MAD, in which sensitive magnetometers, usually carried aboard ASW aircraft, are used to detect very slight distortions in Earth's magnetic field caused by the submarine's steel hull. The technique is effective only at very short ranges—usually a fraction of a mile.

Other techniques are only in the research phase. They include the use of blue-green lasers to probe the ocean depths, searching from space for surface waves or a slight hump in the ocean caused by the passage of a submerged submarine, and looking for minute changes in the water column caused by a submarine's presence. The panel notes that "it is far too early to judge the success of these efforts, particularly because much of this work is pressing the outer limits of science and technology." Says panel member Harold Rosenbaum, "I have seen nothing on the horizon that would render the oceans transparent."

The panel recommends not only that R&D on ASW be stepped up considerably, but that it be "considered as one of, if not the, highest priority activities in the [Department of Defense]." In the meantime, the report argues for a top-to-bottom shakeup in ASW operations, including the rapid introduction of new technologies when they are available and improved operational tactics using existing technologies.

Perry estimates that it will take 5 to 10 years for the Soviets to replace a significant number of their old, noisy submarines with quieter new models, and he says "we can do quite a lot in that time to improve acoustic techniques" and change operations.

The total Soviet fleet of attack submarines (as distinct from nuclear missile carriers) numbers about 300, most of which one congressional expert describes as "second-rate boats." But the Soviets have been great experimentalists in submarine design, introducing new models and technologies at a high rate.

About four Akula-class submarines are already in service, according to Polmar, and the Soviet Navy is also building relatively quiet versions of the Sierra class, a submarine that entered full service in 1986, and the Victor-III, a 1979-vintage boat. In addition, a titanium-hulled attack submarine dubbed the Alpha was fielded in 1978. Its high-strength hull gave it greatly increased depth capabilities, but it turned out to be noisy at high speeds and was extremely expensive. Only seven were built. Three years ago, an entirely new submarine appeared. Called the Mike, it appears to be one-of-a-kind, and it is now thought to be a test bed for trying out new technologies.

In contrast, the U.S. Navy tends to be more conservative, building improvements into a single basic design over many years. It also focuses strictly on nuclear boats—it even persuaded U.S. shipbuilders not to build diesel submarines for Israel and South Korea in the early 1980s. The Soviets, however, continue to build diesel-electric submarines called Kilos, which date from about 1980 and are used mostly for coastal defense. They are extremely quiet when running on batteries.

The panel also notes that some European countries—notably Italy, West Germany, and Sweden—have made major advances in nonnuclear submarine technologies that hold the prospect of very quiet boats at a fraction of the cost of a nuclear submarine. "Being the product of foreign technology, such submarines could well become available to Third World nations in the next decade," the panel says, which could put at risk ships operating near their coasts.

The most modern attack submarines in the 100-strong U.S. fleet belong to the SSN-688, or Los Angeles, class, the first of which entered service in 1976. The panel says that even the Akula is not as quiet as the SSN-688s, and the next generation of U.S. boats, the SSN-21, promises to be even quieter. They will, however, also be very expensive. The first one may cost as much $2 billion and additional copies are likely to run as high as $1.2 billion apiece.

Two years ago, a subcommittee of the House Armed Services Committee voted to block funding for the first SSN-21, arguing that the Navy should go back to the drawing board and come up with a more cost-effective boat. The full committee reversed this decision, however, and the program is now proceeding full steam.

The expert panel essentially took the SSN-21 program as a fait accompli, but it urged the Navy to pay more attention to future designs. The SSN-21 was "the best submarine we knew how to build 6 or 7 years ago," when the program began, says Perry, but there is also need for more revolutionary designs. ■ COLIN NORMAN

Mexican Research Center Closed

An internationally known research center dedicated to the study of Mexico's tropical ecology has been dismantled, a victim of the economic crisis that is squeezing indigenous research throughout Latin America.

The National Research Institute for Biotic Resources (INIREB), based in Xalapa in the state of Veracruz, supported an extensive botanical garden and compiled one of the largest herbaria in Mexico as well as unique collections of native fauna. The center also funded research in basic and applied ecology, and worked to transfer environmentally sensitive practices to Mexico's poor farmers. At its closing last year, the institute had an annual budget of about $3.5 million, employed 100 scientists and technicians, and maintained a network of regional research centers scattered throughout Mexico.

"To close such a place is really very sad and very frustrating," says Arturo Gómez-Pompa of the University of California at Riverside, who founded the institute in 1975 and served as its director until 1985. "At its peak, the center was one of the most active biological research institutes in Mexico."

In recent years, however, the institute floundered somewhat, burdened by union strife, a bloated bureaucracy, and the pressure to support large programs with less money, according to sources inside and outside of Mexico. INIREB was officially closed in November, on the last day of the outgoing administration of former President Oscar de la Madrid.

Gómez-Pompa says that the institute was unique because it attempted to combine the often contradictory objectives of conservation and rural development. One successful scheme involved growing an edible mushroom in the discarded husks of coffee beans. Another involved the production of electricity from the excreta collected at pig farms. The center also developed programs in wood science, pre-Hispanic agriculture, and the monitoring of environmental pollution.

The institute's famous garden and herbarium will be taken over by the National Institute of Ecology, which is moving its headquarters from Mexico City to Xalapa in April. But the fate of many INIREB scientists and their research projects remains unclear. The graduate students of INIREB are left wondering where they will complete their educations, since the Institute of Ecology cannot issue diplomas or academic degrees.

Reached in Mexico City, Gonzalo Halffter, director of the National Institute of Ecology, says he hopes to hire as many INIREB investigators as he can afford, but concedes that his $2.3-million budget will not be enough to absorb them all. Some young scientists from the defunct institute have already begun driving taxis in Xalapa. Such a waste of talent may be the biggest tragedy, says Silvio Olivieri, formerly at INIREB and now at Conservation International in Washington. "They could have improved INIREB. Instead, they destroyed it." ■ WILLIAM BOOTH