Strategic Lessons from an Elusive Sub

Sweden's failure to capture a spy submarine in its coastal waters has implications for antisubmarine warfare and the MX missile

A strategic debate has been touched off by the failure of the Swedish navy to track down and capture a submarine sighted near a sensitive naval base. The significance extends well beyond Sweden's shores, for it suggests that antisubmarine warfare has serious weaknesses. It also may strengthen the arguments of those advocating greater reliance on missile forces in the ocean.

"Submarines are invulnerable for the foreseeable future," says William Nierenberg, director of the Scripps Oceanographic Institution and a top Pentagon consultant. "In the wake of this Swedish incident, I think people are going to be more receptive to that message."

At first it looked like a simple job. The sub was trapped off the Baltic in Hårs Bay, a narrow channel 12 miles long and 3 miles wide that winds past a top secret naval station. Swedish forces quickly dispatched more than 40 patrol boats, minesweepers, submarines, helicopters, and survey ships.

But what started as bold pursuit ended in embarrassment weeks later. Said Lennart Ljung, the Commander in Chief of Sweden's armed forces, "The search could go on practically indefinitely."

As the hunt faltered, experts in the United States began to battle over how a single submarine could have outmaneuvered the best efforts of a modern navy. Some contend the Swedes botched what should have been an easy job. Others pooh-pooh disparaging remarks, saying underwater detection is a tough task in places like the Baltic, and point to future technology as a solution. Still others say subs by nature are almost impossible to locate, and will stay that way.

What set the Swedes in pursuit of the sub was increasing violation of their defense zones. The most publicized incident prior to the present one occurred in October 1981, when a Soviet submarine ran aground near a naval base at Karlskrona. But since 1980, alien submarines have poked through coastal defenses at least 20 and perhaps as many as 50 times. This September, the Swedish Defense Ministry said violations were increasing and intruders "act a great deal more provocatively." To counter the threat, the Swedes adopted a tough new policy whereby intruders would be pursued until caught and identified.

On 1 October, a foreign periscope cut through waves on the bay, touching off a test of Sweden's resolve. As this article goes to press, nearly 3 weeks after the initial sighting, the Swedish navy has still failed to get a fix on the intruder and force it to the surface.

The failure is not for lack of sophisticated technology. The Swedes, though neutral and not a part of the NATO alliance, have developed a vigorous defense industry that builds missiles, subs, destroyers, and other heavy armament. For export, the Swedes sell planes, light cruisers, and devices for electronic warfare that are manufactured by Saab and Philips Defense Electronics. What is not built at home is purchased abroad. To bolster its arsenal, the Swedes recently ordered two antisub devices in large quantity. One is a mini depth charge known as "Malin," which blows a small hole in the body of a submarine and forces it to surface. The other, known as "Elma," magnetically locks onto a hull and lets out a howl. The racket unnerves a crew and helps pursuers track a sub.

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Yet the trick was finding the intruder in the first place. Spotter jets with heat-seeking cameras flew over the bay, to no avail. Sonar contact was spotty. On the tenth day of the search, Commander Ljung suggested the navy had perhaps been following a phantom for days. The sub may have escaped, he said, just before the bay's openings had been blocked by a welter of nets, chains, and magnetic cables. Soon after Ljung's remarks, the rumble of depth charges indicated the chase had begun again in earnest.

The rugged coastline along Sweden is rough territory for sonar because of the Baltic's craggy bottom and varying water temperatures, currents, and salt concentrations. Nonetheless, the search should have been simple, according to Anthony J. La Marco, director of market research and advanced planning at EDO Corporation, which makes sonars used by the navies of the United States, Australia, Brazil, Italy, Japan, the Netherlands, and many countries in the Middle and Far East. "If they catch that sub, it will be a miracle," he says. "They're making too much noise themselves. They've got everybody and their brother out there, ships buzzing around, helicopters dipping over the water with the blades beating down on them. If I was the task force commander, there'd be nobody on the water except for two anchored ships, some distance apart, just listening and triangulating." La Marco should have some idea of Swedish capabilities. According to *Jane's Fighting Ships*, the EDO Corporation sells equipment to the Swedes.

Pursuers relying on sound waves can track a sub either actively, by bouncing sonar signals off a target, like a bat, or passively, by listening with hydrophones for sounds from within a sub. The trouble with passive detection is that a sub can rest on the bottom, engines off, making no sound whatsoever. Moreover, the crew of a sub, if equipped with modern air regeneration equipment, can breathe easy for nearly 2 months.

Bottom stopping is also a problem for sonar, since the density of a sub with full ballast tanks is about the same as that of water. Still, a good operator can pick up clues. "I can grab a violin and it will only squawk," says La Marco. "It's the same thing with sonar. It's an art. When an operator is talented, fresh, not under pressure, and trying to discriminate, he can get results even under bad conditions."

One way around the confusing clutter of bottom signals is to use a sonar with better "vision." Resolution can be heightened by using higher frequencies, on the order of hundreds of thousands of hertz. Such sonars are often used for mine hunting. The drawback is that high frequencies do not propagate well through water, so a clean signal means a mine-hunting sonar must often be almost on top of its target.

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The main difficulty the Swedes face is shallow water, according to those who find little fault in their techniques for trying to track down the intruder. Shallow water not only increases the ease with which an intruder can rest on the bottom, but it greatly confuses sonar readings, creating echoes and dozens of reverberating signals. "It's a difficult problem," says Alan Berman, dean of the Rosenstiel School of Marine and Atmospheric Science at the University of Miami and former director of research at the U.S. Naval Research Laboratory. "Most sonar sets have a limited range in shallow water, and performance is a complicated function of the local bottom, things like how soft it is and what the water temperature is like. You also have the problem of surface noise: shipping, breaking waves, geological noise."

Wide World

On the fifth day of the hunt, a helicopter is armed with antisubmarine bombs.

A typical solution, according to Berman, is the use of stationary magnetic sensors along the floor of a bay, with long cables running to shore-based computers. When a sub passes nearby, signals from sensors can help plot position and direction of motion. There are four drawbacks. Such a system is expensive, has limited range, requires great computing power for reliable readings, and can be fooled by surface ships or by local magnetism in rocks and discarded metal items such as bedsprings.

Despite poor results due to shallow-water echoes or magnetic confusion, contractors at the cutting edge of detection technology say the future looks bright. Powerful solid-state devices are revolutionizing all aspects of computation and signal processing, making mincemeat of what used to be tough problems. Hydrophones can now pull so much information from a signal that they can recognize the "signature" of ships and subs, identifying vessels by name, sometimes at distances of hundreds of miles. The same revolution is touching sonar. Loath to give details of what they claim are classified projects, builders say accuracy is increasing to the point that all waters, deep or shallow, will soon turn transparent. "My understanding," says a spokesman for Hughes Aircraft, "is that what is now under development would take care of any problems the Swedes are having." Hughes builds advanced sonars and hydrophones for the U.S. Navy.

Less sanguine are experts in the armed services. "It's easy for people to say signal processing is going to make the oceans transparent," says Frederick J. Kingsbury, director of submarine sonar at the U.S. Naval Underwater Systems Center in New London, Connecticut. "But I doubt it. There's already more power available than we know what to do with." As for the Swedes' pursuit of the spy sub off the Baltic coast with the aid of current technology, "I don't think we could do any better," says Kingsbury.

Most illuminating about the Swedish drama, to some experts, is how it quickly changed from a game of cat and mouse into a detailed study of the difficulty in tracking down an intruder. Says Berman, who spent 15 years with the U.S. Navy: "The fact that the Swedes sort of sensed that there was a submarine in a given area, yet couldn't pinpoint it, is pretty indicative of the fact that locating submarines is a tough operation in general."

Not surprisingly, Berman is an ocean advocate when it comes to strategic U.S. missiles. "For the foreseeable future," he says, "a sub is certainly the most difficult platform to locate."

The job of concealing a submarine is harder in deep water than shallow, due to the unfettered ability of sonars and hydrophones. The United States has a Sound Surveillance System, switched on in 1954, that now spans the globe, with arrays of hydrophones off the coasts of friendly countries. So, too, deepwater technology is quickly evolving as the U.S. Navy ties listening posts together with satellites, allowing mixed processing and complex triangulation. The problem is that subs keep getting quieter, and the technology of deception keeps coming up with things like decoys, chaff, and false signatures.

"I've studied this for 30 years," says Nierenberg of Scripps. "It's not that you can't catch a sub now and then, either by accident or carelessness or even by determined trapping. But in the open ocean to locate ten of them within those critical 30 minutes, and blast them, is impossible. The Swedish thing hints at the problem."

Conventional wisdom in naval circles holds that once a submarine is definitely known to be in a given restricted area, it can be hunted down with a fair probability of success. As illustrated by the frustrating chase off Sweden, the real world has a habit of disproving assumptions, no matter how believable. The failed hunt and ensuing debate have breathed new life into the ongoing discussion of how to deploy strategic U.S. nuclear arms. While the Administration worries over an invulnerable basing scheme for the MX missile, a vocal minority has continuously pointed to the ocean as an answer to America's strategic dilemma (*Science*, 21 May, p. 828). A recent report by the Aspen Institute, whose panel included former Pentagon research chief William J. Perry, calls for more reliance on submarines at the expense of land-based missiles. In the wake of the Swedish incident, that position may be strengthened.

One place the debate will be of no use whatsoever is to the Swedes, who set a naval flotilla in search of a spy sub but came up empty-handed. On 15 October, the navy said a suspicious oil slick in the bay turned out to be from a Swedish ship. For many of the 700 reporters who had flocked to Sweden to follow the chase, it was the last straw. They started packing their bags. The Swedish navy may have netted a spy sub, but landing it is going to be another matter. Bold pursuit in the meantime has turned into a waiting game.—WILLIAM J. BROAD