June 1982
Ocean Spray?

Algae from the ocean may someday kill insects on the farm.

Many farmers rely on pesticides to keep crops free of insects and to increase yields. But the chemicals can be ineffective if insect populations become resistant to them. And pesticides can be banned if they're too toxic to other forms of life. Consequently, pesticide manufacturers are always looking for new compounds that are both effective and safe.

Sea Grant chemist Joseph Hanke at the University of California-Berkeley suggests that pesticide companies turn to the sea.

One way of looking at the marine environment is that it’s a gold field, and we can go out and mine the marine environment for chemicals that are new and therefore different.

Using marine resources in agriculture is not new. For example, seventeenth century farmers used whale oil to kill insects in rice fields.

Someday, modern farmers may kill insects in the field with algae. Hanke has identified 14 species of red and brown algae that contain compounds lethal to insects. The chemist says much as a skunk protects itself by producing scent, algae defend themselves with toxins.

Hanke says it is not unusual for marine plants to protect themselves from insects because the plants face numerous threats from them. They may be eaten by the larvae of insects that have aquatic life stages. They may be exposed to air and to hungry insects when the tide goes out. And in deeper water, they may be on the menus of lobsters and crabs, which are close cousins to insects.

Hanke is currently testing the effectiveness of algae toxins against pests that plague cotton, corn and tobacco crops. He says because the toxins occur naturally, they could be safer to use than synthetic chemicals.

Casts of Thousands

The earthworm stirs and makes its cast, By this we know it's spring at last.

That poetic tidbit is the creation of Francis Hole, professor of soil science and geography at the University of Wisconsin-Madison. Hole says he wrote the poem after he found several earthworm casts on the edge of a sidewalk one soggy spring day.

What's an earthworm cast? Hole says it's actually earthworm manure. As worms burrow through the ground, they move the soil and organic material through their bodies and deposit their casts throughout the soil. Hole says earthworm casts contain five to 11 times the amount of three major plant nutrients—nitrogen, phosphorus and potassium—as does the soil that contributed to the casting. The casts also improve the structure of the soil by making it more crumbly, so it drains and "breathe" better.

Hole says there are about 1,800 known species of earthworms. They vary by species from place to place according to types of soil. Some worms prefer the acidic soil and deep layer of needles in pine forests. Others live in the less acidic soils of hardwood forests or farm fields.

Oddly enough, says Hole, the most common earthworm, the night crawler, isn't a native of North America. It was brought here from Europe by early settlers. But the night crawler has made a comfortable home here and has given farmers and home gardeners a cheap and efficient means of improving the soil.
Salt of the Earth

Of all the natural compounds, salt may be the most puzzling. Our body fluids contain it, and in judicious amounts, our diets require it. We pay respect to salt in expressions like “he’s the salt of the earth,” “worth his salt,” and even the warning, “take it with a grain of salt.” But scientists believe this worthy compound is a growing threat to world agriculture.

They are alarmed by the gradual salting of croplands by irrigation—a practice born in the floodplain of the Tigris and Euphrates rivers 6,000 years ago in what is now Iraq. This Fertile Crescent, as it was called, once fed a population of between 17 million and 25 million people. Then it became too salty to sustain its crops, and now it is largely desert.

On lands with plenty of rain and drainage, the natural salts in water and soil are easily flushed into rivers and, eventually, the oceans. But in regions with little rain and particularly poor drainage, irrigation gradually deposits more and more salt in the ground. Evaporation from plants and soil releases essentially pure water to the air and further increases salt concentration. In California’s San Joaquin Valley, many farmers must use 5 percent to 10 percent of their land for evaporation ponds to remove salt from irrigation water.

A recent report by the London-based International Institute for Environment and Development claims that salt has already reduced crop production on half the world’s irrigated land. And the U.S. Department of Agriculture’s Soil Conservation Service is investigating the salinity of this nation’s soils. The agency hopes to persuade federal policy makers to give this threat high priority. For America’s fruited plains, such as those in the Imperial and San Joaquin valleys of California, the threat is already real. —December 1984

Chemical Controversy

Will genetic engineering one day make agricultural pesticides and fertilizers obsolete? Or will it make farmers more dependent on chemicals than ever before?

Biotechnologists hope to produce crop plants that resist pests and diseases and fertilize themselves. They say this would free farmers from the need to use large amounts of chemicals in the field. One industry official even calls genetic engineering a “back-to-nature” technology.

But Terri Goldberg of the Committee for Responsible Genetics in Boston disagrees. Goldberg says one of the major thrusts in biotechnology at present is to create plants that are more tolerant of chemical herbicides so the two can be tied together.

I don’t see this back-to-nature movement happening in the biotechnology companies. I see exactly the opposite. In fact, many of the companies that produce herbicides are those companies that are most actively interested in producing new seed varieties that will utilize more and more herbicides.

And more herbicides, says Goldberg, could cause greater environmental harm and pose potential health problems.

Robert Molz of the DuPont Corporation disputes the claim. Molz says the advent of herbicide-resistant plants would enable farmers to use new, less-toxic chemicals in smaller amounts.

And what all this is going to translate into is lower cost of production for the grower, and that will translate into lower costs at the supermarket for you and me. I think it will be environmentally less damaging and result in greater safety to the growers and applicators who use these chemicals.

Molz maintains that new, herbicide-resistant crops would be just the first step toward chemical-free farming. —May 1985
Preventable Pollution

Barnyards and feedlots are a big source of water pollution in the dairy lands of Wisconsin. But they don’t have to be.

Fred Madison, a University of Wisconsin-Extension soil scientist, says farmers can prevent storm water from sweeping manure off their farms and into streams and lakes.

Divert the water upslope. Keep as much water out of the barnyard area as you can. And then, if necessary, collect what water runs out of the barnyard-feedlot area and treat it before it’s introduced to a waterway.

Madison says diversion ditches upslope, gutters and downspouts on barns, and other precautions can steer most runoff away from places where livestock congregate. He says catch basins downslope from those places can trap the rest and hold it until the manure settles out.

What can farmers do with manure? Madison says they should spread it on their fields to replenish the soil. He believes this is generally safe even in winter, when the ground is frozen and cannot absorb manure right away. But he says there are exceptions.

Where farmers do not have land-sufficient land of the right kind of slope and thickness and separation from streams to spread the wastes that their cattle will generate during the wintertime, then storage for the winter months is an appropriate water-quality protection strategy.

Farm improvements to stop water pollution cost money, of course, and that’s something many farmers are short of these days. A new $1 million state fund will give qualifying farmers in Wisconsin up to $10,000 each toward those expenses. Madison says a million dollars is not enough to help everyone who needs it, but it’s a start.

August 1984

Swept Away

Every day, winds whip across open fields and sweep away clouds of dust. Rain carves gullies into unprotected hillsides. The result is soil erosion. It happens mostly on farms, but it occurs in towns and cities, too.

Leonard Johnson, a soil conservationist with the University of Wisconsin-Extension, says land development and construction sites are most vulnerable.

Because the land is disturbed, it’s open and susceptible to active erosion, and a lot of soil can be moved off. The amounts of soil lost per unit area can be truly massive—you know, 10 to 100 or more times what you might get from an agricultural cropland area.

Johnson says urban soil erosion can be a big nuisance. Loose soil piles up on streets and clogs storm sewers. It also washes into lakes and streams, adding to water pollution.

But Johnson says developers and contractors can control soil erosion.

There are some relatively simple and effective things they can do, in the technical sense, in terms of land stabilizing measures, vegetative practices, using mulches, using temporary sediment-retention structures, just managing how the surface water runs, retaining it where appropriate, and protecting the soil surface from raindrop impact and from runoff.

Some communities and states with severe urban erosion require special protection for construction sites. But no matter where it happens, Johnson believes it is in the best interests of land developers to prevent erosion.

February 1982
Coon Valley's Milestone

Coon Valley, located in southwestern Wisconsin near La Crosse, was once plagued by severe erosion. Today, Coon Valley is hailed as a showcase for soil and water conservation.

Nearly 50 years ago, the federal Soil Conservation Service picked Coon Valley—an area of rough, rolling terrain—to become the nation's first major target for erosion control. The area had seen two generations of intensive agriculture and had suffered droughts and floods. It bore scars in the form of barren hillsides, numerous gullies and streams that were choked with eroded sediment.

Many Coon Valley farmers saw erosion ruin their land. In 1933, with help from the Civilian Conservation Corps, they adopted new ways of farming. They began rotating crops, building grassed waterways and terracing steep slopes. They also planted crops in alternating strips that followed the contours of the land. Over the years, these innovations slowed the velocity of storm runoff and helped rebuild the soil.

Because these conservation measures were taken, the gullies have healed over and the land is productive again. Today, the streams in Coon Valley are flowing clearer because less eroded sediment washes into them. The numbers of fish and wild animals in the area—such as trout, deer and ruffed grouse—have increased substantially.

The lessons learned at Coon Valley have been long-lasting and widespread: They've helped establish soil and water conservation techniques that are applied not only in Wisconsin and elsewhere in the upper Midwest, but overseas as well.

August 1982

The Great Land Loss

Louisiana has 40 percent of the nation's wetlands, but 50 square miles of those wetlands wash into the Gulf of Mexico each year. The state suffers the greatest losses of any state in the country to coastal erosion.

That land loss may increase the price we pay for seafood and energy. As Louisiana's wetlands erode, important nursery grounds for fish and shellfish disappear, and when catches go down, seafood prices go up. New restrictions on energy exploration in the wetlands could slow this erosion, but they also could make natural gas and oil more expensive to extract.

Louisiana State University marine scientist Eugene Turner says the dredging of canals is the biggest culprit in wetland erosion. He says his studies indicate that dredging canals to find and extract oil and natural gas in the wetlands accounts for at least 50 percent of Louisiana's coastal land loss.

In places, canals in Louisiana's coastal wetlands are as dense as streets in a crowded subdivision. It's not just the land destroyed by dredging that has people worried. The bigger problem is that the canals interrupt the flow of sediments and nutrients through the marshes. These materials nourish the growth of marsh ecosystems: Without a continuous supply of sediments and nutrients, these fragile areas subside or break up in storms and wash away.

Piling the dredged materials, or spoils, in banks along the canals has divided the marshes into impounded fragments. Turner says the spoil banks keep water from flowing between marsh and adjacent waterways, and many marsh areas have turned into ponds and lakes, some with telltale rectangular shapes.

There are new restrictions on dumping dredge spoils to protect the wetlands. But, Turner says, Louisiana will continue to suffer as a result of 50 years of virtually unrestricted dredging.

March 1983
Across the Fruited Plain

It's a parcel of living history with vistas like those the first settlers faced as they moved west: a veritable sea of grass, shining amber waves harboring a multitude of plants and wildlife.

The Konza Prairie stretches almost 9,000 acres across Kansas. It's the last place in America where unspoiled remnants of the Great Plains still reach as far as the eye can see. Lloyd Hulbert and other biologists at Kansas State University have studied the Konza for more than 25 years.

They are trying to understand how its many components-plants, insects, birds, mammals, soil and streams, to name a few-survive and interact. Hulbert says learning how prairies maintain themselves helps protect the remaining patches. It also benefits agriculture: Prairie researchers learn about grassland management techniques that are useful on grazing lands, and they also learn what kinds of soils prairies form and how they stay productive.

Kansas State bought a thousand acres of the Konza Prairie in 1971. The Nature Conservancy, a private land-preservation organization, bought nearly 8,000 more acres six years later. That assures that the prairie will remain forever wild.

The National Science Foundation has given Hulbert and his colleagues a long-term research grant to continue studying the Konza. The university now has six full-time scientists at work there, and Hulbert says this priceless remnant of the Great Plains will provide research opportunities for generations to come. ■ July 1984

Harvest of Dust

The world is losing fertile land at a startling rate, according to the United Nations. And it's happening fastest in places that can least afford it.

UNEP, the United Nations Environment Programme, estimates that 52 million acres of range and crop land are reduced to wasteland every year. That's an area roughly the size of Minnesota, and UNEP says people are to blame.

In developing countries with fast-growing populations, people are trying to squeeze more from the land than the land can give. They're farming it too intensively, grazing too many animals, irrigating poorly and cutting too many trees. All of that leaves the land barren and infertile-a disaster in places where food, water and other necessities are already in short supply.

The process is called desertification because the abused land, usually dry to begin with, becomes desert. UNEP says up to a third of the world's land, including large parts of Africa, Asia and the western United States, is susceptible to desertification. One of every five people in the world lives in those areas and would suffer if the land became useless.

Unfortunately, once it starts, desertification is hard to stop. People driven off the land by their own misuse of it tend to go elsewhere and repeat their mistakes. And each time they move, the problem grows worse as more people try to survive on less land.

The United Nations Environment Programme says desertification can be stopped, but it will take an international commitment of perhaps $90 billion over the next 20 years. The money is needed to promote environmentally sound development and careful resource management where desertification threatens. The price is high, but UNEP says the price of doing nothing could be much higher. ■ June 1985
Patches of Haven

The finest pieces of wild America are found in the national parks, right? That's what most people think. But in fact, the lesser-known system of national wildlife refuges is bigger, wilder and possibly more important.

President Teddy Roosevelt started the National Wildlife Refuge System in 1903, 30 years after the creation of the first national park. He set aside Pelican Island, located off Florida's coast, as a haven for wildlife, not a tourist attraction for people. Now, 80 years later, more than 750 refuges provide essential habitat for over 800 species of birds and mammals. Alaska's share alone covers more area than all of New Mexico. Every state but West Virginia has refuge land.

The system has proven to be a last resort for saving habitat. As America's frontier succumbed to plow and rail, habitat crucial to wildlife was destroyed. In some cases, whole species, such as the bison, were nearly wiped out. But a thoughtful group of sportsmen-hunters, mostly-realized that their dwindling supply of game was not merely bad luck. They knew something had to be done.

The National Wildlife Refuge System, which is run by the U.S. Fish and Wildlife Service, is now the foremost habitat-preservation effort in the world. Some refuges, like the Arctic National Wildlife Refuge in Alaska, are pristine wilderness. Most are not. It is the smaller sites-a swamp in New Jersey or a prairie in the Dakotas-that allow wildlife to live and breed in areas where most of their habitat was destroyed.

The laws that protect wildlife refuges are less stringent than those protecting national parks. Private and public interests-such as mineral leases-constantly threaten the refuges. Nonetheless, they are patches of haven for embattled wildlife across the nation. March 1984

Paradise Lost

A hurricane that destroyed houses along the Texas coast also blew away private property rights.

When Hurricane Alicia roared into Texas in 1983, houses along Galveston's shoreline crumbled in the gale. The high winds also blew up a legal storm that has cost some homeowners their beachfront property. The state barred owners of several damaged homes from rebuilding. The Texas Open Beaches Act declares land between the ocean and natural shoreline vegetation to be public property. Hurricane Alicia eroded the beach and pushed the vegetation line back 150 feet. That left 300 parcels of private property, some with beachfront houses, on what had become public beach under Texas law. The state confiscated the land. The owners filed suit, claiming Texas unconstitutionally seized their property.

The case went all the way to the U.S. Supreme Court. The court refused to hear an appeal, upholding the state's argument that beaches are public property.

Texas assistant attorney general Kenneth Cross says the state's Open Beaches Act accommodates changes in nature.

When you're talking about the natural landforms down along our coastal areas, it has always been a tradition and always been the law that as nature moves and reshapes the coastline, then the property rights change along with those natural processes. And all that we have done is follow that tradition in these Hurricane Alicia cases.

Cross says nature, not the state, really took the oceanfront property. He says people who build on hurricane-prone beaches assume that risk. In Galveston, Texas, some beachfront homeowners gambled and lost. August 1987
This Land is Your Land

Three and two-tenths acres—that would be your personal share if all the federally owned land in the United States were parcelled out evenly to every man, woman and child in the country.

A third of the nation’s land—740 million acres—is still in federal hands. Most of it is west of the Rocky Mountains and relatively undeveloped. And while the government is not likely to carve it into personal-sized chunks, it remains our common property.

The land is extremely diverse. It includes everything from deserts and vast grasslands to mountains and dense forests. It is rich in coal, oil, natural gas and other fuels. It is a vast storehouse of important minerals and priceless timber. Grizzly bears, bald eagles and bighorn sheep take refuge there. And it has some of the most spectacular scenery on the planet.

Small wonder that the future of this land has become a major public issue. Demand for all of its treasures is growing. Once, there seemed plenty of everything to go around. Now, drilling for new oil may mean sacrificing a bit of wilderness. Protecting bears may mean foregoing a timber harvest. Choosing one treasure may mean losing another, and so people with special interests in these treasures are spending a lot of time, energy and money to persuade the federal government to see things their way.

Preservationists had the upper hand during the Nixon, Ford and Carter years. Development interests gained favor when President Reagan took office. Nobody knows who will prevail in the future. It’s safe to say that the political battle over the use of federal lands is likely to intensify as the nation’s appetite for natural resources grows, and the outcome of that battle will touch us all.

March 1983

An Outpost of Nature

Close your eyes and clear your mind. Now, what’s the first thing that pops into your head when someone says “New Jersey?”

Factories and smokestacks? Gambling casinos and the Atlantic City boardwalk? Sprawling suburbs in the shadow of the Manhattan skyline?

If so, you may be surprised to hear this: New Jersey is the home of a wildland reserve almost as big as Grand Canyon National Park. It’s called the Pinelands National Reserve, or simply the pine barrens. And while it may not knock your socks off the way the Grand Canyon does, it’s still an impressive outpost of nature on the doorstep of the eastern megalopolis.

The early waves of East Coast development simply bypassed the pine barrens. Except for a flurry of iron mining in the 1850s, they remained an economic backwater—a flatland of forests, bogs and streams. Only recently, when city-dwellers began seeking a rural escape, did the pine barrens catch their eyes. But by then, large tracts had become state forest, and attempts to fill the rest with vacation homes and resorts raised an outcry from people who wanted the area to remain wild.

Today, the Pinelands National Reserve is a patchwork quilt of public and private land. It is not wilderness. Cranberry and blueberry farms ring the perimeter, and several small towns dot the interior. The 15-member New Jersey Pinelands Commission has the difficult job of regulating growth in the area without strangling local economies.

The reserve is a haven for birdwatchers, hikers, canoeists and others who seek respite from the cities nearby. The question now is whether the pine barrens can stand the growing influx of recreationists. Their very numbers have shaken its solitude and put new pressures on this outpost of nature at the doorstep of megalopolis.

August 1984
Forest Lawns

A carpet of green grass is still the preferred lawn for most homeowners. But more natural plantings are creeping into America’s neighborhoods.

At least 2,000 people are reconsidering mowing their lawns this summer. That’s how many contacted the National Wildlife Federation last winter to find out how to landscape their yards to attract wildlife. The federation’s Backyard Wildlife Habitat Program offers advice on planting that provide food and shelter for birds, mammals and butterflies.

Coordinator Toni Pepin says that since the program began in 1973, thousands of people have converted their yards to little woodlots or prairies. Pepin says for those folks, flat, sterile lawns just aren’t enough.

I think people are looking at their yards, wanting to do as much as they can with the small amount of space they have, trying to make it favorable to wildlife so they can have the enjoyment of getting to see neat critters in their back yards. They can have lots of fun, just looking out their back doors and out their back windows.

Natural lawns also require less maintenance. Rain soaks in better, so yards need less watering. Leaves and sticks are best left to decompose on the ground, where they provide natural fertilizer. And of course, mowing is out of the question.

Those who have switched to natural landscaping find beauty in their new plantings. But not everyone likes unmanicured lawns in their neighborhoods. Cities like Fort Wayne, Indiana, specifically prohibit natural or wildlife habitats in residential areas. A few communities, however, are more tolerant. Madison, Wisconsin, for example, has an ordinance that allows people to cover their yards with native plants such as prairie grasses or wildflowers. The only catch is that all the neighbors must approve. ■ April 1986

Nature’s Way

People have drastically altered the face of the Florida Everglades in the last century. Now the state of Florida wants to undo some of the damage that’s been done.

When Florida became a state in 1845, the first legislature declared the Everglades swamp worthless and asked Congress to help turn the area into usable land. Thirty-five years later, the state sold four million acres of the Everglades to Philadelphia manufacturer Hamilton Disston and promised to give him more if he drained it.

In the decades that followed, Disston and other developers built large canals and dikes to stop the natural flow of water from Lake Okeechobee through the Everglades to the Atlantic Ocean and Gulf of Mexico. Farmers moved in to grow crops on the former wetlands. Then came urban developers, who helped turn south Florida into one of the fastest-growing population centers in the country.

Only recently have people realized that the Everglades region is far from worthless. It’s one of the richest wetland areas in the world and a haven for water birds. Ninety percent of the commercially valuable fish in the ocean surrounding the Everglades spend part of their lives in its salt marshes. The water that flows through the Everglades replenishes the underground reservoir that is the only source of fresh water in southeast Florida. And finally, Everglades National Park draws 600,000 tourists a year and generates up to $30 million in tourism revenue.

With that in mind, the state of Florida embarked on a plan in 1983 to restore some of the natural water-flow patterns in the Everglades and to add new wildlife preserves. Governor Bob Graham is one of the plan’s strongest supporters. Graham notes that human disturbance has, among other things, sharply diminished wildlife and fish populations in the Everglades and threatened public water supplies. It’s time, the Florida governor says, to help nature take its course once again in the Everglades. ■ October 1985
Locked Out

Congress added more land to the federal wilderness system in 1984 - 8.5 million acres - than in any year since it passed the Wilderness Act two decades ago. Now almost 90 million acres of federal land are off-limits to logging, mining and similar commercial pursuits.

That's good news to wilderness advocates but bad news to Charles Parks, a Stanford University geologist. Parks thinks wilderness preservation has gone too far, locking up land that may contain valuable energy and mineral resources. He fears the United States will run short of critical materials in 10 to 20 years if new sources are not found and developed. He claims areas considered for wilderness designation are not explored carefully enough for mineral deposits beforehand. And he says where deposits exist, their future value is often ignored.

Parks says the Glacier Peak Wilderness Area in the Cascade Mountains of Washington state is a good example. Glacier Peak contains a major copper deposit that has to stay in the ground because mining is outlawed there. Although there's no shortage of copper now, Parks feels we may regret the decision if copper becomes scarce in the future.

The California geologist insists he loves the outdoors but feels public lands should be used to better advantage. He believes, for instance, that the government should lease federal lands now off-limits to mining companies on the condition that the lands be restored once mining is completed.

But preservationists contend there's no way to restore a former mine site to wilderness. Ultimately, they believe undisturbed natural lands are more valuable than anything that lies beneath them. And as Congress recently demonstrated, sometimes it agrees. ■ November 1984

The Value of Nature

Your good health depends on a regular dose of nature.

Consider these facts:

- Hospital patients with views of trees and other greenery recover more quickly than patients in rooms without such views.
- Prison inmates whose cell windows overlook natural landscapes seek health care less often than prisoners with less desirable views or none at all.
- Office workers who can see pleasant outdoor settings from their desks report feeling healthier and less pressured than workers who cannot.

Environmental psychologists Rachel and Stephen Kaplan of the University of Michigan discuss these and other research findings in a new book called The Experience of Nature. The Kaplans consider the findings strong evidence that contact with nature is more than just pleasurable, it's a fundamental human need.

One message that emerges from their study is that public investment in parks, gardens, greenbelts and other natural things is not frivolous, as some taxpayers claim. Another message is that public officials should not judge the benefits of such investments strictly in dollar terms.

Rachel Kaplan explains:

In our book, we discuss the many ways in which the importance of nature shows itself and the implications of this for public policy. I think the accumulation of evidence is more powerful than any dollar amount you might try to assign to the value of nature. There are so many converging forces that show how important nature is to people that, in the long run, we can't afford to ignore them.

The Kaplans say scientific evidence of the link between nature and the human psyche is relatively new but growing. By all indications, the link is a vital one. ■ October 1989
**Surf and Turf**

The coastal zones of the world’s oceans cover as much space as all the dry land on Earth. More than a hundred nations of the world on the ocean coasts are struggling to share and protect these critical areas.

Coastal zones provide most of the world’s food fish. Demand for fish is expected to double by the end of the century. Much of the new demand will come from coastal areas of the Third World nations.

Whether the oceans can meet the demand is questionable. Modern equipment helped fishing fleets triple the world catch from 1940 to 1970, but it also let them overfish parts of the oceans, and some important fisheries collapsed. The competition for what was left prompted a number of coastal nations, including the United States, to extend their claims to fishing rights to 200 miles offshore.


Some countries immediately reaped the benefits of their new ocean territories. Others could not. Canadian fishermen, for instance, have caught more northern cod than before, and the size of their catch keeps growing because foreign fleets no longer have access to Canada’s waters. On the other hand, many island nations in the Indian and south Pacific oceans lack the tools, experience or labor to catch migratory fish that pass through the vast fishing grounds they claim.

What’s more, the Law of the Sea Treaty displaced some long-time fishing nations like Japan, Spain and Germany, which traditionally took most of their fish from waters now claimed by other countries. And the treaty has failed to settle quarrels like that over the Baltic Sea, where several countries share fishing rights but cannot agree on how much fish each nation should harvest.

**Big Bucks in Boats and Bait**

Anglers who throw their lines into the Great Lakes also throw a few billion dollars into the Great Lakes economy.

Twenty years ago, fishing on the Great Lakes was all but wiped out. Pollution, sea lampreys and overfishing had destroyed stocks of valuable fish such as lake trout and perch. In response to these problems, the United States and Canada began programs to restore Great lakes water quality and fisheries. Efforts to control pollution and sea lampreys, along with massive fish-stocking programs, have paid off. The Great Lakes fishery has recovered. Now sport and commercial fishing are major contributors to the region’s economy.

A recent report to the Great Lakes Fishery Commission details the benefits the renewed fisheries bring to the upper Midwest. The report says commercial fishing in the Great Lakes region generates about $270 million a year. Great Lakes sport fishing is even more valuable; it pumps about $4 billion a year into the region’s economy.

Richard Bishop, a University of Wisconsin-Madison economist, says these figures provide a strong argument for continued management and pollution control on the Great Lakes. However, Bishop, who helped produce the report, says it should not be used to argue for restrictions on Great Lakes commercial fishing just to benefit the more valuable sport fishery.

We need to think about being flexible. We know that the Great Lakes ecosystem is in a state of flux. We need to think in the long run about our abilities to capitalize on wherever that resource goes next.

Bishop says commercial fishing on the Great Lakes provides employment and valuable trade today and a way for resource managers to control the balance of Great Lakes fish populations in the future.
**Krilling Fields**

The Antarctic Ocean teems with millions of tiny creatures called krill that several countries harvest as a source of protein. Some scientists wonder how that will affect life in the Antarctic.

Tiny, shrimp-like animals called krill congregate in huge swarms in the Antarctic Ocean. Some scientists estimate that full-scale harvesting of krill could more than double the world’s total annual catch of fish and shellfish.

Krill are consumed primarily by whales, seabirds, penguins, seals and fish. Michael Macaulay, a marine biologist with the University of Washington Sea Grant program, says humans can now be added to the list of predators.

One of the reasons why krill has become an issue is that it’s now being considered both for human consumption and for animal feed. Some people think that because the whales have become so depleted, there’s perhaps a surplus of this animal in the Antarctic. I think it remains to be seen whether there’s an enormous surplus: It’s been estimated at perhaps 150 million metric tons.

Macaulay says the Soviet Union is currently harvesting about 200,000 metric tons of krill annually, and Japan harvests between 25,000 and 75,000 metric tons. The size of the harvest varies depending on market demand.

Macaulay and other researchers fear that larger harvests will upset the balance of the food chain. The Antarctic Ocean is geographically and climatically isolated, and it is not known exactly how many animals depend on krill as a food source. Macaulay says until we learn more about the abundance, distribution and basic biology of krill, we risk depleting not only this potential new food resource but also the many other marine animals that depend on it.

**Silent Net**

Fishermen have laid nets in the sea for centuries. But some modern nets, once abandoned, continue to catch and kill fish and other animals for months.

Nets used in the open seas are called pelagic drift nets. Some of them, gill nets, are made of plastic webbing suspended vertically in the water by floats and weights. The buoyancy can be adjusted to hang the net at any depth. Pelagic drift nets are virtually unbreakable and can be thousands of yards long.

According to marine consultant Robert Eisenbud, gill nets are not biodegradable. And when used indiscriminately, gill nets can kill many fish that are never harvested. Eisenbud says the nets not only catch fish but also snare birds and marine mammals. He says about 10,000 porpoises die in drift nets each year.

Lost and discarded nets may also be a problem, but some nets are not lost unintentionally. Eisenbud says U.S. aircraft have observed foreign boats fishing in protected water. Once the intruders discovered they were under surveillance, they cut their drift nets to make a quicker getaway.

Sometimes abandoned gill nets wash ashore, but usually they continue to catch fish until the weight of the catch drags them to the bottom. According to Eisenbud, cast away gill nets can drift aimlessly for months or even years and continue to catch fish, mammals and birds.

He adds that in the North Pacific alone, fishermen from Japan, Taiwan and Korea set about 20,000 miles of net a day. That adds up to more than a million miles of fishing net a year.

Eisenbud says it is up to the nations involved to address the dangers of indiscriminately deploying gill nets or to find alternative methods of fishing.
Down Under, Down Under, A Big Fishing Plunder

Less than fifteen years ago, the pristine waters off Antarctica were rich with marine life. Today those waters are fish-poor.

Antarctic waters once seemed too remote for profitable commercial fishing. But a treaty negotiated during the 1970s changed that.

The treaty is the Law of the Sea. The international agreement allows countries to extend their jurisdiction over coastal waters out to 200 miles. Many areas that were once international fishing grounds became restricted. Several eastern-bloc countries-including the Soviet Union, Poland and East Germany-were shut out of their traditional fishing grounds. They turned to Antarctica and began to fish there in the early 1970s. Their catch peaked at nearly a half million tons in the 1979-1980 season. It has since plummeted to nearly a tenth that amount.

Kenneth Sherman, chief scientist of the Antarctic Program for the National Oceanic and Atmospheric Administration, says the decline occurred because Antarctic fish stocks are different from those elsewhere.

We’re looking at fish populations that have evolved over the millennia, with no perturbation of the kind that can be imposed in a relatively short period of time by the efforts of man-the-predator using big fishing nets over the bottom.

Sherman says the cold-water fish grow at rates nearly half that of fish living in warmer waters. This and other factors significantly change the amount of fish that may be taken yearly without harming the fishery.

A joint U.S.-Polish research team, part of a 19-nation committee that oversees Antarctic marine resources, is now studying the situation. Sherman is optimistic that international agreements to protect the fishery can be reached soon and the once-rich fishing grounds will regain their lost vigor.

May 1987

The South Rises Again

One of the most toxic compounds contaminating the Great Lakes is toxaphene, a pesticide now banned in the United States.

Around the Great Lakes, the names of some pollutants-PCBs, dioxin, dieldrin-have become household words. But one chemical, toxaphene, has received considerably less publicity, though researchers say it is potentially as dangerous as the others.

Toxaphene, they say, found its way to the Great Lakes by an unexpected route: the air. According to John Sullivan, a Wisconsin Department of Natural Resources environmental scientist, most of the toxaphene that entered the Great Lakes originated in the southern United States and was carried north by the wind.

Sullivan, coauthor of Toxaphene Status in the Great Lakes, a recent report by the University of Wisconsin Sea Grant Institute, claims that even though it is banned, enough toxaphene was carried from southern soils to create problems.

When it was used in the United States, it was used largely on cotton crops in the southern United States. And through volatilization of the pesticide from the treated croplands and ultimately reaching the atmosphere, it was being transported from the southern portions and certain western portions of the United States to the Great Lakes basin and reaching the basin through atmospheric deposition, both wet and dry types of deposition.

Like other long-lasting contaminants such as PCBs, toxaphene can end up in the food chain. First absorbed by plants and microscopic animals, it can concentrate in waterfowl and in some large fish, particularly trout and salmon. And as with other contaminants, there are more questions than answers about the effects—if any—that eating toxaphene-tainted fish might have on humans.

January 1986
Our Brimming Great Lakes

A scientist says we may have misjudged the influence of climate on the brimming Great Lakes. Record high water levels in the last two years have caused great anguish among Great Lakes shoreline residents. Waves are flooding low shorelands, topping sea walls and eroding coastal bluffs. However, the chief hydrologist at the federal Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan, says the lakes are only doing what comes naturally.

Frank Quinn says old shorelines and lake sediment samples indicate climate conditions of centuries past. He says what is considered the region’s normal climate may not be so normal after all.

The period from about 1930 to 1960 may very well have been among the warmest 30-year periods in the last 2,000 years. It was also extremely dry. We’ve built our economy around the Great Lakes based on what may very well be dry, low lake-level conditions. And current conditions, with the rather cool and wet climate and high lake levels, may very well be the norm when we look at the last 2,000 years or so.

Quinn has modeled the effects of various climatic conditions on the Great Lakes. He points out that three times in the last three years, the lakes have exceeded levels predicted to happen, on average, once every hundred years. He says lake levels could go higher and persist indefinitely.

For example, we know that if we get several more years of the wet conditions that we had in 1985 and ’86, it’s possible for Lake Michigan to go up another foot and a half or so over the next three years.

Quinn says people must take into account possible long-term changes in climate and higher water levels in the Great Lakes. ■ February 1987

A Costly Diversion

Diverting water from the Great Lakes could ultimately cost industries in the region millions of dollars.

In some arid western and southwestern states, demand for water is growing while supplies are diminishing. Some people envision piping water from the Great Lakes to help meet the demands of the Sun Belt.

Erhard Joeres heads a University of Wisconsin-Madison research team investigating how diversions might affect Great Lakes water levels and certain Great Lakes industries. The researchers investigated one scenario that would remove 10,000 cubic feet of water per second out of Lake Superior. They found that over five years such a diversion would lower water levels in Lake Superior by as much as two feet and those in Lakes Michigan and Huron by eight inches.

Joeres, a civil and environmental engineer, says the team then determined how much the drop in water levels would affect two major industries.

The economic analysis really was a matter of trying to come up with some real numbers on how shipping and hydropower were dependent on water levels.

Economists on the team found that lower water levels would force Great Lakes ships to carry lighter loads and therefore make more trips. Lakeside hydroelectric power plants would have to cut electricity production and turn to more expensive coal or nuclear energy. Research team member Stuart Rosenthal explains:

The effects of that type of diversion would be between $70 million and $95 million per year. The effect of any diversion appears to be roughly 10 times as great on hydropower production than on shipping in terms of total costs.

Joeres says these estimated economic losses are relatively small compared to the adverse effects diversion could have on water quality and fisheries in the Great Lakes. ■ September 1985
If it rains heavily in Milwaukee today, the city’s sewers are likely to overflow into Lake Michigan. But a network of tunnels could one day put Milwaukee on top of the problem.

Modern sewer systems are built with two separate networks of pipes—one for sewage and another for stormwater. But Milwaukee’s turn-of-the-century sewer system carries both. And a heavy rainstorm, combined with the city’s normal output of sewage, is more than the system can handle. Such storms often force the city to release rainwater and untreated sewage from the overburdened sewer lines into Lake Michigan and its tributary rivers. That, of course, pollutes the lake.

Milwaukee plans to spend $2.4 billion on improvements during the next decade to remedy the problem. One sewerage district official says it’ll be the largest wastewater construction project in the nation.

Besides installing better pipes and more modern treatment plants, Milwaukee will dig 17 miles of giant tunnels to hold the overflow when there’s a downpour. The deep tunnels, as they’re called, will range up to 30 feet in diameter and hold as much as 275 million gallons of wastewater until treatment plants can process it.

The idea is simple, but its construction is not. At a cost of roughly $13 million a mile, a giant machine called a mole will bore out thousands of tons of rock to form the tunnels. But first, the 900-ton mole must be lowered piece-by-piece down a 300-foot shaft and assembled.

The big question is whether the tunnels will work. The Milwaukee Metropolitan Sewerage District insists they will. The Wisconsin Department of Natural Resources is not so sure. The DNR says the tunnels may have to be lined with concrete—at additional cost—so they won’t leak. But the agency will wait to see until the first tunnel section is built. ■ July 1985

Some communities in the Great Lakes basin still depend on groundwater for their water supplies. Mequon, Wisconsin, a suburb of Milwaukee, is one of those communities, and surprisingly, several wells there are going dry.

Heavy use of well water for homes and golf courses in Mequon has drawn down the groundwater in one area. The result is what hydrogeologists call a “cone of depression.” In this local spot, groundwater has dropped 40 feet below the level of Lake Michigan. In Wisconsin, groundwater normally flows eastward into the lake. But Mequon’s cone of depression is drawing water back the other way.

Douglas Cherkauer of the University of Wisconsin-Milwaukee says this reversed flow highlights the critical relation between Wisconsin’s aquifers and Lake Michigan.

We know how much river water flows in, and we know how much rainfall goes in. We probably can approximate how much water evaporates off the lake. But we have no idea how much water flows in underground.

Cherkauer’s Sea Grant research team has been checking groundwater levels and movements in other Wisconsin coastal areas as well. The researchers have used electronic devices offshore to detect porous lakebeds where seepage in or out of the lake could take place. Special devices planted in the lakebed itself have measured rates of actual seepage.

The objective is to piece together a map that reveals the present and potential movements of groundwater along Lake Michigan’s western shore. This work should help communities like Mequon take steps to protect the quantity and quality of water sources in a developing area of the Great Lakes region. ■ March 1983
An Island in Distress

“Water, water everywhere, but not a drop to drink.” That old adage may become all too true for the three million people who live on Long Island in New York.

Long Island is surrounded by the Atlantic Ocean. But converting seawater to drinking water is costly, so the islanders rely on wells that tap the groundwater beneath them. Unfortunately, that water is becoming polluted.

About half the rain that falls on Long Island eventually becomes groundwater. As it filters through the soil, the rainwater picks up traces of chemicals from old dumps and landfills, agricultural pesticides and other contaminants. Besides that, Long Islanders are using their groundwater faster than the rain can replace it. Seawater is seeping in to fill the gap, contaminating the groundwater with salt.

Sarah Meyland belongs to a New York state legislative commission that is studying Long Island’s water problems. She says better management of activities on the land is the key to protecting the groundwater.

The solution is going to be to try to protect those parts of the land that are still pristine, to protect those parts of the aquifer that are still pristine, so that we will have pristine water in the future in some places. Some parts of the island will probably have to have treatment. We will probably have to start sharing our water on more of a regional basis. We would like to ultimately see regional management of the aquifer system.

Meyland believes Long Island’s communities can preserve their drinking water by adopting new zoning laws, phasing out landfills, limiting industrial growth and minimizing the use of fertilizers and pesticides. ■ June 1983

Hidden Polluters

Some of the most serious polluters of groundwater are underfoot and out of sight.

Every community has underground storage tanks—at service stations, schools, factories, farms, hospitals and elsewhere. The tanks store everything from gasoline to chemical wastes. There may be 2.5 million of them in the United States, and it’s estimated that as many as 100,000 of them are leaking.

Most tanks are made of steel and built to last 20 to 30 years. When they get older, they rust, and eventually they leak. Leaky storage tanks threaten groundwater in many parts of the country, including the upper Midwest, but nowhere have they been more troublesome than in Florida, where the water table is high, soils are porous and sandy, and groundwater is especially vulnerable.

Most of Florida’s population gets its drinking water from the ground. But many of the state’s underground storage tanks leak fuel or chemicals into that water. In Belleview, Florida, 10,000 gallons of gasoline seeped out of an underground storage tank a few years ago. Two years later, gasoline turned up in all three of the community’s drinking-water wells, and they were shut down. The people of Belleview had to truck in fresh water for more than a week. After that, they had to boil all the water they got from a temporary well for eight months until a new permanent well was drilled. Ironically, Belleview had once boasted the purest water in Florida.

Until recently, underground storage tanks were largely unregulated. But federal law now prohibits the installation of some types of tanks. The U.S. Environmental Protection Agency and many states are developing standards for other tanks—new and old—that contain hazardous substances. The EPA regulations are scheduled to take effect over the next three years. ■ January 1986
Killer Waves

It speeds through the ocean at up to 600 miles an hour. But you can't see it until it reaches shore, where it can ravage coastlines and kill thousands of people.

It's not a secret weapon or a dreaded creature in a horror film. It's a tsunami—a powerful wave that radiates from underwater earthquakes in the Pacific Ocean. Only a few feet high but nearly 100 miles between crests, a tsunami hides its destructive force until it approaches land. As it nears shore, the surge of water slows down and piles up into a wave that can reach as high as a 10-story building when it hits land.

In Japanese, tsunami means "great harbor wave." In 1896, one of these giant waves killed 27,000 people in Japan. Almost all Pacific Ocean countries have suffered damage from tsunamis.

In 1948, the United States established the Pacific Tsunami Warning System. From Hawaii, the system includes a far-flung network of seismographs to measure earthquakes and tide gauges to report the beginning and progress of tsunamis. A second warning center now operates in Alaska to watch more closely over North America's Pacific shores.

The U.S. government's National Oceanic and Atmospheric Administration has stationed a satellite more than 22,000 miles above the Pacific Ocean that instantly relays warning signals over the entire region. And the United States is helping Chile place monitoring instruments along its coast that will tie into the system.

The tsunami warning network now includes 18 nations and territories that cooperate to alert people to the giant waves before they hit.

October 1984

Mussel-bound Oil Rigs

The underwater legs of offshore oil drilling platforms may appear long and skinny. But they do grow mussels.

A small but enterprising company is profitably harvesting mussels that grow on the legs of offshore oil rigs in California's Santa Barbara Channel. These mussels are not the biceps body builders work so hard to develop but the small shellfish that many of us love to eat.

Ten years ago, California biologist Robert Meek saw a business opportunity in the mussels and barnacles encrusting the legs of offshore oil rigs. Oil companies were spending hundreds of thousands of dollars to scrape off the crusty marine growth because its total weight and shape threatened the platforms' stability.

Meek knew that the water was rich in nutrients and cleaner in the Santa Barbara Channel than in the pollution-prone tidal mud flats where most mussels are commercially harvested. Why not scrape these creatures off the oil rigs, he asked, suction them up to the surface and sort out the edible mussels?

The California scientist and his marine research company, Ecomar, were able to persuade Chevron, Phillips, Texaco and other oil companies that it was a good deal all around. But it took several years to convince regulatory agencies that the proposal was environmentally sound and the mussels were safe to eat even though they were growing under an oil rig.

This year Ecomar will sell about 320,000 mussels—three times as many as it sold three years ago. Meek claims his mussels have thinner shells and are sweeter than those taken in shallow water. He sells many to East Coast dealers at premium prices.

Ecomar is experimenting with growing a special Japanese oyster in seed beds suspended from the platform legs. The company's success proves that oil and water technologies can mix.

January 1987
Splash!

Fifty million years ago an asteroid slammed into the ocean, rocking the Earth.

Comets, asteroids and meteors have left craters all over the Earth’s continents. But a team of Canadian scientists recently found the first such crater on the floor of the ocean. Lubomir Jansa of the Bedford Institute of Oceanography says the so-called Montagnais crater in the Atlantic off Canada’s east coast is nearly 30 miles across and more than a mile and a half deep. Jansa says the object that blasted open this crater must have been almost two miles wide and traveling at 40,000 miles an hour when it hit.

Jansa says the force of the impact that made the Montagnais Crater 50 million years ago is unimaginable. It packed the wallop of nearly 300 billion tons of dynamite.

The entire stockpile of atomic weapons right now is about 16,000 megatons. The Montagnais impact had a destructive power about 18 times larger than the total nuclear arsenal.

The impact was so devastating that it may have helped drive the dinosaurs to extinction. Some scientists believe that millions of years ago, such a crash threw huge amounts of dust and water vapor into the atmosphere, changing the Earth’s climate and dooming the dinosaurs.

Jansa and his colleagues are investigating this possibility. They are also thrilled by the success of advanced techniques that used seismic information to reveal the crater, which lies buried beneath sediment on the Atlantic Ocean’s floor.

History on the Bottom of the Sea

Pages of the Earth’s history lie in thin layers on the ocean floor.

Among the clues to the world’s past are microscopic organisms that lived in the ocean and fell to the bottom after they died. John Kutzbach, a University of Wisconsin-Madison meteorologist, says changes in the abundance of these organisms reflect the evolution of the Earth’s climate over millions of years. He says scientists read these changes in cores taken from ocean-bottom sediment.

Once we get back before a few thousand years ago, we’re placing more and more reliance on ocean sediment cores for understanding the Earth’s history, because you have a book that’s accumulated at the bottom, page by page, which is there to be read.

Kutzbach is working on a climate research project that analyzes core samples from the floor of the Indian Ocean. Some of the core samples were drilled below more than 6,000 feet of water, and they contain hundreds of feet of sediment dating back as much as 10 million years.

Different organisms thrive in different environments. Kutzbach says the types and abundance of organisms in different sediment layers reveal changes in the oceans’ temperatures and nutrient levels. He says these organisms also reveal past air and water currents and indicate the temperature of the prehistoric atmosphere.

Since 70 percent of the Earth’s surface is covered with ocean, if we understand the Earth’s ocean history, we have some pretty good ideas of what’s happening over the land surface, too.

Kutzbach says the Indian Ocean project will help explain climate changes around India, the Himalaya Mountains and the Tibetan plateau—changes that affected climates around the world.
Acid in the Ocean

Acid rain, a threat to northern lakes, may also threaten the ocean coasts.

Because of the sheer size of the oceans, researchers have commonly considered them immune to the effects of acid rain. But a study by a private environmental research organization indicates acid rain may indeed affect the ocean coasts.

Environmental Defense Fund staff scientist Diane Fisher wrote a recent report documenting damage along the Atlantic Coast in Chesapeake Bay. Fisher says the way acid rain harms coastal waters is unexpected. She says it’s not the acid that does the damage.

People have sort of assumed that acid rain would not be a problem in the oceans because the acidity in acid rain is not a problem. But the nutrient property of the nitrogen in the acid rain is a problem, and that’s what we looked at in our study. The nutrient encourages the growth of algae, which chokes off the water and makes it impossible for anything else to grow there.

Fisher estimates one-quarter of the nitrogen that enters the bay comes from acid rain generated in part by nitrous oxide, a component of auto exhaust. She says a current Chesapeake cleanup initiative aiming to cut nitrogen pollution by 40 percent will be crucial in limiting the damage. But Fisher notes there is a larger issue.

I think that acid rain is a problem not just for a few lakes, it's a problem for our coast, it's a problem for our cities, it contributes to pollution problems there, and I don’t think people in any part of the county should assume that acid rain is not a problem for them.

Fisher says legislation now before Congress could help cut acid rain, taking a burden off some areas hard hit by this pollution from the sky.

Skimming the Surface

Maybe you can't judge a book by its cover, but you can learn a lot about an ocean or a lake by looking just a few inches below its surface.

These first few inches of water teem with life. Microscopic plants and animals important to the food chain live here along with the eggs and larvae of fish and shellfish. In the Great Lakes, tiny animals near the surface provide food for small fish, such as alewives, which in turn become prey for larger fish sought by sport and commercial fishermen. In the oceans, surface waters play a crucial role for valuable commercial species such as flounders, crabs, lobsters and anchovies.

Changes in the top few inches of water can affect life both above and below the surface. Some scientists believe the impact of pollution on this part of the environment deserves closer study. University of Wisconsin-Madison water chemist David Armstrong has analyzed the pollutants in the surface layer of Lake Michigan.

We found that concentrations of metals such as lead, cadmium and zinc were higher in the surface microlayer than they were in the water below, so there is an increase in concentration at the surface.

Armstrong has learned that a high proportion of the pollutants that concentrate at the water's surface fall from the air. And though other factors exert greater influence over contaminants in the Great Lakes, Armstrong believes this microlayer is still important because it is where many contaminants enter the food chain.

The surface layer accounts for only a small portion of the entire volume of a lake or sea, but it may hold answers to many questions that involve deeper waters.

July 1988
Scales of Justice

In Connecticut, the scales of justice weigh dead fish.

Industries that dump or spill chemicals into public waters often face heavy statutory fines. Some states have decided this is not enough. In Connecticut, companies that discharge unwanted chemicals into public waters are also fined for fish that die and recreation that is lost because of the pollution.

William Hyatt of Connecticut’s Department of Environmental Protection says the extra fines recover more of the actual costs of damage from water pollution.

In addition to the fines that are paid because of a violation of law, when a fish kill occurs, there’s also a loss to the citizens of the state that results from the kill itself.

Penalties for fish kills are based on the value of the fish and the number and size of those that die. Hyatt says all species of fish have been assigned a dollar value based on figures from the American Fishery Association. For example, a walleye or a salmon may be worth nearly $3; a trout may be worth about half as much.

When fish die in a chemical spill, says Hyatt, state officials count and measure fish in part of the polluted area. Then they calculate the fine based on the number and average sizes of each species that died. Money that is collected goes into a fund to improve sport fishing in Connecticut.

Hyatt says other states have programs similar to Connecticut’s. But he says Connecticut is unique because it also charges for the value of lost recreational time due to chemical pollution.

The state has determined a dollar value for an average fishing trip. Fines for water pollution reflect the number of fishing trips that are lost while a stream or lake is recovering from chemical pollution. Hyatt says this lost recreational value can far exceed that of the lost fish.

Tourists and Toxins

Honeymooners and toxic wastes: Niagara Falls remains popular and polluted.

For tourists, Niagara Falls is one of nature’s great spectacles. But environmentalists call it an open sewer full of toxic wastes. That’s because the Niagara River, which connects Lake Erie with Lake Ontario, is surrounded by chemical waste dumps. Love Canal is the best known, but many others—hundreds, by some estimates—also leak poisons into the river.

A recent report by University of Toronto scientists said the water pouring over Niagara Falls is laced with PCBs, chloroform, chlorobenzene, and other suspected cancer-causing chemicals. The scientists said the mist kicked up by the cascading water also contained these toxins.

U.S. and Canadian officials deny that Niagara Falls mist poses a threat to humans. And though the Ontario study is not the first warning about Niagara’s pollution, the tourist industry there has remained healthy. Marguerita Howe, head of Operation Clean Niagara, an Ontario-based environmental group, says tourists seem unaware of the river’s contamination.

I wonder how many of them really know a great deal about it. I have a feeling that they don’t, and certainly the tourist people in both communities would hesitate to emphasize there is a problem in the Niagara River.

Although Howe sees irony in the condition of the water that inspires awe in Niagara Falls tourists, her main concern is drinking water. The river is a major source of water for Lake Ontario, where more than five million Americans and Canadians get their drinking water. It is for their sake, says Howe, that government and industry must clean up the Niagara River.

May 1988

June 1988
**Lake Woes, Begone!**

A dash of lime may protect a Minnesota lake from acid rain.

Hundreds of lakes in northern Minnesota, Wisconsin and Michigan are sensitive to acid rain because their water is soft. Soft water lacks the minerals needed to neutralize acid, and this could spell trouble for fish that do not reproduce in acidic water. To protect fish in these northern lakes, scientists are studying the possibility of adding lime—actually, ground limestone—to keep the water from becoming acidic.

Last May, researchers from the U.S. Fish and Wildlife Service and the state of Minnesota sprayed five tons of lime into Thrush Lake, a small trout lake in northern Minnesota.

David Wright coordinates the project for the Minnesota Department of Natural Resources. Wright says lime applications have limited but practical value. They probably will be most useful for protecting special fish populations worth the expense. But he stresses that liming is a short-term remedial action and not the answer to the acid rain problem.

Unlike some lakes in the eastern United States and Canada, lakes in Minnesota do not yet show damage from acid rain. No lakes in Minnesota have lost their fish to acidity. However, scientists may have found early warnings of acidification in Minnesota’s Thrush Lake. They’ve discovered a plant called sphagnum moss living on the lake bottom. Wright says this was a big surprise for two reasons: First of all, sphagnum moss commonly lives in highly acidic bogs, and second, the moss usually lives above water.

Sphagnum moss itself can make water more acidic. Adding lime to the waters of Thrush Lake may kill the moss, and that, in turn, could improve water conditions for some of the lake’s fish and other plant and animal life.

In effect, the scientists are using northern Minnesota’s Thrush Lake as a giant test tube. They will be watching their experiment until 1993.

**Tomorrow’s Trophy**

“Catch and release” catches on throughout the county.

There’s a growing trend in sport fishing these days called “catch and release.” Put simply, if you catch a fish, you turn it loose again—even if it is big enough to eat.

James Addis, director of the Wisconsin Department of Natural Resources’ Bureau of Fish Management, explains the reasons behind this trend.

Those who catch and release like to release those intermediate-sized fish in the hope that they’ll survive, contribute to another day’s fishing and also grow into bigger fish which will provide trophies.

Addis says you can do many things to help a fish survive being caught. Keep the fish in water as you remove the hook and avoid using a net. A net can entangle a fish, hook or line and delay the fish’s return to water. If you are fishing from a beach, take the fish away from waves to unhook it because sand can damage fish gills.

Addis says if you must take the fish out of water, keep it level to prevent damage to its internal organs. Moisten your hands or gloves with water before touching the fish and be careful not to rub off its protective slime. Freshwater fish, especially thin-skinned species like trout, are susceptible to skin infections.

Avoid touching the gills or belly when you remove the hook. Then use needle-nose pliers to turn the hook and pull it free. If the hook is deep in the fish’s stomach, leave it in and cut the line. In many cases, Addis says, that will improve the fish’s chance of surviving.

When you are ready to release the fish, move it slowly through the water first to revive it. If the fish came from deep water, gently plunge it headfirst and straight down. This can give a tired fish a boost. Above all, Addis says, common sense and care help fish survive fishing and contribute to tomorrow’s trophies.

**November 1988**
Scavenging Submerged Souvenirs

Sport divers who pluck souvenirs from sunken ships are plundering our maritime heritage.

David Cooper, a researcher at the University of North Carolina-Greenville, says valuable information about shipping disappears when sport divers remove personal effects and sailing gear from sunken wrecks. Cooper says when these artifacts are taken, archaeologists lose information on the age and condition of a ship, the social status of its crew, and the conditions of shipboard life.

There’s a lot of information to be gotten off a wreck, and when that stuff is taken away and put on someone’s mantlepiece, all that information is lost.

Cooper is studying a sunken Great Lakes schooner, the Fleetwing, which ran aground in 1888 on the shore of Lake Michigan in northeastern Wisconsin. He says such wrecks can provide physical evidence of Great Lakes shipbuilding during the nineteenth century. The sunken remains can yield details about how the industry adapted to certain types of cargo and special problems of sailing on the Great Lakes. In the late 1800s, grain was a major commodity in the Great Lakes region, and the Fleetwing may provide clues about how ships handled and carried such cargo.

Cooper has run into the problems of scavenging firsthand. He says his work on the Fleetwing is difficult because the wreck has been thoroughly picked over.

Most all of the moveable artifacts have been taken from the site: the anchors, the windlass... a furniture company even took away two truckloads of material.

Some states, such as Michigan, have established reserves to safeguard underwater historical sites. And Cooper says sport divers are becoming more aware that scavenging is not a responsible part of their pastime. ■ October 1987

Teach Your Children

Parents who introduce their kids to boating should also teach them how to survive on the water.

For some children, boating with their parents is a special part of their lives. But often they do not learn how to handle a boat in an emergency without help.

Dolly Garza of the Alaska Sea Grant program says children should be prepared to fend for themselves following a mishap on water. But the boating safety specialist says some parents assume they will always be around to protect their kids in emergencies.

You have parents who don’t teach their children how to run the boat or how to put on a life preserver or how to use safety equipment. They assume that they’ll always be there to do that.

Garza suggests that parents teach their children the basics of boating: how to start a motor and run the boat to shore, where to find the fire extinguisher and emergency supplies, and how to use them. Garza also urges parents to show their children how to use the radio to call for help, how to describe the boat and an accident, and how to pick out landmarks to describe the boat’s location.

Garza says kids should know how to survive a boating accident on their own.

They have just as much chance of finding themselves either stranded because they’re lost, or being the only survivor of a shipwreck or a plane wreck. So I feel they need to know just as much as adults do.

The boating safety specialist also recommends that parents take their children to a pool or beach to practice floating in life preservers and survival suits. Parents sometimes buy the wrong sizes for their children and should make sure the survival equipment fits before it is needed. ■ August 1987
Handicapped on the High Seas

A special sailing program takes the “dis” out of disabled.

The Lord Nelson is no ordinary ship. At first, she looks traditional, reminiscent of old British sailing vessels. At 140 feet and 400 tons, she sports a crow’s nest and three masts that fly up to 18 sails. But look closer and you’ll notice a network of special harnesses and tracks, electric lifts, even an elevator. And you’ll see audio and video equipment adorning the helm. All this enables disabled sailors to challenge the high seas.

People who are blind or deaf, and those with polio or other disabilities, can help navigate, maneuver sails and perform daily shipboard tasks. These adventures are just part of the National Ocean Access Project.

Although it focuses on sailing, the project aims to make all water sports accessible to the physically disabled. Its activities around the country include water sports projects on both coasts and on Lakes Erie, Ontario and Michigan.

John Lancaster directs the private, nonprofit venture. Lancaster has sailed the Lord Nelson and warns it is not a pleasure cruise. But he adds it can be rewarding for everyone.

Disabilities become transparent. Any attitudinal or other barriers that may exist between people with disabilities and people without disabilities soon go away and are forgotten in the joy of the joint project that’s before the individuals.

Lancaster says up to half of the 40-person crew can be handicapped, including eight who use wheelchairs. Any physical disability is acceptable and no experience is required. There’s a permanent crew, and Lancaster says the ship meets Lloyd’s of London’s highest safety standards.

Lord Nelson cruises are quite popular. The ship is scheduled to make a voyage around Great Britain this summer and 10 trips around the Bahamas next winter. ■ July 1988

Hanging Ten on Lake Michigan

Grab your board and hit the beach. Surf’s up at Sheboygan!

The hotdoggers come from Detroit and Minneapolis, Racine and Ashtabula. When the weather’s just right, they stack their boards on top of their cars and head for the surf. No, they’re not going to Malibu Beach. They’re going to the Indiana Dunes or the long pier at Sheboygan, Wisconsin.

According to the Great Lakes Surfing Association, about 2,000 surfers chase waves around the Great Lakes. Association president Dave Irwin says waves may be better on the ocean, but when the wind blows across the lakes from the right direction, it can stir up waves three to five feet high. Surfers call some of these “mushburgers.” They’re as high as regular ocean waves, but instead of rolling over, they just crumble when they approach shore.

A good wave on the Great Lakes can carry a surfer about 50 yards, and the best are said to be along the eastern shore of Lake Michigan at Grand Haven, Michigan. In the fall, the air turns cool but the water stays warm, ideal conditions for surfing championships. Dave Irwin says about 100 people met at Grand Haven last September, competing for trophies in the surfing association’s annual contest.

Storms often bring the best waves, and storm surfing is popular in the fall and even into the winter. Enthusiasts have been known to don wetsuits and carry their boards over ice along shore to get to the water.


He feels there’s no comparison between regular board surfing and wind surfing, another popular water sport. In wind surfing, you have to spend time setting up the sails. Board surfing, he says, is just free: You grab your board, run into the water and go. ■ November 1988
Sedimental Journey

Much of the upper Mississippi River's abundant wildlife lives in shallow backwaters, but these valuable environments are disappearing.

Backwaters are the transition zone from marshland to deep river. Many were formed 50 years ago when the U.S. Army Corps of Engineers built a string of navigation dams to make the upper Mississippi safe for barge traffic. But Henry Snyder of the U.S. Fish and Wildlife Service in Winona, Minnesota, says silt is filling in parts of the river where the current is weak, and this is especially true in the backwaters.

What we are seeing now is the result of 50 years of aging and filling in the backwaters. People are beginning to notice that some of the good fishing spots and some of the good duck-hunting spots now have been filled in. And we just don't have a very good ability to deal with this on a large scale.

The problem is large. The upper Mississippi drains millions of acres of farmland. Snyder says many farms in the drainage area lose more than 10 tons of topsoil per acre a year. In an average year, more than 100 million tons of soil enter the upper Mississippi, and much of it settles in the river's backwaters.

The Fish and Wildlife Service predicts that the backwaters will become marshland within 50 years and dry land within a century. In hopes of saving the backwaters, conservation agencies from five river states have asked the federal government to promote erosion control on farms throughout the upper Mississippi watershed. They fear that without such controls, the river will lose its most biologically productive areas and the fish, waterfowl and other wildlife they support.

The Soldiers Grove Solution

Wisconsin's Kickapoo River has been both bane and blessing to the communities situated along its banks. The first settlers in the Kickapoo Valley used the river to power mills, and towns eventually grew around the milling centers. But the Kickapoo, located in southwestern Wisconsin, has never been a tame river. Periodically, it jumps its banks and floods towns like Soldiers Grove.

Although plans to control the course of the Kickapoo had been kicked around since the 1930s, none had been carried out. By the mid-1970s, it was clear something had to be done. Tom Hirsch, former community development coordinator for Soldiers Grove, says the town's residents had several choices.

There were three alternatives, and these were discussed at some length in planning documents as well as in environmental assessment. And they boiled down to three choices: do nothing; the structural solution, which is, as the Corps of Engineers had envisioned it, earthen levees and some channelization-deepening the channel so that it could carry more water through Soldiers Grove; and the so-called nonstructural solution, which was to remove the people and their property from the floodplain of the Kickapoo River.

The 500 people of Soldiers Grove, after much debate, settled on the last alternative. Hirsch says the decision to move the town a quarter-mile from its original location was unique. Most often, rivers are moved, not people.

Today a new Soldiers Grove sits on high ground, away from the temperamental but unmo- lested Kickapoo. Although not the solution for every flood-plagued town, relocation could become an accepted alternative to dams, levees and dredging.
The River's Keeper

Along the Delaware River, Cynthia Poten is known as the river keeper.

The sound of bulldozers is becoming more common along the pristine reaches of the upper Delaware River in New York, Pennsylvania and New Jersey. It means new homes and new shopping malls. To Cynthia Poten, it also means new threats to the upper Delaware's clear water.

Poten works for the American Littoral Society, a national nonprofit organization founded to conserve coastal waters. Her job title is river keeper, and her duty is to watch over the river's health.

For the past year, Poten has kept an eye on potential threats to the 300-mile-long Delaware. Two of her biggest concerns are pollution by toxic chemicals and diversions of water to New York City.

Poten's days are often as long and winding as the river itself. Some days, she meets with citizen groups to talk over new ways to treat sewage in developing areas. Other days, she works with attorneys to fight a plan to fill one of the Delaware's wetlands. And, on occasion, she gets in her canoe to collect water samples from the river for testing.

Poten considers the river inseparable from the surrounding streams and countryside.

The river is a living water system. The smallest tributary eventually becomes the Delaware River. All of these waters that flow together and eventually flow into the river are threatened by numerous problems.

Other river keepers are at work around the country. In New York, for example, private groups employ river keepers to monitor the Hudson River and Long Island Sound.

River keeping is not Poten's only job. She also runs a small garden business. She has no formal scientific training, but she feels strongly that everyone is responsible for protecting the environment. She says government agencies may be well-intentioned, but they are often handicapped by politics and can do only part of the job.

The Irrigation Nation

Israel waters its crops more efficiently than any other nation in the world. It needs to. According to Sandra Postel, a researcher for the Worldwatch Institute in Washington, D.C., the tiny country has no drop of water to spare.

Israel is using about 90 to 95 percent of its supplies. The Israelis have essentially no additional fresh water to tap to augment their supplies, so they are in a situation where they have to find ways to increase water efficiency if their economy is going to continue to grow and if they're going to continue to expand irrigation or food production.

Israel moved rapidly from ancient farming methods to high-technology agriculture. Postel says advanced systems like drip irrigation help Israel's farmers deliver just the required amounts of water rather than flood their fields.

Israel has a strict government allocation system to encourage efficient irrigation. The government estimates how much water a crop needs and charges stiff fines if a farmer uses more.

Farmers have used computer-controlled irrigation systems and high-yield, salt-tolerant crops to produce more with less water. A gallon of water yields twice as much food and fiber today as it did 30 years ago. This lets Israel meet most of the agricultural needs of a population that has grown from 800,000 in 1947 to about 4 million now.

But Israel is still pushing the limits of its resources. Irrigation water becomes more and more salty as it's reused. Israeli officials estimate that by the end of this century, half of their country's irrigation water will have to pass through purification plants before it's used on anything but salt-tolerant crops.

May 1985
**Fresh Water from the Sea**

Most of us take water for granted. We can turn on the tap any time we want and get a drink or wash our hands. But until about 15 years ago, that simple act was a luxury for the people of St. Thomas in the U.S. Virgin Islands.

Lying 1,200 miles southeast of Florida, St. Thomas is a Caribbean island rich in natural beauty but very poor in fresh water. Historically, the islanders have gotten their water from brackish wells or from cisterns that store the rainwater that runs off the roofs of their houses.

Over the past few decades, though, tourism on St. Thomas has exploded, creating a need for more reliable supplies of water. To solve this problem, the islanders have turned to the water that lies all around them: the salt water of the Caribbean Sea.

In 1981, Aquatech - an Israeli firm - built one of the largest desalination plants in the Caribbean region on the island of St. Thomas. According to technician Hanan Rosbruch, the Aquatech plant separates the salt from seawater using a steam distillation process and waste heat from the St. Thomas power plant. The salt, diluted in seawater, is pumped back into the ocean.

Rosbruch says the plant can produce about 2.5 million gallons of fresh water a day. To the islanders, that water's worth about $100,000.

Because the plant is constructed mainly of plastic piping, it won't deteriorate from the corrosive seawater and fall apart. Only a few years ago, that's what happened to St. Thomas' first desalination plant.

Rosbruch says his plant is economical and very easy to maintain. Best of all, the islanders and tourists on St. Thomas can turn on the tap any time and get fresh water from the sea.

**Thirst Aid**

Water is a scarce commodity in the growing cities of the desert Southwest. So scarce, in fact, that wastewater in El Paso, Texas, is too valuable to throw away.

El Paso, with half a million people, is the first big city in the country to pump treated sewage back into its underground water supply so it can use the water again. The city has just opened a unique water recycling plant to make it possible.

Local water utility official Robert Bustamante says the recycling plant turns out much cleaner water than conventional waste treatment plants.

We have to go through much more intense treatment. There are many more stages in this particular plant than in a sewage plant that discharges effluent into a river or lake.

El Paso's water recycling plant can purify 10 million gallons of water a day. That's enough to meet 10 percent of the city's needs. And Bustamante says the plant will prolong the life of the city's main water source.

Right now, we're getting the majority of our water from an underground source that is being depleted: We're extracting more water out of the groundwater aquifer than what nature is replenishing, so we're mining this particular source. This plant is going to slow down that depletion; it's not going to eliminate it.

The Texas city is stretching its water supply in other ways. City reservoirs are lined with plastic to prevent leaks. Many residents are landscaping with native plants suited to the desert climate. And water is priced to encourage conservation.

But even all those things won't slake the city's thirst if El Paso keeps growing, and local officials are eyeing new, untapped water sources in New Mexico for the future.

**May 1983**

**July 1985**
Leaky Pipes

The water supply systems of many American cities need costly repairs. But changing attitudes about water use may be just as important as fixing pipes.

About 10 years ago, engineers discovered some of the water pipes still used in Boston were made of wood and were installed at least 150 years ago. Those old pipes are a sign of a problem that faces many older eastern cities like Boston: Their water supply systems need massive overhauling.

The Freshwater Foundation estimated that Boston lost 20 percent of its water through leaky pipes in 1983. The U.S. Army Corps of Engineers reported in 1980 that one-fifth of the nation’s larger cities required replacement or restoration of their water supply systems. The Army Corps estimated this would cost between $50 billion and $80 billion over the next two decades.

The big question, according to James Crewes, a civil engineer with the Army Corps, is this: Who is going to pay for revamping those water supply systems?

The major issue is: Should it be done by federal dollars, or should federal dollars help, or should it be done by nonfederal? Of course, the administration’s policy is that water supply is a nonfederal responsibility.

Crewes says many states, like Massachusetts, are solving water problems with new laws and public information campaigns that promote conservation. For example, Boston’s successful “Use Less Water” campaign provides educational materials about water conservation to schools and grants for innovative water-saving devices.

Such efforts, Crewes says, are needed to help raise public awareness about water supply and conservation issues. They also will help make the public cost of replacing the 150-year-old wood pipes easier to accept.

Not a Drop to Drink

Enough water falls to earth as precipitation each year to support more than five times the present world population. Yet people still suffer from lack of water. Why? Mostly because some regions enjoy an abundance of water while others go thirsty.

Sandra Postel of the Worldwatch Institute recently examined the global water supply, and she predicts dry times ahead for much of the world. Postel says farmers account for about 70 percent of the world’s water consumption, and they already face shortages. The Soviet Union provides one example.

The Soviet Union has the problem that most of its water is in the northern and eastern parts of the country, but most of its people and the best land for agriculture are in the southwestern part of the country. The Soviets have developed the supplies in the southwestern part of the country almost to their limit, so that in many dry years, all the water resources in that region are essentially used up.

Postel says many American farmers will also need new water sources sooner or later.

In the United States, for example, in the high plains area, which includes a lot of Midwestern states, farmers have been relying for several decades now on water from the Ogallalla aquifer, which is essentially a nonrenewable water resource.

In regions not blessed with much water, Postel believes shortages will be severe within 15 years. She says North Africa and the Middle East will need every drop of their usable water by then. Parts of Europe and Asia will also tap nearly all of their reliable water supplies. Unfortunately, she says, pollution and poor management will make those supplies even more scarce than they are now.

February 1985