gineers who carry it out. Each area of inquiry and each project has its own peculiarities and complexities and calls into play an individual combination of technical disciplines and facilities. Vocabularies, techniques, and perspectives differ—as they ought to—but some common problems can be discerned in virtually all research. Important progress is being made within Interior to ensure that emerging methodological innovations are applied as widely as possible, consistent with goals and priorities.

Among the problems shared by nearly all researchers are those of information sensing and recording, handling, and retrieval. Here electronic communications techniques offer exciting opportunities. These techniques have been given extensive applications in the major scientific spheres in which Interior scientists are engaged.

Observing and recording

The first of these is the observation of natural phenomena. In Interior this problem is often acute, because the research is concerned with phenomena that occur on a vast scale and cannot be transferred to or duplicated in the laboratory. Simultaneous observation and recording of widely dispersed data is now feasible with electronic monitoring systems.

The Federal Water Pollution Control Administration has some 29 complexes of recording and monitoring devices installed along various rivers and estuaries. The most sophisticated of these complexes is found along the lower Potomac where four devices have been installed which automatically collect water samples and make eight chemical, physical, and visual analyses every hour. The data are transmitted over telephone cables to central logging equipment at FWPCA headquarters in Washington. Continuous visual display of daily variations in pollution indicators will permit rapid response whenever water quality standards are violated. The equipment also prepares input tapes for digital computers. Data from all recording and monitoring systems are now stored in a PHS computer installation in Cincinnati, Ohio, from which Federal scientists, contractors, and grantees can retrieve information regarding the pollution behavior of any of the rivers being monitored.

In the North Pacific, the Bureau of Commercial Fisheries has made a successful start on a project that will eventually result in the dispersal of up to 50 submersible monitoring buoys over a vast area of the ocean. Suspended at varying depths, these buoys send temperature and salinity measurements via radio signal to small shipboard computers which process the data in a manner similar to the FWPCA installation. A major objective of this system is to identify the boundaries of large water masses which are known to be controlling factors in fish migrations. An instantaneous picture of water mass locations will greatly enhance our ability to predict where large schools of tuna are most likely to be.

The Geological Survey has installed 31 seismograph telemetry stations in five "clusters" along earthquake fault lines in California. Each station consists of a small electronic package buried in a shallow hole and connected by cable to the nearest telephone line. The telemetry network permits monitoring of minute but highly significant earth movements throughout the area. The data are placed on 16-mm film and processed continuously, making it possible to locate hypocenters of seismic events for display on a three-dimensional plot.

Handling Floods of Data

The second major problem area stems from the "data explosion." Increasingly we are learning that research must deal with staggeringly complex interactions and with data in such volume that historic approaches to analysis and evaluation are totally inadequate.

In a few cases Interior scientists have found that the interactions of relevant factors fall into patterns which can be expressed as mathematical models. It then becomes possible to predict with great accuracy how, for example, a river system or mining operation will be affected by variations in any factor.

The FWPCA has developed a complex general model for simulating the behavior of river basin systems. The model accommodates variations in water and land use, institutional arrangements, and changes in water management. It permits analysis of the effects of differing rainfall patterns, waste inputs, dams and reservoirs, and differing water control measures. Using the model, scientists at FWPCA can get answers to questions such as: How do current management practices in a particular basin influence water quality? What changes in management would provide what quality at what cost? And will the flow in a wild river be sufficient to maintain a required wetted perimeter for fish spawning?

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