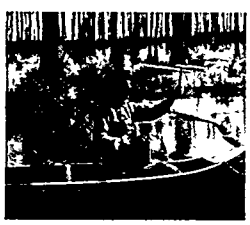
1971 The first terrestrial carbon cycle models were developed from data obtained by the International Biosphere Program, jointly supported by the AEC, the National Science Foundation, the U.S. Forest Service, and other agencies.

1972 Oak Ridge and Columbia University scientists used carbon-14 and the inorganic chemical properties of seawater to quantify the ocean carbon cycle and to determine the fate of CO_2 produced by fossil fuel combustion.



1972 The AEC designated Savannah River as the first National Environmental Research Park.

1973 The Atmospheric Release Advisory Capability was established at Livermore to track and predict the transport of potentially dangerous atmospheric releases, both natural and anthropogenic.

facilities were being developed on major river systems throughout the U.S., and oil exploration and waste disposal were being proposed for offshore waters. The resulting interdisciplinary studies led to fresh insights into continental shelf dynamics—and ultimately to confident predictions of the consequences of oil spills, to standards for the release of hazardous substances at sea, and even to scientific fishing forecasts.

Impelling the earliest of this oceanographic work was concern about ocean-borne transport of radioisotopes away from the sites of atmospheric weapons tests in the South Pacific. But an equally vital human health issue was the accumulation of radioactivity in seafood. Accordingly, AEC-supported researchers founded the field of marine radioecology by studying the bioaccumulation of radionuclides in marine organisms and assessing the consequent ecological risks. One of the researchers, Roger Revelle, of the Scripps Institution of Oceanography, received the Presidential Medal of Science in 1990, in part for his pioneering work in this area. As part of this effort, the first application of carbon-14 as an ecological tracer was to measure photosynthetic rates in the world's oceans. For twenty years, AEC research provided fundamental insights into marine food chains and produced most of the world's information on the rate of CO_2 fixation and on its fate in the oceans—information that would feed naturally into later work on global climate change.

The Outdoor Laboratory

This prescient work on ocean ecosystems points, in fact, to yet another strand of environmental research, one intricately entwined with studies of atmospheric and oceanic dynamics and the dispersion of air- and waterborne contaminants. Its early theme was the fate and effects of radioactivity released into terrestrial and freshwater ecosystems. In concert with research on human health effects, these strands of environmental exploration thus sought a complete picture of the impacts of nuclear technology: What is the fate of the radioactive materials we release? What are their direct effects on humans? And what are their effects on the biosphere of which we are a part? The seventies would again broaden the charge to encompass all energy-related emissions, but the larger question would remain the same: What are the consequences of the energy choices we make?

In approaching such questions, the AEC's most pervasive contribution followed the theme of its efforts in nuclear medicine and atmospheric studies, namely, the use of radioactive tracers. Beginning with modest efforts at several universities and national laboratories, *radioecology* grew to encompass studies of material pathways and flow rates through terrestrial and aquatic ecosystems of every description. The research involved nearly all of the AEC national laboratories, in part because of their locations in different environments of the country.

At first, radiotracer studies dealt mainly with iodine-131, a short-lived fission product deposited on the landscape from

MEASUREMENTS AT SEA

■ In light of their research activities, it is not surprising that the energy agencies have also played a significant role in developing instrumentation for oceanography. Examples include acoustic sounders to measure the mass and movement of plankton, modified flow cytometers that have isolated new species of organisms, and expendable microcomputer-controlled sensors that can be dropped from airplanes or ships. Another was a fast-repetition-rate fluorimeter, developed by Paul Falkowski at Brookhaven, that measures real-time photosynthesis in seawater. Notably, this instrument played a central role in recent, highly publicized experiments that produced a short-lived phytoplankton bloom in the South Pacific by "fertilizing" the ocean with iron. ■