

SCUBA DIVING FATALITIES in AUSTRALIA AND NEW ZEALAND

2. THE ENVIRONMENTAL FACTOR

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Background

In a previous report¹ it was determined that amongst recreational Australian and New Zealand diving fatalities during the 1980s, the environmental factors contributed to 62% of the deaths. One hundred consecutive deaths, which complied with strict requirements as regards data acquisition, were assessed. The figures therefore represent both actual numbers and percentages of the total.

In 52% of the cases the environment was a probable contributing factor, and in 18% it was considered likely. In some instances there was more than one environmental contributing factor.

The environmental factors included both natural hazards (eg. tidal currents, sharks, etc.) as well as man made hazards (boats, dam outlets, etc.).

In the ANZ series we only considered the factors which materially contributed to the divers death. Because of this, such situations as fresh water diving, altitude exposure, etc. are not recorded in this series, as they *per se* do not contribute to the death.

In 47% the diver either had no experience of the diving environment being encountered, or an inadequate experience to cope with that environment. In less than 50% of cases was there sufficient training or experience for the planned dive.

Results

In the 62% of cases the following environments contributed to the deaths. The total of percentages (each 1% is one death) in table 1 is more than 62 as in some cases more than one environmental factor was present.

EXCESSIVE WATER MOVEMENTS

This was by far the major environmental problem (36 %) contributing to diving deaths.

In 15 % the tidal current was too great for the diver to negotiate. In 15 % there was rough surface conditions contributing, often involving "white water" and surging water around rocks. One of these cases involved exposure

to surf. In 2 % it was a normal to and fro surge which caused the problem. In 3 % there was a sudden unexpected under-water surge which put the divers into the difficulty. Dam outlets trapped two divers (2 %).

DEPTH

Depth, which contributed to 12 % of the deaths, did not always equate with nitrogen narcosis. Sometimes the depth itself was simply too great for that person. In four cases it was considered a major factor, and in eight others, likely. In most of these cases it was the greatest depth to which that diver had dived

Table 1

ENVIRONMENTAL FACTORS	
Environment	Percentage
Water movement	36
Excessive depth	12
Poor visibility	6
Cold	5
Marine Animals	5
Caves	5
Entanglement	4
Exit and Entry Problems	5
Boats	3
Diving under a ledge or boat	3
Night Diving	2
Total	86

MARINE ANIMAL INJURY

Marine animals contributed to the death in 5 - 8 % of the cases. In one case there was a shark attack. In two others there was obvious evidence of shark attack, but it was not clear whether this occurred before or after death. In another episode a shark bite, probably from a wobblygong, initiated the incident but did not of itself cause the death.

In one instance the presumed attack was possibly from a eel. In one well recorded instance, a squid was caught by the diver on his spear and during its attempted removal it damaged the diver and initiated, very rapidly, a series of events which lead to his death. This is the only recorded case of a death from a cuttlefish injury. In another episode there was a Crown of Thorns injury probably responsible for causing vomiting underwater and the initiation of the fatal sequence of events. In another case, which was considered too indefinite to be included, there were multiple coelenterate stings on the legs,

CAVES

Of the six deaths (6 %) in caves, two involved double fatalities.

In four of these deaths the caves were in the ocean, and one of these involved only a small entrance through which the diver could only enter after removing all breathing equipment, and trying to breathe from a very long octopus regulator, the equipment being pushed in front. In another two cases the caves were of the fresh water type.

DECREASED VISIBILITY

Six divers (6 %) died in conditions of decreased visibility.

ENTRY AND EXIT PROBLEMS

Five divers (5 %) died because of problems with either entry or exit. One of the deaths occurred because of poorly planned entry and others because of difficult or unavailable exits.

COLD ENVIRONMENT

Although the cold environment was considered to be a contributing factor in five cases (5 %), none were involved in diving under ice, and they occurred because of inadequate protection or excessive exposure.

ENTANGLEMENT

Environmental hazards caused entanglement in only four cases (4 %). In three of these it involved lines used by divers and in one it involved kelp. Not included in this figure is entanglement in harnesses or diving equipment.

BOATS (N = 2-3 %)

Boats were involved in two or three cases (2-3 %). In one case the boat caused apprehension on the part of the deceased, but was not a physical threat. In another, the boat definitely caused the death. The third diver was possibly run over by a boat.

TRAPPED UNDER LEDGE OR BOAT

Three divers (3 %) died after being trapped under a ledge or boat.

NIGHT DIVING

Two divers (2 %) died during night dives.

Discussion

It is important to realise the difference between these figures and those given in the United States by the National Underwater Accident Data Center (NUADC)^{2,3} and Australia by Project Stickybeak.⁴ In both those surveys the figures referred to the incidence of the particular environment, i.e. all the cases who dived in caves were classified as cave divers. In this Australian and New Zealand (ANZ) series, only when the environment actively contributed to the death was it included.

Thus a cave diver, who happened to have a coincidental dissecting aneurysm of the aorta, is not counted as a cave diving death in the ANZ series.

In some cases there have been more than one contributing factor. Thus two fresh water cave divers who got hopelessly tangled in their own lines, at 59 metres depth, were recorded as only two cases in the 62 affected by the environment. Nevertheless they were recorded 3 times within this part of the survey, as cave diving, as entrapment and as depth. The reason they would be included in cave diving is that, in the open water there is every likelihood they would have reached the surface and not died. The reason the depth was included was because of the almost certain narcosis and resulting poor judgement contributing to the incident and because depth increased their air consumption. The reason the entanglement was included was that it took so long for the rescuers to disentangle them, even with knives and good lighting, that the divers themselves would have found it particularly difficult. They would not have been included in the poor visibility section, as they both had adequate lighting available.

By far the most significant environmental factor was that of water movement with which the diver could not cope. In almost half these cases there was a tidal current. It was evident that divers were not able to cope with strong currents, probably because of the excessive drag on equipment. In many cases the current had the effect of either separating the diver from his safe environment (boat, shore, etc.) or of inducing him to swim very strenuously in an attempt to regain that safety. Fatigue, panic, cardiac dysrhythmias, salt water aspiration and asthma provocation may result.⁵

In just under half the cases of excessive water movement, there was rough surface conditions. It was evident that a diver in "white water" is a diver in trouble. The reasons for this might have been related to the fact that "white water" is usually fast flowing and turbulent, having the same effect as tidal currents, or it might have made the diver less buoyant and therefore requiring more effort to remain on the surface. The interference with visibility associated with "white water" might also have been a factor.

In those cases in which there was unexpected underwater surge, the deaths were due to trauma, with the divers

being battered against rocks and losing or damaging equipment.

There were 2 who died because they were trapped and drawn into a **pressure outlet** (a valve) in a fresh water dam. It was not appreciated that the outlets in dams, although not very deep, nevertheless cause a considerable pressure difference. In both cases the body was drawn into the outlet pipe. Although the flow of water was not great in either case, the pressures were excessive once the divers body had been drawn onto and had obstructed the orifice.

The effect of depth in contributing to 12% of the deaths, is probably an underestimate. In many other cases it may have contributed, because of the influence on nitrogen narcosis, consumption of air supply, resistance to breathing, ascent problems, panic, etc. In no case in this series was depth related to decompression sickness, as the latter disease was not a cause of fatalities.

There is a tendency to belittle the importance of marine animals, and in many such injuries the pathologist would be unlikely to observe even a fatal injury (e.g. from a cone shell or blue ringed octopus bite).

Fresh water cave diving was not particularly common in this geographical area, and in 4% of the deaths the caves were ocean caves, in which the customary cave diving procedures were not followed.

It was clear from the lack of experience in the cases in which the environment contributed to the death, that training in that environment was usually inadequate. It was not readily appreciated by many of the divers who succumbed, or by many of their companions, that training for one diving environment does not necessarily translate to others.

These cases confirmed, again, that diving is carried out in a potentially hazardous environment, and this can be unforgiving when adequate precautions for safety are not taken.

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DIVING ACCIDENT CASES TREATED AT THE H.M.Z.N.S. PHILOMEL RECOMPRESSION CHAMBER IN 1988

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Summary

This report on diving accident cases treated at the Philomel recompression chamber during 1988 shows that the cerebral effects are more refractory than previously thought when assessed by general practitioner observation, family observation and scientific assessment at a Post-Concussion Clinic.

Cases treated

A group of six doctors, the Philomel Recompression Chamber Roster, provided the Diver Emergency telephone advice and treatment for decompression sickness (DCS) and arterial gas embolism (AGE) during this period. Thirty cases required treatment in the recompression chamber. One was an Indonesian aviator under training with the Royal New Zealand Air Force and the remainder resulted from sport diving accidents. Of the thirty cases, twenty-three have been contacted subsequent to discharge, and of those 23, eight are permanently and significantly damaged as a result of their diving accident, and five are unable to return to normal employment.

Two follow ups were conducted, one at six months and the second at two years. Three of the cases are still consulting me on a regular basis, but all are functioning at a cerebral level much below that before their diving accident. The usual symptoms occur intermittently, headaches one day per week or two, thought blocks, poor concentration, muddled thinking, dropping things, falling, altered sensation, limb weaknesses, getting lost, etc. The presentations have marked similarities to post viral, or chronic fatigue/ME syndromes.