generating station. Intrigued, several other countries studied the idea, but until 1920 most of the effort went into talk. Finally Japan tried the idea, followed two years later by the United States, which made a primitive attempt in the Geysers district of California. Both nations failed, but subsequent successes in areas as diverse as Iceland, Mexico, New Zealand and the Soviet Union, as well as Japan and the U.S., have charged up the geothermal power business until the world now uses about one million geothermal kilowatts a year, equal to the energy of some 1.15 million tons of coal.

And if the business isn't booming in the U.S. the way its backers think it ought to—only 5 percent of the world's output is in the U.S.—the reason is the lack of adequate laws.

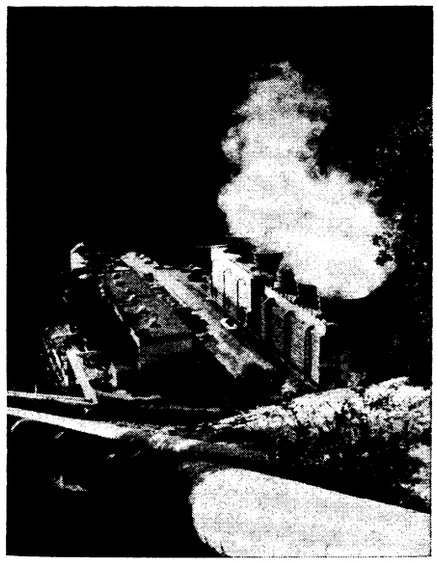
Almost half a century ago, Congress passed what is still the only legislation giving access to the country's underground resources: the Mineral Leasing Act of 1920. This multifaceted document covers petroleum and natural gas leases, mining claims and general mineral rights on Federal lands, but says nothing at all about hot water, rocks and steam.

The only commercially operating geothermal power plant in the country, therefore, is one located on privately-owned land in Sonoma County, Calif., in the same Geysers area where the first U.S. experiments were tried. "The Government has dug no holes," says an Interior Department official, "and it doesn't plan to." Industry will have to do it all.

Frustrated industry, however, dependent on rights to Federal lands for most of the country's heat reservoirs, has no way to do it under present law. As a result, companies hopeful of getting a piece of the geothermal action have been stepping outside at least the spirit of the law in trying to get in on the ground floor. The effort to draft a new piece of legislation has occupied the House Interior Committee for a hot week of hearings and promises to take even longer in internal deliberations before doing the same thing in the Senate later this year.

In about 1960, says the Interior Department, these companies began obtaining rights to work the Government's land for oil, natural gas, potash, sodium or whatever was available under the Mineral Leasing Act. Much of this land, however, was obviously not going to yield much of what it was claimed for. Instead, the Government maintains, the companies only wanted to get some kind of advance claim on the land that could, under a "grandfather clause," be transferred to geothermal energy rights when an appropriate law came into being.

Last year a law came along that was just what industry had ordered. With considerable pushing, it passed both houses of Congress, only to be vetoed by President Johnson. The Johnson Administration was, and still is, violently opposed to the grandfather clause, and wants a fresh start and competitive bidding for all geothermal energy rights. All leases should be short-term—in fact the shorter the better—and renegotiable



Pacific Gas and Electric Co.

The U.S. geothermal power plant.

at the Government's discretion every 10 years.

Industry wants leases that run indefinitely until the steam or hot water runs out, and competitive bidding only for previously identified geothermal sources. Rights to unidentified sources, or wildcats, would go to the discoverer; it is not unlikely that a number of previously registered but strangely unproductive oil, gas and mineral claims would suddenly be discovered to be rich geothermal wildcats as well.

Once the legalities get ironed out, the technology looks simple. The U.S. Geological Survey estimates that even with present technology the world geothermal power production could be increased as much as 10,000 percent and that heat reserves within our present reach could keep up that rate for half a century.

Getting down to where the heat is is much simpler than drilling for oil. Oil wells are now getting down as deep as four miles below the surface, while the heat miners are discussing depths of only a few thousand feet.

Extracting the heat, on the other hand, poses some special problems. Getting it up through the rock, which is a relatively poor heat conductor, is one. A proposed solution is to drill deep enough to puncture a large number of the heat carrying channels or fissures in the rock; but these get fewer and fewer at greater depths as the weight of the rock above crushes them shut. Another remedy may be atomic energy, which could be used underground to crush the rock and make it heat-permeable without violating the nuclear test ban.

Whatever the problems, the value of the goal will hasten their solution. The heat available in the outer 60 miles of the earth's crust is equal to more than 12 billion times the energy of all the coal consumed in the U.S. in 1965. The world's coal resources are diminishing, but the great global heat mine has barely been tapped.

LAKE ECOLOGY

Dead Fish by the Ton

A freshwater lake is not a permanent thing. No matter how large, how deep or how apparently pure its waters are, every lake, according to limnological theory, has a finite life cycle.

Generally, a lake will go from a cold, deep body of water to a warm, shallow pond and then turn into marsh and, eventually, dry land as vegetation and decaying animal matter slowly fill it in. As the lake passes through each stage of its life, its animal forms also change, typically from trout in the early stages to lesser fish such as perch and carp and then to frogs, snakes and, perhaps millions of years after it formed, to foxes and deer.

This process, inevitable in any case, has proved especially sensitive to the effects of mushrooming civilization. Nowhere have the effects of thoughtless conquest of nature become more apparent than on the Great Lakes where entire fish populations have vanished.

So when vast numbers of fish turned up dead in Lake Michigan last week it seemed to point to another in the continuing series of disasters to natural populations caused by pollution. Yet, Michigan, thanks to Chicago's practice of flushing its sewage down the Mississippi River, has been one of the cleanest of the Great Lakes.

As it turned out, the hundreds of tons of dead fish washing up on the beaches had not been killed by pollution, although the incident is another result of the human impact on the Great Lakes.

The fish are alewives, originally an Atlantic Ocean fish, according to M. R. Greenwood, director of the Bureau of Commercial Fisheries' Exploratory Fishing and Gear Research Base at Ann Arbor, Mich. They would not be in the Great Lakes at all if it were not for the existence of the Welland Canal and St. Lawrence Seaway, he says.

Construction of the canal, it became apparent some years ago, made

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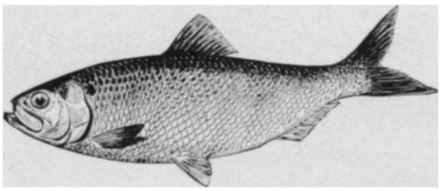
it possible for lamprey eels, also originally from the Atlantic Ocean, to find their way into the upper Lakes where they multiplied rapidly while feeding

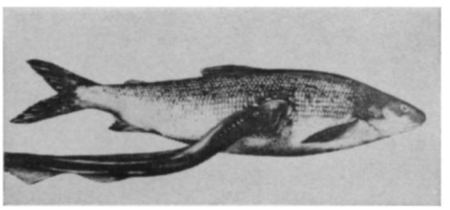


Interior

Alewife: smelly nuisance on shore.

on the juicy lake trout and whitefish they found there.

As the eels grew fat and ever more numerous, the populations of trout



Interior

Lamprey and dinner—a whitefish.

and other desirable fish rapidly dropped to near zero.

This, then, paved the way for the alewives. With the alewife-eating trout out of the way, the little—nine inches at most—alewives had essentially free run of the Lakes. Even the voracious lampreys found them too small for a satisfying meal and so left them alone to multiply.

Today, Greenwood estimates, there are several billion pounds of alewives in Lake Michigan alone. They have become the basis of a booming fishing industry which sells them for pet food and fish meal to processing plants that have set up along the Lake.

They have also become an annual nuisance, he notes, when they die after spawning. The city of Milwaukee has, for example, had to hire a commercial fisherman to do nothing but clean up the dead alewives from its lakefront.

This year's unusually large numbers of dead alewives simply attests to the especially successful hatch of alewife eggs observed by limnologists three years ago . . . the length of a typical alewife's life-span.

Besides its dual role as nuisance and profit-making industrial fish, the alewife is now slated for a third role—that of helping to restore some semblance of the natural ecological balance of fish in the Great Lakes.

The State of Michigan, Greenwood says, has been stocking Lakes Superior and Michigan with lake trout and Boho salmon from the Pacific Coast. These fish, it is hoped, will eat the plentiful alewives and grow to provide fun and food for sport and commercial fishermen.

Success of the salmon and trout-raising program rests on the previous success of an anti-lamprey program. The eels, which would regard a salmon or trout as 24 hours worth of food, have been successfully controlled in Lake Superior and are on their way out in Lake Michigan, according to Greenwood.

Their demise has been largely due to use of a chemical lampricide placed in the streams where the eels lay their eggs. The chemical, discovered in 1957, kills the lampreys but not fish. Electric weirs have also been used to keep the eels from their spawning grounds. The chemical is now slated for use in the streams around Lake Huron, to rid the upper Lakes of lampreys.

THALIDOMIDE

A Clue to the Mechanism

Until German scientists reported in 1961 that 150 deformed infants—lacking developed arms and legs—had been born to women taking thalidomide during early pregnancy, the sedative was not a suspected teratogen. And because the details of its behavior in the body were poorly understood—as is the case with many drugs—scientists could not have predicted its interference with normal embryonic growth.

And so, with the hope of coming up with a measure for predicting which other drugs might also produce gross abnormalities in unborn infants, investigators set to work to clarify the mechanism of thalidomide's behavior at the molecular level. Their goal was to find out exactly how thalidomide works chemically; how its molecules combine with or interfere with chemical activities in living organisms.

Thalidomide is made up of three molecular rings. And, the design or structure of its third ring resembles the molecular design of a substance called glutamic acid—a naturally occurring amino acid present in all completed proteins. Because of this resemblance, some researchers concluded that thalidomide interferes with the metabolism of glutamate—a salt of glutamic acid implicated in the manufacture of nucleic acids. Presumably thalidomide caused deformities by blocking the synthesis of certain of these acids in cells which would eventually develop into limbs.

As a result of this conclusion, suspicion was cast on the safety of other compounds containing molecular structures similar to glutamate. A variety of