AGRICULTURAL ENGINEERING

FERTILIZING THE SEA

A firm wants to add nutrients to the ocean to create fisheries and soak up carbon dioxide

"Give me a half-tanker of iron, and I'll give you an ice age," said the late oceanographer John H. Martin, referring to the concept of stimulating the growth of phytoplankton by adding iron to ocean water. According to this scheme, which has been called the "Geritol solution" to global warming, the newly spawned microscopic plants would draw carbon dioxide from the atmosphere to support photosynthesis and carry carbon to the deep sea after they died.

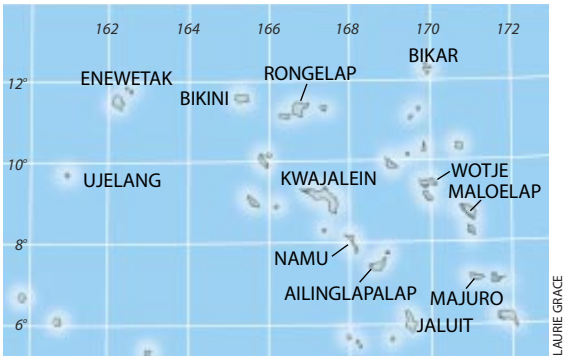
While putting it less brashly, Michael Markels wants to apply the same principles, not only to alleviate the buildup of greenhouse gases but also to establish fisheries in otherwise nutrient-poor waters. Markels, a chemical engineer who founded the McLean, Va.–based company Ocean Farming, Inc. (OFI), literally wants deserts to bloom at sea. "The oceans, for the most part, are a great barren wasteland: 60 percent of the plant life comes from just 2 percent of the surface," he says. "Fertilization is required to make the barren parts more productive."

Markels was inspired by the "IronEx" experiments designed by Martin—former director of the Moss Landing Marine Laboratories near Monterey Bay, Calif., who died in 1993—and carried out near the Galápagos Islands in 1993 and 1995. In both outings, researchers successfully created phytoplankton blooms in fertilized patches of ocean, and in the second experiment, they measured a 60 percent drop in the flow of carbon dioxide from the ocean to the atmosphere. But these effects were short-lived, lasting less than a week after the last infusion of iron.

It is possible to do better, Markels says, by using the right mix of iron, phosphorus and trace elements. The materials would be encapsulated in buoyant, chemically protective containers that keep the nutrients in the "photic zone" longer and release them over time. Through continuous fertilization, he hopes to simulate conditions off the coast of Peru, where nutrient-laden water is brought to the surface by upwelling.

OFI has secured an option from the Marshall Islands for private property rights to all or some of the 800,000 square miles in the "exclusive economic zone" surrounding the archipelago—the first agreement that has ever been made to privatize a portion of the ocean for fish production and carbon dioxide sequestering. Under the agreement, OFI will pay the Marshall Islands government a minimum of $3 million a year for rights to the entire region and a reduced fee for a smaller area. Markels estimates that with a 100,000-square-mile area, "we could sequester in the deep ocean one fourth to one third the amount of carbon dioxide that the U.S. puts into the atmosphere."

OFI is conducting experiments in the Gulf of Mexico during the first half of this year to determine the best means of fertilization and the optimal mix of nutrients. Oceanographic studies around the Marshall Islands will be carried out next to establish baseline concentrations for key chemicals. With sufficient funding, commercial operations could begin as early as 2000, whereby a ship would steadily deposit fertilizer throughout that nation's territorial waters.



***MARSHALL ISLANDS** could be the site for commercial ocean fertilization.*

Scientists familiar with the venture have voiced numerous concerns. Caution is in order, says Sallie W. Chisholm, a Massachusetts Institute of Technology oceanographer who participated in the IronEx studies, because "the gap between science and private enterprise is just too big." To illustrate that point, she notes that the upwelling systems off Peru have been evolving for hundreds of millions of years. "You can't expect to duplicate that just by pouring nutrients into the water," she argues.

David A. Caron of the Woods Hole Oceanographic Institution maintains that there is no way to predict which phytoplankton species will be stimulated by fertilization or what kinds of fish might feed on them. "The last thing you'd want to do is produce 100,000 square miles of toxic bloom. That would be a mess, not a fishery," he says.

Moreover, it would take a huge fertilization effort to make a sizable dent in the global carbon dioxide problem, Caron says, adding, "Who knows what the side effects would be? We're talking about intentional eutrophication"—an oxygen-depleting process resulting from organic decay that has led to deleterious environmental consequences in lakes and coastal zones throughout the world.

If adverse impacts become evident, Markels says, operations would cease immediately. "We only have to stop fertilizing, and all traces of the nutrients are gone in about 20 days," he contends.

But some problems may not be apparent without an extensive, and expensive, biological sampling effort. Caron thinks an adequate monitoring program would take three to 10 years, which may not be economically feasible. "It's not cost-effective for them to do that, especially since they don't have to do it," Chisholm says. Some side effects, moreover, may be irreversible: "Once you kill the reefs in that area, which you probably would do, it's not clear they would ever come back," she adds.

Markels realizes the potential for problems, which he hopes to avoid, but also sees the potential for significant benefits to humanity. "If we don't do anything that might possibly cause harm, we'd never do anything at all. We might never have transformed the land—increasing agricultural output by a factor of 2,000—with all the advances that came with it," he asserts.

Those who view ocean fertilization as an unproved option for boosting food production and averting global warming are not recommending that nothing be done. "But before we resort to radical manipulations of this planet, we ought to make greater efforts to reduce carbon dioxide emissions," asserts Andrea C. Ryan, an environmental policy researcher at M.I.T. "And even if we do consider 'geoengineering' options, ocean fertilization still may not be at the top of the list."

—Steve Nadis in Cambridge, Mass.