orbiting solar power station to meet future U.S. civilian energy needs have noted that such a station could be easily sabotaged.)

Still another program is the so-called "dark satellite" program, said to be an effort to design "invisible," communications satellites with minimal spectral signatures, and possibly even covered with peculiar mirrors to camouflage them in sunlight. Said to be sponsored by Defense Research and Engineering, the satellites would be placed in orbit 115,000 kilometers from earth, in a turned-off mode. Recently, Pentagon officials have been hinting darkly that there may already be such satellites, hiding deep in space and ready to take over if some other, vital satellite fails.

While the real answer is obviously classified, the outside observer asking whether U.S. satellites are indeed vulnerable must conclude that in fact they are. They could be put out of commission by an operational killer, or by a large explosion somewhere near their orbital path, or by some more sophisticated weapon, such as one using a high energy laser (which the Soviets are also developing). It is equally obvious that, even though defense communications, submarine navigation, and other vital functions rely on other systems as well, military programs in general are becoming more and more reliant on satellites. For example, the much-touted revolution in precision-guided weapons which could give the U.S. a decisive new edge over the Soviets in a tactical war in Europe, will rely heavily on satellites. "We keep preaching to everyone that what you need is a mixed bag," laments one Defense Communications Agency official. "But the plain fact is that satellites can do whatever job you need done better than other systems. The worst thing about satellites is that you come to depend on them."—DEBORAH SHAPLEY

International Biological Program: Was It Worth the Cost and Effort?

For a 7-year period ending in 1974, the United States participated in the International Biological Program (IBP)—an ambitious effort that was supposed, in this country at least, to revolutionize ecology and usher in a new age of "Big Biology." Some 1800 American scientists engaged in IBP work, supported by $57 million in federal grants plus substantial contributions from other organizations. It was the largest research effort ever launched in biology, a field which had traditionally been dominated by individual investigators working on small-scale problems.

But was it worth the money and effort expended? That question is directly addressed by an evaluation committee appointed by the National Academy of Sciences, the organization that served as home base for American IBP leaders during most of the program's active life. Curiously enough, the evaluation committee never explicitly answers its own question. It simply finds that the program produced some major accomplishments, had some acute problems, met some goals, missed others, and turned in a "creditable" performance, considering that it was greeted with apathy and hostility by key elements of the scientific community and had enormous difficulties meshing its goals with those of granting agencies.*

"It's a minor miracle the program worked as well as it did," says Paul J. Kramer, the retired Duke University botany professor who headed the Academy's evaluation team. Kramer told *Science* that, while his committee never quite stated that the program was worth the time and money, virtually all members of his evaluation team did in fact conclude that it was. "I believe it was fairly unanimous," he said. "We weren't ducking the issue. We just didn't want to take an advocacy position."

Kramer's group was established by the Academy in 1973 to review the organization and management of the American IBP effort to see if lessons might be derived to assist future international programs of similar scope.† The committee interviewed key federal officials, read IBP documents, obtained detailed statements from some 35 participating scientists, interviewed faculty members on several campuses, sent a questionnaire to 100 or so participants, and obtained comments from foreign scientists. The committee submitted its report to the National Science Foundation (NSF), which funded the evaluation effort, last December, but the document has only become available in recent months through the National Technical Information Service. It is one of two major evaluations of the American IBP program. The other, conducted by Battelle Columbus Laboratories, focused on three of the major ecosystems studies that were part of the American effort (*Science*, 28 May, p. 859).

The origins of the IBP can be traced to discussions that started in 1959, apparently inspired by the accomplishments of the International Geophysical Year, but it was not until 1964 that the international effort really got under way with a general assembly in Paris of scientists from 32 countries.

The initial American response to the program was marred by bungling among the scientific leadership and opposition or indifference among working scientists. "It started out very badly," recalls Kramer. "There was not enough groundwork done in advance. There was very little attempt to acquaint the scientific public with what was planned. It was all thought up at the higher levels by scientific politicians—those scientists who like to develop programs. The ecologists and biologists were told very little about it. So it was difficult to work out programs that would attract them."

A U.S. national committee operating under the International Union of Biological Sciences was in charge of organizing the American effort from 1960 to 1965. According to the Academy's evaluation, it strongly favored an international program but made little effort to inform the biological community or obtain funding. It just assumed that biologists would participate and that funds would be forthcoming, probably from NSF.

Both assumptions proved overoptimistic. The NSF had already been

*The committee's 81-page report *An Evaluation of the International Biological Program* is available from the National Technical Information Service, Springfield, Va. 22161; PB 253 158; $5.00 paper, $2.25 microfiche.

†In addition to Kramer, the evaluation committee included Fred R. Eggan, University of Chicago; John A. Moore, University of California at Riverside; A. G. Norman, University of Michigan; Charles E. Olmsted, University of Chicago; Frederick E. Smith, Harvard University; Earl L. Stone, Cornell University; and Roy A. Young, Oregon State University.

burned once by the International Geophysical Year, which was originally supposed to cost $2.2 million and ended up costing $40 million, not including logistic support from the military. This had a "traumatic effect" on federal program officers, the Kramer group reports. The initial attitude of NSF officials "vacillated between reluctant support and opposition," largely because they feared the IBP would drain off funds from ongoing projects whose support was already deemed inadequate. The National Science Board, the policy-making body for NSF, was also divided, with some members "strongly opposed."

Attitudes among those biologists who were aware of the proposed IBP were "very mixed." The Federation of American Societies for Experimental Biology seemed "strongly opposed," while the American Institute of Biological Sciences encountered "both interest and doubt" among its members. Molecular and cellular biologists, then the glamor-laden kingpins of the biological world, were "inclined to fear possible competition for available funds."

Meanwhile, the Academy had become increasingly involved in the planning and took over leadership of the U.S. effort in late 1964. Gradually, it became apparent that funds for a coherent U.S. program were "not readily realizable." Funding agencies took the not unreasonable position that they would only fund projects which *they* considered worthy and important; they were not about to hand over a big chunk of money for some ill-defined IBP program.

In late 1965, Donald Hornig, then presidential science adviser, told NSF to "coordinate" federal support for the IBP. But there wasn't much to coordinate. Few other agencies were interested; they sent low-level people to attend meetings of an interagency coordinating group. The only result of Hornig's directive was that NSF became more supportive of the program, especially after IBP supporters induced the House science subcommittee to hold hearings on the program in 1967 and Congress approved line-item support for the IBP in the NSF budget. The Foundation soon became far and away the chief supporter of the IBP, putting up $48.5 million of the federal government's $57 million contribution over a 7-year period. As a result, only those projects that fell into areas normally supported by NSF received significant funding. Agricultural research was largely ignored, even though biological "productivity" was a key theme of the IBP effort. And studies of the adaptation of human populations to their environments—another key focus of the IBP—got relatively short shrift, because they fell outside NSF's normal mission and the National Institutes of Health weren't interested.

As it finally evolved, the American IBP program was divided into two parts. The most eye-catching was the "integrated research programs," featuring cooperation between several universities and institutions, and often involving vast multidisciplinary armies of scientists, armed with computers and the techniques of systems analysis, in large-scale studies of entire ecosystems, such as a grasslands, Eastern deciduous forest, desert, tundra, or coniferous forest. The other was a more loosely coordinated batch of projects built around roughly common themes—such as nutrition or conservation of plant genetic materials—but lacking central management and funding.

A Spotty Record

How successful was the effort? That depends on the criteria used for judging.

If one judges the program by four grandiose claims put forth at the 1967 congressional hearings, then the American IBP effort, while making "major contributions," according to the Academy evaluation, nevertheless failed to live up to its own rhetoric.

The first major objective, as cited at the hearings, was to develop systems analysis models of complete ecosystems in order to predict the effects of natural and man-made ecological changes. That effort largely failed, primarily because the goal was "unrealistic in view of the lack of valid theory and experience in dealing with such large and complex systems." There was considerable success in modeling simpler processes and systems, such as nutrient cycling and photosynthesis.

The second objective was to increase scientific knowledge about ecosystems in order to improve resource management. The IBP unquestionably generated a vast amount of data, but much of it seems to be inaccessible. There is no central library of IBP papers; many unpublished reports can be obtained only from the investigators; synthesis volumes, although in preparation, have not yet appeared (other countries are far ahead in this respect); and plans for establishing data banks have foundered, making data storage "one of the less successful aspects of the IBP."

The third objective was to improve international understanding through cooperative programs. As it turned out, there was very little collaborative work among scientists of different countries. Nor was there much cooperation—as originally hoped—between scientists from advanced and developing countries. However, the IBP did stimulate a flow of information and visiting among countries, and U.S. and Latin-American scientists cooperated in several projects.

The fourth objective was the training of a large number of scientists, an effort which the Academy evaluation deems "one of the more successful aspects of the US-IBP." In particular, "the experience of working with scientists in other disciplines on large multidisciplinary projects was stimulating and broadening," with effects apt to become "more evident during the next decade."

Although that may seem a spotty record, with only one of four objectives fully met, the Academy evaluation concludes that the IBP "made major contributions toward all of its major objectives," which were probably inflated to begin with, given the "characteristic hyperbole" used in testifying before congressional committees.

The Academy credits the IBP with some "noteworthy" accomplishments, while acknowledging that no final judgment of the program will be possible for many years—when the vast output of books and papers is complete and one can assess the permanence of the stimulation introduced by the IBP. Already visible results include the development of interdisciplinary approaches to biological problems, greater use of systems analysis, increased knowledge and interest in soil biology, improved methods and instruments, and standardizing of research methods so that results from various laboratories are comparable.

Significant Criticisms

But the Academy committee agrees, at least in part, with some major criticisms that have been lodged against the IBP. It calls it "unfortunate" that the program failed to include much agricultural research. It agrees that "some IBP spokesmen claimed credit for more than was accomplished." It acknowledges that some investigators and projects that were probably not good enough to win support on their own merits were able to get funding as part of the IBP, but it says that some of this routine, narrow, data-collection type work by young scientists was "invaluable" to the overall program. Finally, it seems willing to accept the allegation that "no notable discovery or scientific breakthrough" can be credited to the IBP. "This may well be true," the committee says, "but the edifice of science is enlarged by a multitude of

additions, small and large, with only rarely an event that changes the design." Besides, "we do not believe that the scientific achievements of the IBP can yet be viewed in full perspective."

The evaluation committee derives a number of "general precepts" from the IBP experience that it hopes will enable the managers of future large-scale programs avoid some of the problems that plagued the IBP. This focus of the report inevitably led the evaluators to harp on the program's shortcomings. But the committee's overall judgment of the IBP is essentially favorable.

"Although the U.S. program failed to realize certain objectives, such as the production of workable, large-scale models for entire ecosystems and the establishment of readily accessible data banks, it convincingly demonstrated the effectiveness of a multidisciplinary approach to research on complex problems," the Academy group says. "We conclude that, overall, the U.S. performance was creditable and that substantial scientific contributions were made. The coordination of research projects left something to be desired, but we doubt that under the prevailing circumstances a substantially more coherent program could have been developed."

—PHILIP M. BOFFEY

Jimmy Carter's Advisers: Drawing from the Public Interest Movement

New aides and advisers whom Jimmy Carter has selected would appear to offer an insight into the character of a Carter administration if he is elected. The names of such staff members and advisers, including those on a science policy task force headed by Lewis M. Branscomb (chief scientist for IBM), are now becoming available.

One of the most interesting and perhaps significant indicators is that the 10-member transition team that Carter has set up in Atlanta includes three young men with extensive experience in the public interest movement. One of the three is responsible for government organization, which of course takes in the organizational arrangements for making and executing science policy. Another is responsible for policy planning with respect to energy and natural resources management.

The Carter campaign organization has recently assembled 16 advisory task forces, including the one for science policy (see box). The makeup of the science policy task force does not, however, allow easy characterization except to say that most of its members appear to be from the mainstream of the scientific community. In any case, the potential influence of such advisers will probably be much less than that of the full-time policy planning staff which has been assembled in Atlanta. This newly established part of the Carter-Mondale organization has the responsibility of outlining the course of a new administration and identifying many of the people who would hold important positions in it.

The three policy planners with backgrounds in the public interest movement are:

• Harrison Wellford, policy coordinator for government oganization. Wellford, 36, was the first executive director of Ralph Nader's Center for the Study of Responsive Law in Washington. He comes to Carter's organization from the staff of Senator Philip Hart (D–Mich.), who has himself been closely identified with encouraging the public interest movement.

Wellford, who is from North Carolina and Virginia, is a graduate of Davidson College and was a Marshall Scholar at Cambridge University. He also was a research associate at the Institute of Politics at Harvard, and holds a Ph.D. in government from Harvard. His book *Sowing the Wind: Food Safety and the Chemical Harvest*, written under Nader auspices, was accepted by Harvard for his doctoral dissertation. Wellford recently received a law degree from Georgetown University.

• Joe Browder, policy coordinator for energy and natural resources. Browder, a 38-year-old native of Amarillo, Texas, gave up his position as director of the Environmental Policy Center (EPC) in Washington to join Carter. Although relatively little known outside environmental circles, the EPC is an important lobbying group, having led the effort to pass strong federal legislation with respect to such matters as strip mining, land use, and outer continental shelf oil development. An adjunct of the EPC is the Environmental Policy Institute, which has made some useful analytical studies.

Browder holds no college or university degrees, but he is a talented, self-taught amateur naturalist and an achiever in the manipulative arts on a par with some of the finest and most respected Washington lawyers. He had a big part in persuading the Nixon Administration to make a half-billion-dollar commitment to the preservation of Florida's Big Cypress Swamp. His first experience as a professional environmental activist was as south Florida field representative for the National Audubon Society, and he later headed the Washington office of Friends of the Earth.

• Joe Levin, policy coordinator for health, welfare, courts, and criminal justice. Levin, 33, was formerly legal director and general counsel of the Southern Poverty Law Center in Montgomery, Alabama. He will work closely with Larry Bailey, a 35-year-old black from Charles Town, West Virginia, who is policy coordinator for urban affairs. Bailey has a master's degree in education from Antioch College and was formerly assistant director of the U.S. Conference of Mayors.

The coordinators for the other three policy areas—business and labor, foreign policy and international security, and economic planning and the budget—come from more conventional backgrounds. The budget policy coordinator, Bowman Cutter, 34, is a Virginian whose last job was as assistant to the president of the *Washington Post*. He is a Rhodes Scholar and a graduate of Harvard and Princeton's Woodrow Wilson School.

Anthony Lake, 36, one of two foreign policy specialists, was special assistant to Henry Kissinger when the United States invaded Cambodia in 1970. He immediately resigned in protest.

All of the policy coordinators are expected to exchange information and suggestions regularly with Richard Fleming, the transition staff's talent hunter who will be collecting the names of promising prospects to serve in a Carter administration. The 31-year-old Fleming holds