Whale tracking is all up in the air

Tracking the underwater wanderings of whales can be a tricky business. Not only must scientists try to shadow a cetacean for weeks at a time, but while doing so, expedition members also must risk losing the whale and turning the tracking process into an oceanic game of hide-and-seek.

Now one researcher has found a way to keep close tabs on a pilot whale without ever leaving his office. Bruce R. Mate of Oregon State University's Hatfield Marine Science Center in Newport has tapped the resources of satellite tracking in order to follow the forays of a whale found beached on Cape Cod, Mass., in June. To date, the satellite has relayed information about the whale's diving habits for about seven weeks, habits that are monitored 24 hours a day by a small transmitter neatly attached to the whale's dorsal fin.

"This far exceeds any amount of information we've gotten from a whale before," Mate told SCIENCE NEWS. "We're learning what they're capable of for the very first time."

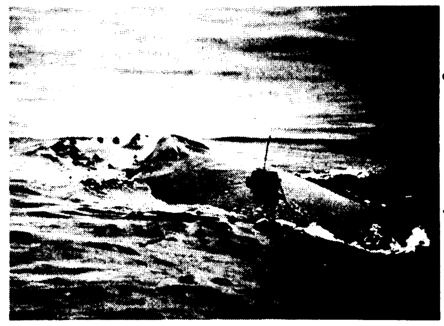
Mate is continuing his weekly compilation of preliminary results and plans to present his findings in September at the International Argos Users Conference in Washington, D.C. Although he used a satellite to track a humpback whale for six days in 1983, this is the first time one has been used for tracking an ocean mammal long-term, he says. In those four years, technology has downsized the transmitter by half and increased its longevity some four times. Mate is working with John Prescott of the New England Aquarium in Boston and Joe Geraci of the University of Guelph in Ontario.

Whale researchers haven't used satellite tracking in the past, he says, because until recently, there wasn't a transmitter small enough to monitor a whale's diving habits by satellite without restricting its movement. The transmitter is specially designed to withstand deep-sea pressures and is operated by organic lithium batteries, which provide more power per unit size than any other commercially available battery, says Mate. About the size of a large coffee cup, the device contains a microprocessor that essentially keeps track of a quartz clock during the dives. As the whale descends after a dive, the device begins keeping track of the time, and then, when the whale surfaces, it checks the clock and computes how long the dive was. In addition, Mate says, it checks the temperature, adds the latest dive to those monitored in the past 12 hours and computes an average time of duration for those dives.

Mate's relay for all of this information is a National Oceanic and Atmospheric Administration satellite, which is principally used for gathering and sending weather data. Mate receives information from the satellite some 12 times a day, and by analyzing the Doppler shift recorded by the satellite as it passes over the whale, he can deduce the whale's location within about 500 meters most of the time. At press time, the whale was about 110 miles east of Boston, and when last sighted in July it was traveling with about 100 other whales.

What Mate's seen so far has been revealing. "I guess the consistency of the animal is something that really amazes me," he says of the whale that does a couple thousand dives a day. "I'm impressed at how much they move. Within the first two weeks they moved over 600 miles." For an animal that is about 11 feet long and weighs about 1,000 pounds, "that's a pretty energetic critter." In addition, Mate says, the dive patterns change when the whale finds food, squid being its main fare.

In conventional tracking, Mate says, constant shipboard surveillance is required and researchers estimate the duration of dives by noting the time between the beeps recorded on ship that indicate the whale's ascent. Satellite tracking, on the other hand, provides a more precise measurement of how long each dive is. The satellite also can follow its target to hard-to-reach places, such as the northern Arctic during the months without sun. And with satellite tracking, Mate says, researchers don't run into the



Mate/Oregon State University

This satellite transmitter, shown on a humpback whale, contains the same electronics as the one attached to the pilot whale being tracked.

problem of a nearby ship possibly altering the whale's natural course. One of the only disadvantages, he says, is that the transmitter being used for this satellite is a little larger than those used in conventional tracking, and could cause some hydrodynamic drag for the whale.

Mate hopes to track the animal for a total of two and a half to three months. The best thing about the transmission technique, he says, is that it eliminates the expense of hiring a crew of scientists and chartering a vessel to monitor a whale. He figures that by now a chartered boat alone would have cost him $150,000. The biggest expense with satellite tracking is the transmitter, he says, which costs $3,000 to $5,000. Receiving transmissions, on the other hand, costs only about $3 per day — cheaper, Mate says, than taking a graduate student to lunch. — *K. Hartley*

Keeping dioxins down in the dumps

When the contents of a household trash can — an unsavory melange that may include chicken bones and food scraps, empty cans and bottles, plastics and foils, worn clothing and rags, and lots of paper products carrying a wide range of inks and coatings — burn up in a municipal incinerator, the process creates hundreds of compounds, which get trapped in fly ash or escape into the air. This noxious mixture spewed out by incinerators includes about 200 compounds known as polychlorinated dibenzodioxins and polychlorinated dibenzofurans, many of which are toxic and some of which are potentially cancer-causing.

For the last decade, researchers throughout the world have been studying how dioxins and furans are generated and how to reduce the levels of these compounds in emissions from municipal incinerators. Because incineration is a major contributor of dioxins to the environment, fears of contamination have slowed the building of incinerators to solve urban garbage problems.

Two recent reports, however, show that incinerators can be operated under conditions that minimize dioxin and furan emissions and provide clues about the conditions under which dioxins form.

One study, conducted at an incinerator facility in Pittsfield, Mass., concerned the role of combustion in generating and destroying dioxins and furans. The research was initiated by the New York State Energy Research and Development Authority (NYSERDA) in Albany and supervised by members of the Dioxins Committee of the American Society of Mechanical Engineers (ASME), based in New York City.

The researchers looked at how a wide range of combustion conditions and refuse quality affected the amount of dioxins and furans formed and destroyed during combustion. They found that neither the amount of polyvinyl chloride (PVC) plastic found in trash nor the wetness of the garbage is related to the level of dioxins or furans produced under good combustion conditions. Some scientists had suspected PVC in trash as a major contributor to the formation of dioxins.

The level of carbon monoxide and the incinerator operating temperature, however, were found to be related to dioxin levels. According to the study, by monitoring carbon monoxide amounts or tracking temperature, incinerator operators can minimize dioxin production. For the Pittsfield plant, carbon monoxide levels had to be below 100 parts per million and the temperature between 1,500°F and 1,800°F.

"Minimizing conditions will be different for different plants," says NYSERDA's Joseph R. Visalli, project manager for the incinerator test. "You have to know the incinerator, and you have to do some testing."

This research and other studies also hint that burning garbage at temperatures higher than a certain level may be counterproductive. "There's been this feeling that the higher the temperature, the better off you are," says Visalli. Higher combustion temperatures may, in fact, lead to greater carbon monoxide production because of incomplete combustion and to the vaporization of larger quantities of heavy metals, which become part of the fly ash and act as catalysts for the production of dioxins.

Chemist Francis W. Karasek of the University of Waterloo in Waterloo, Ontario, reports in the Aug. 14 SCIENCE that fly ash plays a major role in the production of dioxins. "We found that [fly ash] is indeed a very strong catalyst," says Karasek, "which causes dioxins to form from almost anything." That process seems to occur most readily after the fly ash has cooled to about 300°C, often in a pollution control device such as an electrostatic precipitator. The chief culprits are the heavy metals present in the fly ash particles.

Karasek suggests that one way to solve the dioxin emissions problem is to add a substance that "poisons" the catalyst, preventing it from contributing to the formation of dioxins. "We've been doing quite a bit of experimental work in which we are able to introduce compounds that render the fly ash completely inactive," he says. "It's possible to completely block the formation of dioxins."

Controlling combustion is still important, says Visalli. "Whatever pollution control you put on, you still want to minimize the amount [of pollutants] that goes into it," he says. "The less that's produced and the more that's destroyed, the less you have to worry about it in the ash."

Another alternative is to eliminate metals from garbage before it is incinerated. "We need to know more about where some of these chemicals are coming from in the waste," says Visalli. Pigments in printing inks, for example, may contribute heavy metals. The Pittsfield researchers also found traces of dioxins (but not furans) in the garbage even before incineration. "There are a whole host of things that should be removed from refuse and recycled," Visalli says.

Much remains to be learned. Still unclear is the role that metals play in the formation of compounds other than dioxins. More full-scale tests of incinerators should be done to confirm the Pittsfield results. And researchers need a better understanding of how to take samples and analyze them for dioxins so that the results are reliable and accurate.

Nevertheless, says Floyd Hasselriis of ASME's dioxin committee, the Pittsfield study "is the first clear road map [for incinerator operating conditions] that we've had. We really understand it pretty well now."

"To me," says Visalli, "the dioxin controversy, if it's done anything positive, has inspired research into learning how to better combust [garbage] and better control emissions. I think we're achieving that." *—I. Peterson*

Gene therapy takes aim at liver, lungs

Two studies released last week describe progress in an experimental technique that may someday replace organ or tissue transplants as a means of correcting certain metabolic disorders. In both cases, researchers are using recombinant DNA technology to correct for a class of diseases in which one or more defective genes result in an inability to produce particular proteins in the body.

Savio L. C. Woo of the Baylor College of Medicine in Houston reports that he and his colleagues successfully infected liver cells with recombinant retroviruses, and that these viruses directed the liver cells to produce a new protein. The research points to the possibility of stimulating genetically defective liver cells to produce normal proteins by using custom-crafted viruses as genetic delivery vehicles — a process known as somatic gene therapy.

"The liver may be the preferred target for somatic gene therapy of many inborn errors of metabolism that are currently indications for liver transplant," the researchers write in the August PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Vol.84, No.15).

The research, however, confirms the importance of incorporating the proper genetic "switch," or promoter, into a genetically engineered carrier virus in order to get expression of an inserted gene. Working with liver cells cultured from mice, the researchers experimented with three different viral promoters. They found that only one of them — the herpes TK promoter — was capable of being "turned on" in liver cells. "That's in contrast to skin cells," says one of the researchers, Fred D. Ledley, "where all three promoters work just fine."

The research is aimed at developing a treatment for one of the most common inborn errors of metabolism — phenylketonuria, or PKU (SN: 2/8/86, p.84), in which liver cells fail to produce the protein phenylalanine hydroxylase. Each year in the United States about 1 in 12,000 infants is born with the deficiency, which carries potential for toxicity and mental retardation.

"These kids can be kept on a [phenylalanine-free] diet, but that's palliation, not a cure," Ledley told SCIENCE NEWS. In addition, he says, "There are really dozens of liver disorders — many of which are lethal — that we just can't treat." Although liver transplants are becoming increasingly successful, Ledley notes that "the key advantage of gene therapy over organ transplants is that you don't need to find a donor."

In related research, scientists at the National Heart, Lung, and Blood Institute (NHLBI) in Bethesda, Md., transplanted gene-altered cells into mice, then tracked the long-term production of a human protein by those cells. The cells had been induced via retroviral gene transfer to produce alpha 1-antitrypsin, a protein that protects lung tissue from naturally occurring but potentially damaging enzymes. Inherited deficiencies of alpha 1-antitrypsin today account for 20,000 to 40,000 cases of emphysema in the United States.

Robert I. Garver Jr. and his colleagues report in the Aug. 14 SCIENCE that alpha 1-antitrypsin diffused into the blood and lung tissue of mice for four weeks after genetically engineered alpha 1-antitrypsin-producing cells were injected into the rodents' abdominal cavities. The research suggests that physicians may someday treat genetic deficiencies of certain circulating proteins by implanting "colonies" of specially engineered protein-secreting cells.

These findings differ from those of Woo and others at Baylor, who found that the addition of PKU-correcting protein to the general circulation was insufficient to correct that genetic deficiency. The difference, according to Ronald G. Crystal of the NHLBI team, may be that phenylalanine hydroxylase — the PKU protein — needs to interact with cofactors inside liver cells, while alpha 1-antitrypsin works in the extracellular space. "I think the approach we're using can be useful for conditions in which the deficient protein is an extracellular protein, such as alpha 1-antitrypsin, growth hormone, or complement [an immune system protein]."

In addition, Crystal says, his team's technique may prove more useful than the current practice — also still experimental — of using bone marrow cells to manufacture missing proteins. Instead of using marrow cells, which are genetically variable and can respond to gene transfers in unpredictable ways, the team uses monoclonal fibroblast cells that are genetically uniform and that express inserted genes more efficiently. *—R. Weiss*