Diving in High-Risk Environments

Fourth Edition

by Steven M. Barsky

DIVE RESCUE INTERNATIONAL

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Hope you like this book!
Best Regards,
Steve Barsky

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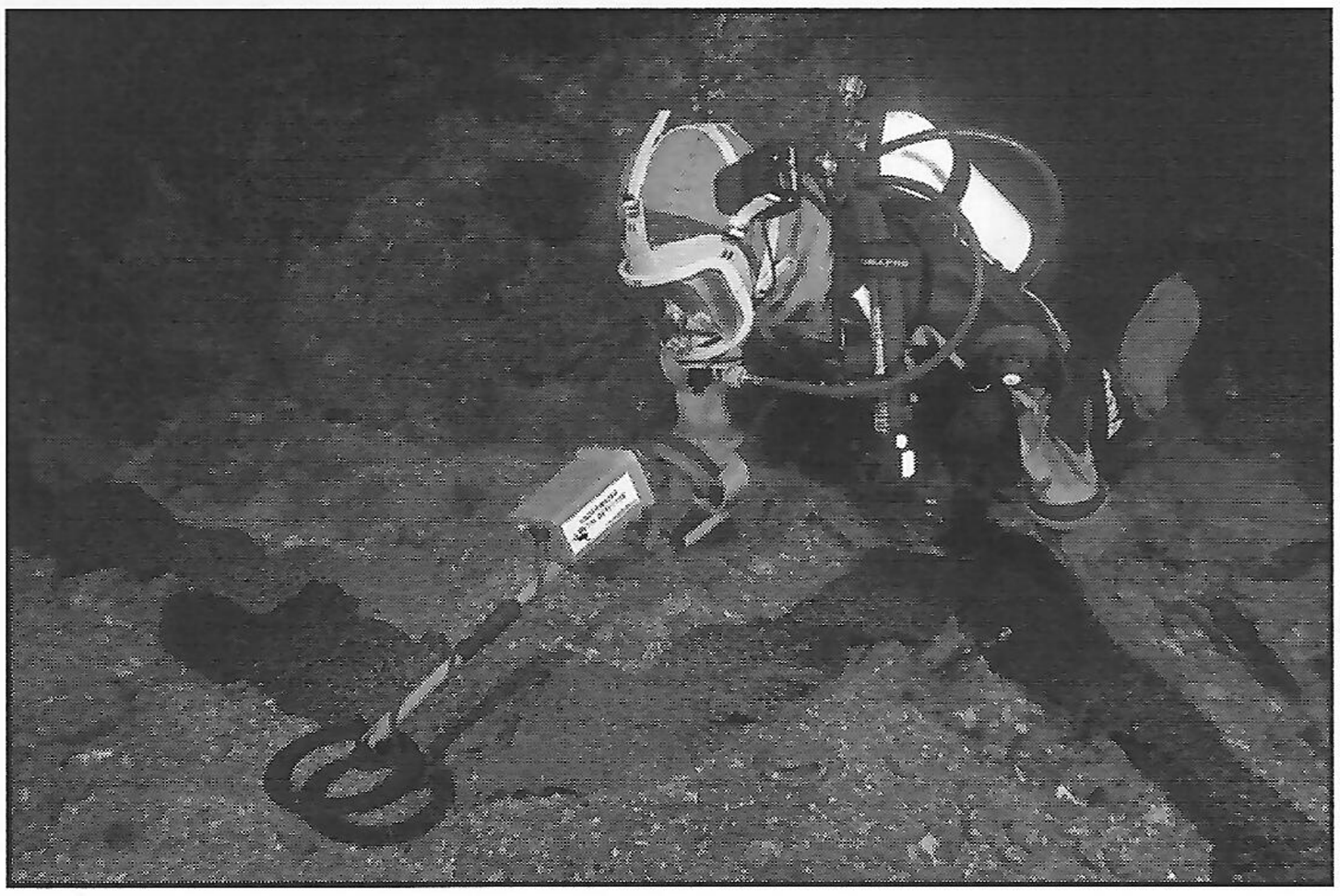


No matter what type of diving gear you use, you must have the proper training to use it correctly.

equipment itself that's dangerous, but the environment where this type of gear is ordinarily used, i.e., heavy underwater construction, that poses the risks for the commercial diver.

Sophisticated diving equipment such as full-face masks, umbilicals, helmets, and dry suits all require specialized training. Without proper training, accidents may occur.

No matter what type of diving gear you use, it's essential to realize that not all equipment is compatible with all contaminants. There is no one set of gear that will make you invincible underwater.

Risks in Using Full-Face Masks

There are several ways that a full-face mask can leak unexpectedly. For example, if you jump into the water or do a backwards roll off a small boat, it's possible for water to force its way past the face seal of most full-face masks and expose you to contaminants. Straps on full-face masks must be regularly checked for signs of cracking and must be replaced before they break. Even a particularly strong current can force water past the face seal of a full-face mask.

Risks in Using Diving Helmets

Wearing a diving helmet places a lot of strain on your neck, even if you do not have any pre-existing injury. If you know you have a problem with your neck, you should not attempt to wear a diving helmet.

The breathing systems on all diving helmets are not designed the same. Some helmets allow high levels of carbon dioxide (CO_2) to built up inside of them. Carbon dioxide is the gas that triggers our stimulus to breathe. Excess carbon dioxide inside your helmet will leave you feeling that you cannot breathe for comfort. If the CO_2 level becomes too high, it can actually cause you to pass out.

Diving helmets that use demand regulators without a regulator adjustment knob can leave you with insufficient gas to breathe at deeper depths if you are using a low-pressure compressor as your air supply. Even the largest low-pressure compressor cannot keep up with the demands of a hard working diver at depth, and a regulated high-pressure gas supply must be used at deeper depths.

Both diving helmets and full-face masks use diaphragms and exhaust valves in their breathing system that are typically made of silicone or other synthetic rubber materials.

There are no "universal" diaphragms or exhaust valves that will resist all chemical contaminants.

Risks in Surface-Supplied Diving

Whenever you are using surface-supplied diving equipment there is always the risk that your hose can become entangled, trapping you on the bottom. Yet, as long as the hose is intact, and air is still flowing through the hose, you can survive, provided you have sufficient insulation to keep you warm until you are freed. Entrapment underwater while using surface-supplied gear is usually much less serious than if you are using open-circuit scuba equipment. If you get trapped underwater while using open-circuit scuba, once your air supply is gone you will die.

Another risk common to surface-supplied diving is the possibility that a passing vessel may snag the diver's hose and either sever it or cause the diver to rise towards the surface quickly, causing a lung over-pressure injury or decompression sickness. To prevent this type of accident, vessel traffic in the area where the diver is working should be restricted and the appropriate diving flag and vessel day shapes should be used.

Risks in Using Dry Suits in Warm Conditions

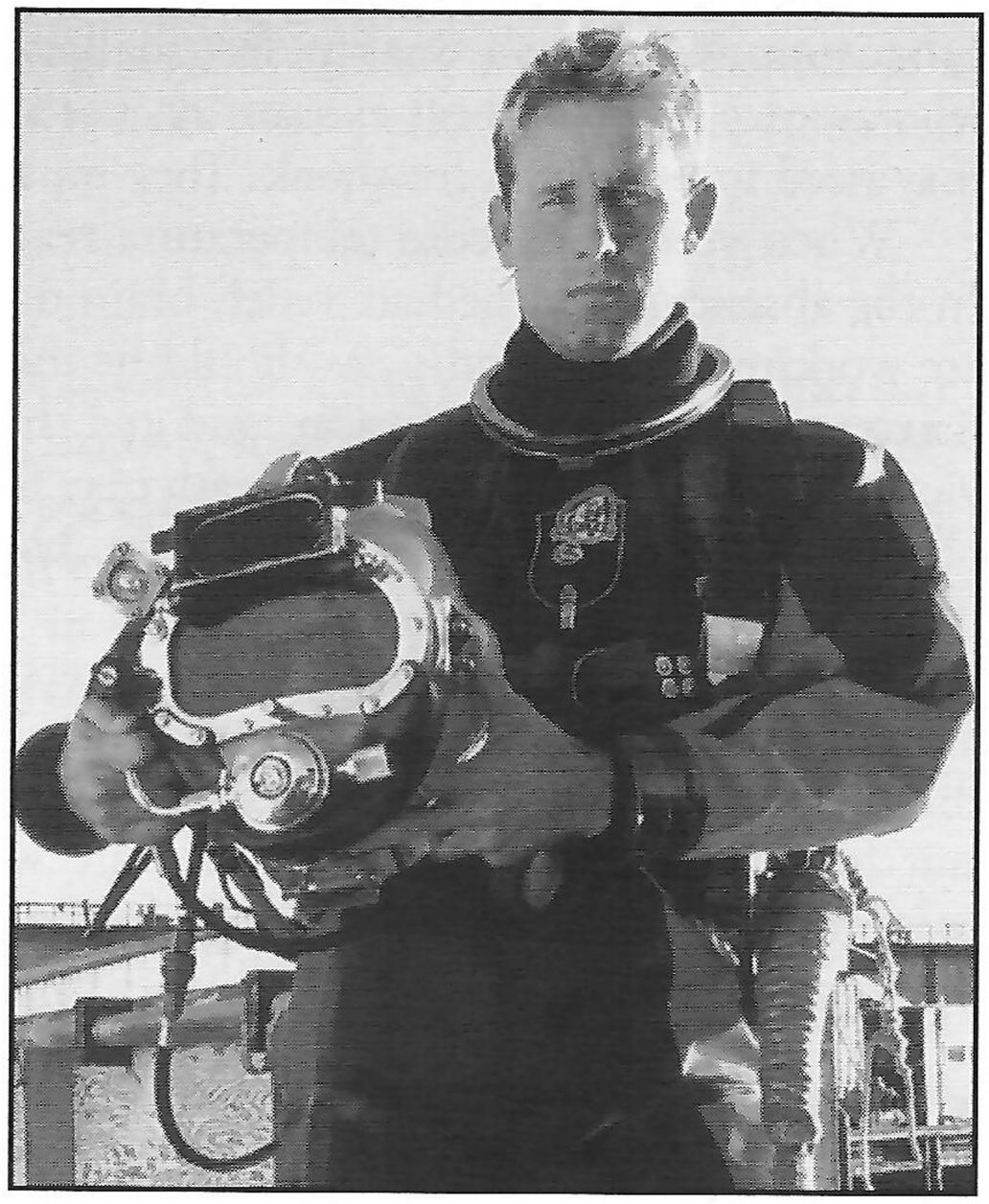
Anyone using a dry suit must be properly trained to use this type of equipment. Although dry suits are relatively simple to use, without proper training you can experience rapid ascents or descents.

Probably the most serious problem with dry suits is the possibility of overheating and suffering from heat stroke while you are wearing the suit. Body heat builds rapidly when you are totally encapsulated, i.e., wearing a dry suit, dry gloves, and a diving helmet. While you will sweat inside the suit, there is no way for this moisture to evaporate to help cool your body. Heat stress is more likely to occur while topside, but it also can occur underwater. Divers can also experience heat rash, heat cramps, and heat exhaustion.

During warm weather, it is essential to keep divers who are suited up cool while topside. In surface-supplied diving, where one diver normally remains on the surface as the "stand-by" diver to go to the aid of the diver in the water, heat stress can be deadly.

Heat stress causes your body to experience an elevated heart rate, fluid loss, and a rise in your core temperature (the temperature of your torso). Once a diver becomes heat stressed, it takes longer for their heart rate to recover to normal than it ordinarily would.

When a diver is heat stressed, he will



It is very easy for a diver to overheat while using a dry suit.

There is no way for a diver to cool down in hot water unless he is wearing special equipment. The diver needs to be equipped with special cooling undergarments.

show signs of fatigue and irritability. This can lead to carelessness, a higher than usual accident rate, and poor performance.

Working in warm, humid conditions may cause heat rash. Since the dry suit traps both heat and moisture from the body, experiencing heat rash is a distinct possibility. Heat rash appears as a red or pink rash that leads to discomfort and itching. The skin may be dotted with tiny pimples, which can lead to secondary skin infections.

When a person loses significant amounts of body fluids and salts through perspiration, they may experience heat cramps. Personnel working in hot conditions who report pain in their arms and legs, stomach cramps, and muscle spasms may be suffering from heat cramps.

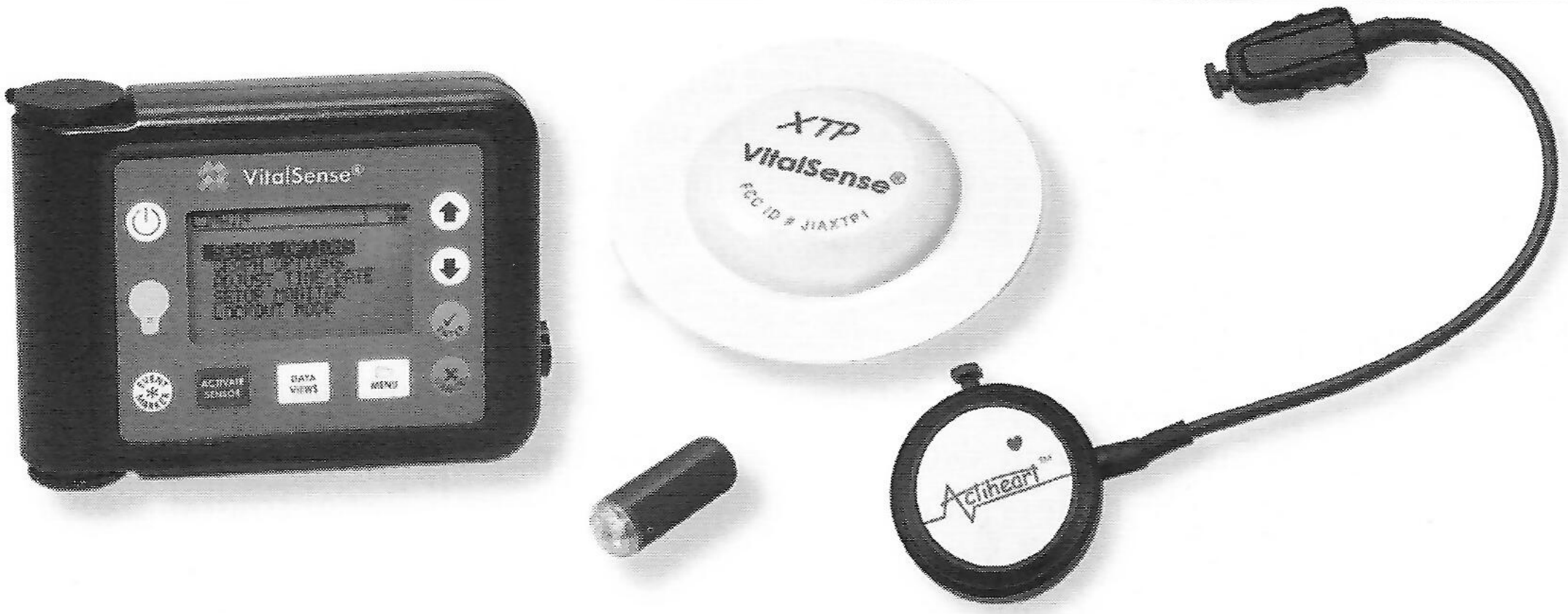
Heat exhaustion is actually a mild form of shock that is caused by heavy perspiration with inadequate replacement of fluids and electrolytes. Persons suffering from heat exhaustion will have a weak pulse, shallow breathing, clammy skin, and fatigue. Divers who are experiencing heat exhaustion need to get out of their gear, sip sports drinks, and may need to be treated for shock. They must not become chilled.

When your body core temperature reaches 105 degrees or higher, heat stoke occurs. In the absence of immediate relief, brain damage or death may occur. All personnel who are working in hot conditions should be monitored for signs of heat stroke which include nausea, rapid pulse, confusion, and red, hot, dry skin. Without prompt treatment, the victim will slip into a coma and death may follow. It is vital to reduce the body temperature of a person suffering from a heat stroke. Hospitals achieve this by submerging the victim in an ice water bath.

It is generally recommended that divers and all personnel be monitored for heat stress any time the temperature at the work site is 70 degrees F or warmer. Divers may experience discomfort at lower temperatures while on the surface depending on the amount of dry suit insulation (undergarments) they are wearing under their suit. Health professionals recommend monitoring personnel during hot weather operations using the following parameters:

- **Measurement of Body Water Loss**

Every person who uses any form of encapsulation during the operation should be weighed each morning and evening to check for water weight loss. Care must be taken to weigh the person when they are wearing the same amount of clothing. Fluid weight loss should not exceed 1.5% of their total body weight.



Clockwise from left: Body temperature and heart rate monitoring device, skin temperature transmitter and recording device, heart rate recording device, core temperature transmitter and recording device. Before using any equipment like this in an underwater environment, check with the manufacturer. Some items may only be suitable for topside monitoring.

• Body Temperature Monitoring

Each morning, before work begins, baseline body temperatures should be taken of all personnel who will be encapsulated. Personnel should be monitored continuously, if possible. Electronic systems are now available that can provide this monitoring continuously, at least while the diver is topside. The system includes a sensor capsule that is swallowed and a data collection unit that can be downloaded to a personal computer.

Body temperatures must not exceed 99.6 degrees F following any work period. If a person's body temperature exceeds this level, their next work period should be shortened by 33% with no decrease in their rest period.

• Heart Rate Monitoring

Electronic systems are now available that are unobtrusive and can be used to measure individual heart rate during the job for topside personnel. If no electronic system is available to measure each team member's pulse, then the pulse can be taken at the wrist. Following any work period, the diver's heart rate should not exceed the maximum age-adjusted heart rate (calculated for men as 200 - person's age in years = maximum heart rate and for women as 226 - person's age, with a standard deviation of 15-20 b.p.m.). During recovery, the heart rate should not exceed 110 beats per minute one minute into the rest period. The diver's resting heart rate should not exceed 60-80 beats per minute.

Risks in Using Dry Suits in Cold Conditions

Divers can also experience problems with dry suits underwater if their suit is punctured or torn in cold water. Some types of dry suit insulation will not keep you warm once it is wet and rapid body cooling may occur. Hypothermia can lead to a loss in reasoning ability and coordination, weakness, shivering, and cardiopulmonary arrest.

You can also experience hypothermia if you fail to wear sufficient dry suit underwear for the water temperature. Unfortunately, predicting how much insulation you need to wear for a dive is an inexact science. Many factors come into play including the water

temperature, your percentage of body fat, the type of suit you are wearing, the type of underwear you are using, and your activity level during the dive. More information on dry suit insulation can be found in the section on dry suit underwear later in this book.

Of course, there is always the risk that the suit can fail when exposed to certain types of pollutants. Diving in contaminated water is always a calculated risk.

Risks in Diver-to-Diver Contamination

If you do not have a dry suit, full-face mask, or helmet specifically assigned to you, you must be very cautious about decontaminating the equipment if you must share the equipment with other divers. It is far too easy to pass infectious material from one diver to the next.

Extra care must be taken with diving helmets and full-face masks to ensure that they are properly decontaminated because it is easy for saliva and mucous to be trapped in the regulator unless it is properly cleaned. Any infectious material that can be transmitted through the skin can be passed from diver to diver when dry suits and undergarments are shared. For these reasons, sharing equipment is not recommended unless there is sufficient time to decontaminate equipment properly between each user.

Pollution Comes from a Diversity of Sources

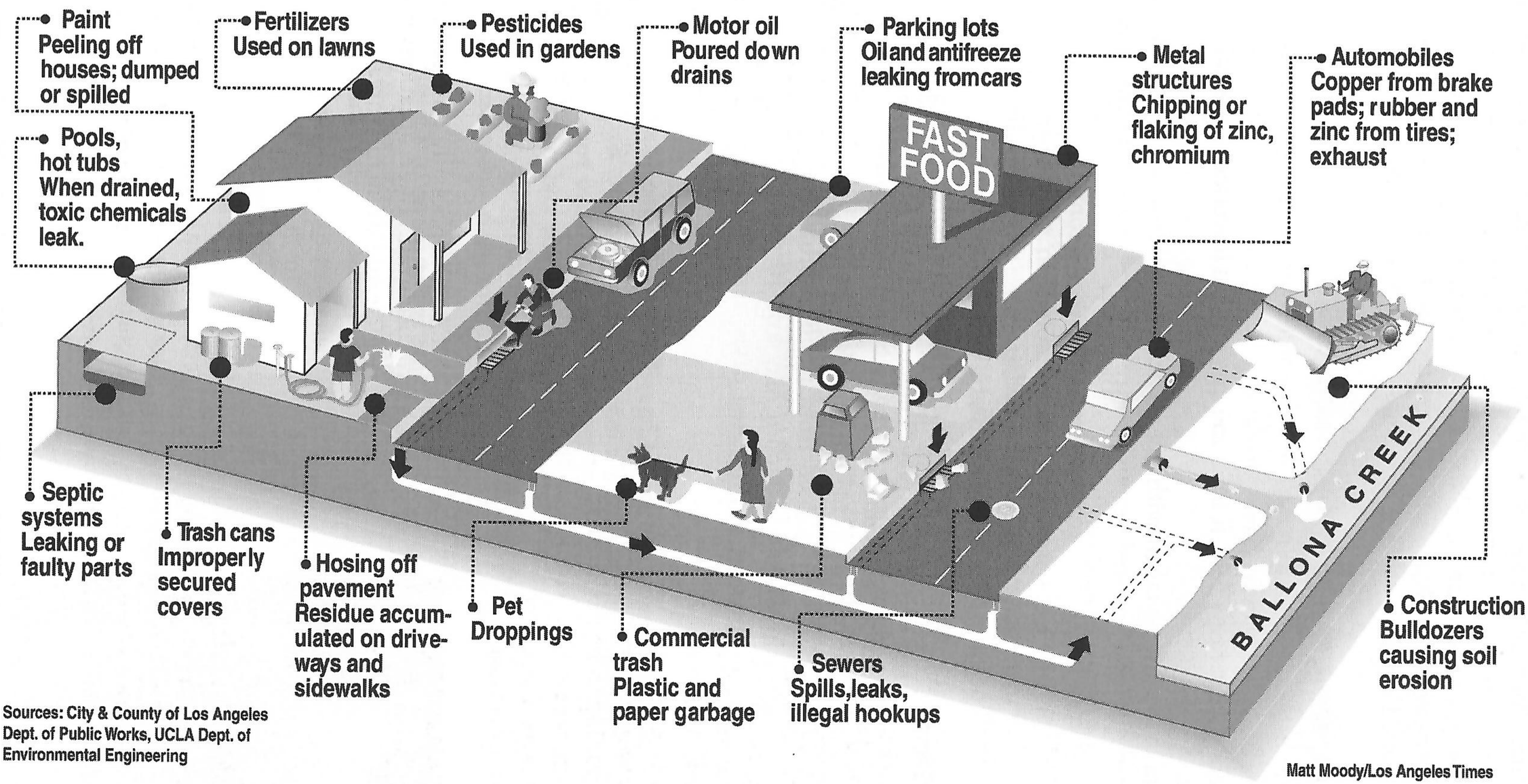
In most parts of the world, pollution comes from a variety of sources, rather than a single local polluting chemical plant or sewage waste facility. For example, in the city of Los Angeles it is estimated that there are about 367,000 dogs and 254,000 cats. Obviously, not all of the waste from these animals is picked up by their owners, and much of it ends up washing into local storm drains and then into the ocean. Other wastes that eventually end up in the sea include waste oil from cars, brake dust, fertilizers and pesticides, etc. Each individual pet, wild animal, person, or automobile contributes to the total accumulation of pollutants, or what is known as "*non-point source pollution*."

The long-term effects of being exposed to low levels of pollutants on a repeated basis are just beginning to be understood. Not enough work has been done to identify the dangers from drug wastes that have passed through human or animal systems and are now present in the waters where people dive or swim. Other chemicals that we use to dye our hair, treat hair loss, or remove body hair may all be present in small amounts in the environment.

However, there are obviously locations where industry or individuals have intentionally dumped contaminants or accidents have occurred. These situations may pose a more obvious immediate and dramatic threat.

There are many different disinfectants that may be used to reduce the risk of the transmission of infectious diseases from diver-to-diver. Check with the manufacturer of your equipment to see what they recommend.

Non-Point Sources of Pollution



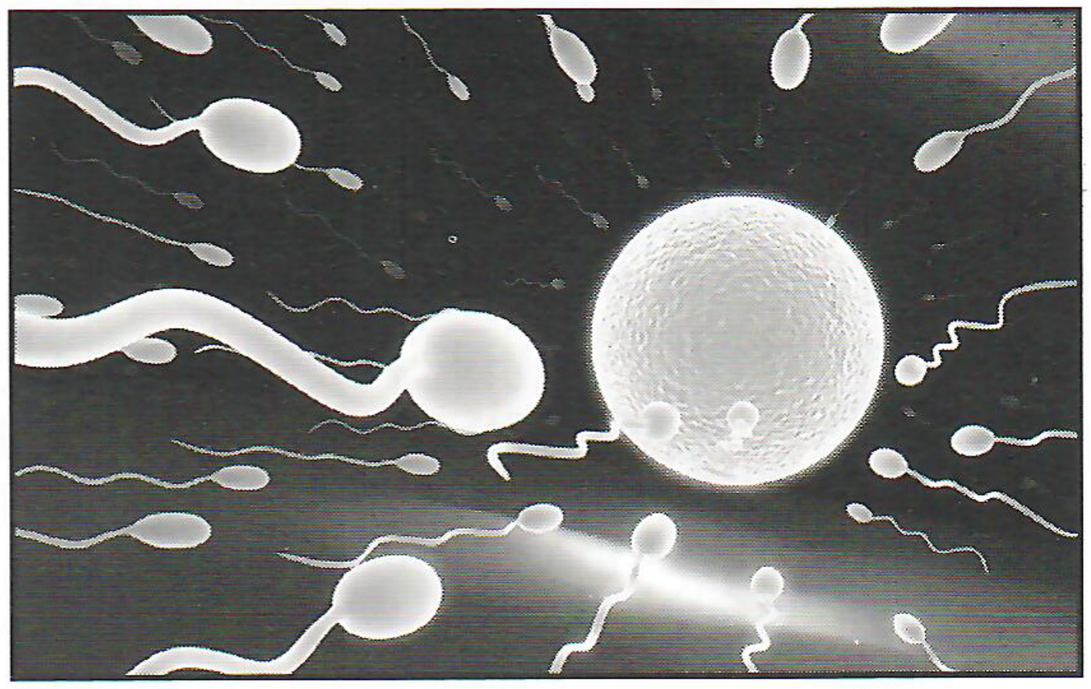
Sources: City & County of Los Angeles Dept. of Public Works, UCLA Dept. of Environmental Engineering

Matt Moody/Los Angeles Times

Pesticides Can Cause Reproductive Damage

Pesticides are another type of chemical compound with which most people are familiar. Many people use pesticides in their gardens and homes. Farmers use pesticides to protect their crops.

Scientific studies have shown that repeated exposure to pesticides causes reduced sperm concentration, poor sperm motility (swimming capability), and deformed sperm structure in healthy men.



Exposure to pesticides can cause damage to sperm in otherwise healthy males.

If you are a male diver, who is considering having a family, then this should be of concern to you, if you dive in an area known to have run-off from agriculture. For example, anyone who must dive regularly along the coastline of Ventura County in California, where there is a great deal of land devoted to farming, should be aware of this potential problem.

Cancer Found in Israeli Navy Divers

A recent scientific study in Israel was the first to draw a connection between diving in polluted water and health problems in divers. The study was performed by Dr. Elihu Richter and a group of his colleagues. It was an "epidemiological study," which means the research was designed to draw a correlation between a group of people who suffer from cancer and the causes of cancer. Conducting this type of research is not simple and the results were scrutinized by another group of scientists in what is known as a "peer reviewed" process, prior to publication.

Dr. Richter and his team analyzed the health records of 682 Israeli Navy special forces divers who trained in the Kishon River and Haifa Harbor between 1948 and 1995. The Kishon River is notorious for its high levels of pollution, including releases of industrial and agricultural wastes. The river dumps into the port of Haifa. The port is subject to pollution from vessels of different types, and certainly many ships painted with tributyltins have probably docked in this waterway. As special forces divers, the men almost certainly trained in both hull search techniques as well as methods for attaching mines and other devices to ships.

As you might expect, the medical records for Navy divers are quite complete. In fact, there were 16,343 person years included in the survey. When the study was completed, the physicians concluded that the incidence of cancer found in these divers (51 cases in 682 divers) was higher than what would be expected, and was statistically significant. Gastrointestinal cancer, skin cancer, and central nervous system cancers were all reported. Further studies need to be done on other populations of divers to validate their findings.

Israeli Navy divers who trained in the port of Haifa and the Kishon River have higher rates of cancer than expected.