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UNITED STATES UNDERWATER  
FATALITY STATISTICS-1973

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## ABSTRACT

During 1973 a survey of diving accidents involving U.S. citizens was undertaken using a clipping service, plus queries to various federal, state, and local agencies and to individual scuba divers and instructors in high activity areas. This work was completed in 1970 and 1971 under research grants from U.S. Department of Health, Education and Welfare. The present efforts are funded by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Manned Undersea Science and Technology Office and the U.S. Department of Transportation, U.S. Coast Guard Underwater Safety Projects Office.

Comparisons are made for the data acquired for the four years 1970, 1971, 1972 and 1973.

A paper by the Manned Undersea Science and Technology Office of the National Oceanic and Atmospheric Administration (MUS&T, March 1975) estimates a 15 to 25 percent increase in diver population for 1971-1972 while the numbers of fatalities have increased at less than 2.6 percent. Therefore, the fatality rate per year actually appears to be decreasing.

In general, no large changes in accident patterns were detected in 1973. The total of 147 fatal accidents (123 compressed air, 24 skin diving) is only slightly higher than 1971 and 1972 totals. Geographic distribution of the fatalities is also similar with past years, with Florida and California contributing almost half the victims. Weather factors were found to contribute to about 25 percent of the accidents, and Florida cave accidents showed an increase in 1973. Fewer beginning divers were involved in accidents this year and fewer of the accidents involved training. Most of the divers used the "buddy system" but buddy separation remained a serious problem, with a number of cases involving the failure of the victim to remain on the surface following a dive, plus his inability to help himself or, in several cases, to even notify his partner of his problem.

Of the 49 autopsies, most showed "drowning" as cause of death. However, there were nine detected embolisms and six heart attacks, in this group suggesting that a third or more of the fatal group may have suffered an incapacitating injury at some point in their dive. No serious equipment problems were detected and relatively few of the accidents were equipment caused.

Almost a quarter of the scuba group were involved in a multiple accident, ten involving two victims and one, three. The bulk of these were cave deaths, although two involved boats dragging their anchor offshore.

The pattern of skin diving deaths remains variable, although fewer skin divers use the buddy system. One skin diver was killed by an apparent great white shark attack off Baja California, Mexico.

Four professional scuba fatalities and five professional fatalities while using surface-supplied compressed air are treated as "special nature" cases and are excluded from the non-professional scuba tables.

## PART 1

### HISTORY AND SOURCE ANALYSIS

#### 1.1 Introduction

For the fourth consecutive year, the Scuba Safety Project has collected data on fatal diving accidents involving U.S. citizens both in U.S. waters and elsewhere in the world. This work was completed in 1970 and 1971 under research grants from U.S. Department of Health, Education and Welfare. The present efforts are funded by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Manned Undersea Science and Technology Office and the U.S. Department of Transportation, U.S. Coast Guard Underwater Safety Projects Office.

Comparisons are made for the data acquired for the four years 1970, 1971, 1972 and 1973.

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This part of our report will discuss the completeness in the 1973 survey, will outline the ground rules for inclusion of a fatal event in this survey, and will suggest the various ways in which fatal diving events are located and studied. The effort in 1973, as in the previous years, has been to obtain as complete data as possible on every fatal diving accident. Once again, it is our belief that very few U.S. fatal scuba accidents remain outside this compilation.

Four professional scuba fatalities and five professional fatalities while using surface-supplied compressed air are treated as "special nature" cases and are excluded from the non-professional scuba tables.

The acquisition of skin diving fatal events is a much more difficult problem and although the 1973 census contains several more of these accidents than in prior years, it is



not possible to say whether this represents a trend or whether the Project's ability to locate skin diving fatalities has improved with time. Skin diving accidents, especially those involving children, are often impossible to identify in press stories. Very often the fins, mask and snorkel are removed from the body either during rescue or at the water's edge in which case the event is classified as an ordinary drowning both in the press and in local law enforcement reports. However, it is probable that we are locating a substantial fraction of skin diving fatal accidents involving active divers whose reputation in the diving field usually means that a press story notes the involvement of skin diving equipment in the drowning.

### 1.2 Previous Survey

During the 1973 investigative period, no new cases for 1970, 1971 or 1972 were uncovered. The results of these earlier surveys have been reported in various papers and reports (Schenck and McAniff, 1971, 1972a, b, and 1973). As will be evident in the tables presented in the following sections, no large changes in the number or pattern of accidents has been detected during the 1973 calendar year. There is no indication in any of the data from the four years that we are not still obtaining a relatively complete sample of these events. We, therefore, feel that the data presented here from the four year period can be taken as reasonably indicative of the actual trends in these types of accidents for the U.S. population.

### 1.3 Source Analysis for 1973 Cases

During this year there were no fatal cases involving non-U.S. citizens in U.S. territorial waters, although seven U.S. citizens died in waters outside the U.S. territorial limits; one in Canada, two in the Caribbean area, three in Mexico and one in Okinawa. In almost every case, death occurred in the water or on the way from the water to a hospital. In a single case, which we have included, the diver died in the hospital sometime after a dive in which he suffered a near-drowning event. Medical opinion and description suggested strongly that this person's death was directly caused by the water in his lungs obtained during his dive. In a second double fatality in which neither body was ever found, local police authorities suggested that

this may not have been a diving accident at all. Their opinions were based on the fact that one of the divers was a convicted felon out on bail. However, our study of this incident in which a car, boat trailer and boat were abandoned, have convinced us that we are dealing with a genuine accident. With the exception of these three cases, the rest of the 1973 accident population involved relatively straight-forward occurrences in which the basic facts were usually well established by our investigations.

Table 1.--Primary Source of 1971, 1972, and 1973 Fatality Data

<u>Source</u>	<u>1971</u>		<u>1972</u>		<u>1973</u>	
	<u>Skin</u>	<u>Com- pressed Air</u>	<u>Skin</u>	<u>Com- pressed Air</u>	<u>Skin</u>	<u>Com- pressed Air</u>
Newsclipping Service	11	91	8	92	18	85
Official Sources	2	4	6	8	4	21
Solicited and Un- solicited letters	3	15	1	17	2	21
Located while investigating another case	0	6	1	4	0	0
Not available	<u>1</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>0</u>
Total	17	116	16	123	24	127

The methods for locating fatal cases were similar to those used in previous years. They included one clipping service which has proved itself to be reliable and relatively comprehensive, mailing of queries to many active divers and persons

involved in diving, phone queries to high-risk areas, Coast Guard operational and SAR (Search and Rescue) reports, and very great assistance from a number of regional specialists in scuba accident work including Tom Ebro of Los Angeles County, Dave Desautels and the National Association of Cave Divers, Roy Damron of the Governor's Committee on Water Safety in Hawaii, Richard Plumb and Reider Sand in Washington, James Martindale and State Police Sgt. Clifford Ellis in Michigan, and Thomas Graham in Wisconsin.

After several years of this work we are receiving a large number of unsolicited reports from police, coroners, public safety officials and divers, who have become aware of this work. The "instant alert" postal reply cards introduced a year ago and discussed in a previous report (Schenck and McAniff, 1973) have proved again to be helpful and several cases on which we have been unable to locate newsclips were discovered through the use of the postcards.

Table 1 shows the "primary" source for our accident data over the past three years. We define a "primary" source as one that is planned and regular in character such as the press clipping service, SAR reports, or reports from regional investigators who study diving accidents. If a case is located through the clipping service, we regard this as the primary source regardless of when the clipping is received. If the case is not detected by the clipping service, but through one or more of the other means, we then regard the primary source as that source which first alerts us to the accident.

During 1973, as Table 1 shows, the news clipping service located somewhat fewer scuba cases than in previous years, but appears to have done reasonably well on the skin diving events. The official sources have helped fill in this gap while the letters and instant alert cards have also shown an increase in coverage. We have not noted any significant increase in the number of clippings located through other means outside the clipping service. There are always a few cases which the clipping service has clearly missed and on which we have newspaper stories sent by persons in the field.

The U.S. Coast Guard Underwater Safety Project Office in Washington has continued to be of considerable assistance in alerting us by phone or mail as soon as it had any word of a diving accident. Seven of the 1973 cases would not have been located without this assistance.

FIRST CLASS

Permit No. 73

Post Office

Wakelield, R. I.

02880

**BUSINESS REPLY MAIL**

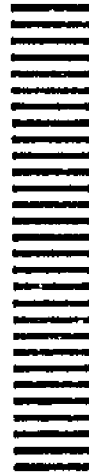
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

NATIONAL UNDERWATER  
ACCIDENT DATA CENTER

P.O. BOX 68

KINGSTON, R. I. 02881



**. . INSTANT ALERT . . UNDERWATER ACCIDENT . .**  
(SKIN DIVER, SCUBA DIVER, ETC.)

(Mail Promptly . . . Complete Report to Follow)

Name of Victim:	.....	Fatal? .....
	<i>Last</i> <i>First</i> <i>Middle</i>	(yes or no)
Address:	.....	Designate Location
	..... State .....	by code number .....
Location of	.....	1. Ocean, Bay, Sea
Accident:	..... State .....	2. Minor Lake, Pond, Slough
Name, Address,	.....	3. Quarry, Pit, Open Mine 3A. Cave
Phone of Reporter:	Address: .....	4. River
	..... State .....	5. Major Lake, Pond
Date and Time of	.....	6. Swimming Pool
Accident:	<i>Day Mo. Yr.</i> ( <i>Use 24 Hour Clock</i> )	7. Great Lakes
		Victim's Sex .... Age ....

FIGURE 1.--(INSTANT ALERT) POSTAL REPLY CARD

In the past, our only method of judging the number of missed cases has been based on comparing the University of Rhode Island census with other regional lists. However, this year this has been difficult to do. The decreased number of cases produced by the clipping service has meant that we have had to count more heavily on our regional reports, for example, three of the Florida scuba cases were missed by the University of Rhode Island and provided to us by Mr. Desautels. One Florida case has been located by the University of Rhode Island and missed by Mr. Desautels. Two additional Washington cases were provided by Mr. Reider Sands in Washington. Two cases missed by our clipping service and other methods appeared on an accident list provided by diving authorities in the Los Angeles area.

On the basis of these numbers it is difficult to estimate how many additional cases from 1973 may have escaped the various data gathering methods. If such cases exist, they probably occurred in areas where scuba diving is an uncommon sport and where few, if any, fatalities have occurred. The high incidence areas; the northeast, Florida, Michigan, California, Hawaii, and the northwest areas, are, we believe, sufficiently covered by our investigators such that we doubt that any cases are lacking there. Although it is impossible to statistically suggest how many missed cases exist for 1973, we suggest on the basis of past experience that they are probably less than five. In short, it is doubtful that additional data on 1973 that may become available later will significantly alter the trends and conclusions suggested in the tables in the following sections.

#### 1.4 Problems in Case Investigation

The investigation of a scuba fatality usually involves the following activities: telephone inquiries and interviews with divers involved in the event plus police, medical personnel, and relatives of the victim; solicitation and study of death certificates, autopsy documents, and police reports, and where possible study of the equipment either by personnel in the Project or by field investigators where this may be possible. This equipment aspect of the investigation is frequently not possible for the obvious reason that the equipment may be dispersed, lost or sold before we can alert local authorities concerning the necessity of inspection. In addition, we always suggest that tank air be analyzed. This is, however,

done very seldom except in those few areas where local officials are experienced in dealing with scuba accidents.

The credibility of eye witness accounts must be regarded with caution. There were a number of cases in 1973 in which cross-checking of stories, and in one case the comparison of eye-witness stories with photographs taken at the scene, shows serious discrepancies. It is very unusual to find in an interview involving a buddy diver any admission of failure, error or lack of vigor in a rescue attempt. Thus, the conclusions regarding the causes and progress of fatal scuba accidents must remain relatively subjective. This type of investigation is best carried out by persons skilled in the art of interview and in the interpretation of narratives made by witnesses soon after a terrifying or traumatic event. We have always regarded descriptions by divers not connected with the victim or by police officers who are sometimes on the scene soon after the death to be the most trustworthy accounts of what actually occurred. Unfortunately, it is often the buddy diver who knows the most about the accident but who also has the most ego-involvement in presenting a story favorable to himself. There is no way to avoid biases that may creep into this group of statistics due to such very understandable human failings. However, it is important that students of diving accidents recognize this problem as they study and interpret results such as ours. The accident victim is the only person following the event who can not present his side of the story. We feel that this is one explanation for certain commonly-held assumptions by many students of diving safety that many, if not most, fatal accidents are the fault of a single diver, the victim. Certainly, many of these accidents are the result of lack of caution, lack of training or downright stupidity on the victim's part; however, there remain in our opinion a very substantial group of scuba deaths, possibly more than one-third of the total which are genuine accidents, difficult to prevent and, therefore, requiring vigorous and aggressive assistance on the part of buddy divers if death is to be prevented.

### 1.5 Conclusions

To summarize Part I, the Scuba Safety Project has once again attempted to provide a complete census of fatal diving accidents involving U.S. citizens. Nothing in our file suggests that a significant number of cases have been missed in 1973. While

individual cases may leave room for doubt due to the unreliability of witnesses close to the event we still believe that in the bulk of the census we have established reasonable explanations for the fatal event and in those cases where no explanation has appeared, the special character of the case (for example, the body of a lost diver may never be recovered) makes it doubtful that any amount of investigation would unearth the truth.

Just prior to publication, a massive amount of data was received from the National Association of Underwater Instructors which contained four additional non-professional scuba fatalities which had not been detected by the URI effort. Tables and text have been updated to include these.

## PART 2

### GENERAL SCUBA ACCIDENT STATISTICS

#### 2.1 Fatality Totals; General and Geographic Breakdowns

Table 2 shows the four year fatality totals including skin and surface-supplied divers as well as those using compressed air scuba. The four year pattern is remarkably constant, both in totals and in the relative breakdown among the several kinds of diving. At the state level, much wider variations are evident (Table 3 and Figure 2). Florida shows the most obvious increase for the 1973 year, due to modest increases in cave fatalities (compared with 1972) and also to increases in open-water, fatal events. New York shows a modest upswing over the previous year, while Washington, after a "bad" 1972, shows a decrease from 15 to 9 scuba fatalities. It is interesting that the Carribean area, which has had at least five deaths for each of the previous three years, showed only two scuba deaths in 1973, although our information suggests that Carribean diving, particularly of the "resort" type has steadily increased year by year.

#### 2.2 Distribution by Day and Month

Once again, the bulk of the accidents occurred on the weekends (Saturday and Sunday, Table 4), while the middle two quarters of the year contribute almost two-thirds of the total, suggesting an increase in scuba activity during the summer period (Table 5).

#### 2.3 Environmental Aspects of Scuba Accidents

As in prior years, the primary source of scuba accidents remains the ocean and its coastal bays, harbors, and inlets (Table 6). Cave diving totals are again high and all such cases in 1973 occurred in the relatively restricted area of North Florida where U.S. Cave diving is centered. The Great Lakes area is showing increasing involvement in the fatality totals while lake and pond totals for 1973 show a large (and inexplicable) decrease. The single swimming pool fatality involved a trainee diver who apparently injured his lungs in an instructional session and died hours later in a hospital. NO autopsy was available to suggest whether this diver died from an overpressure event (the class was doing "doff and don"



Table 2.--Summary of Diving Fatalities, 1970, 1971, 1972, and 1973

Activity	Fatalities							
	1970		1971		1972		1973	
	Male	Female	Male	Female	Male	Female	Male	Female
Scuba diving, non-professional	101	8	106	7	105	12	112	6
Scuba diving, professional	3	0	1	0	1	0	4	0
Scuba diving, record attempt	0	0	0	0	1	1	0	0
Skin diving	26	3	17	0	15	1	23	1
Diving with sur- face supplied air	4	0	2	0	2	0	5	0
Compressed air explosion	0	0	0	0	1	0	0	0
Total	145	133	139	151				

NOTE: This table will differ from past reports because scuba deaths are now split into "non-professional" and "professional".

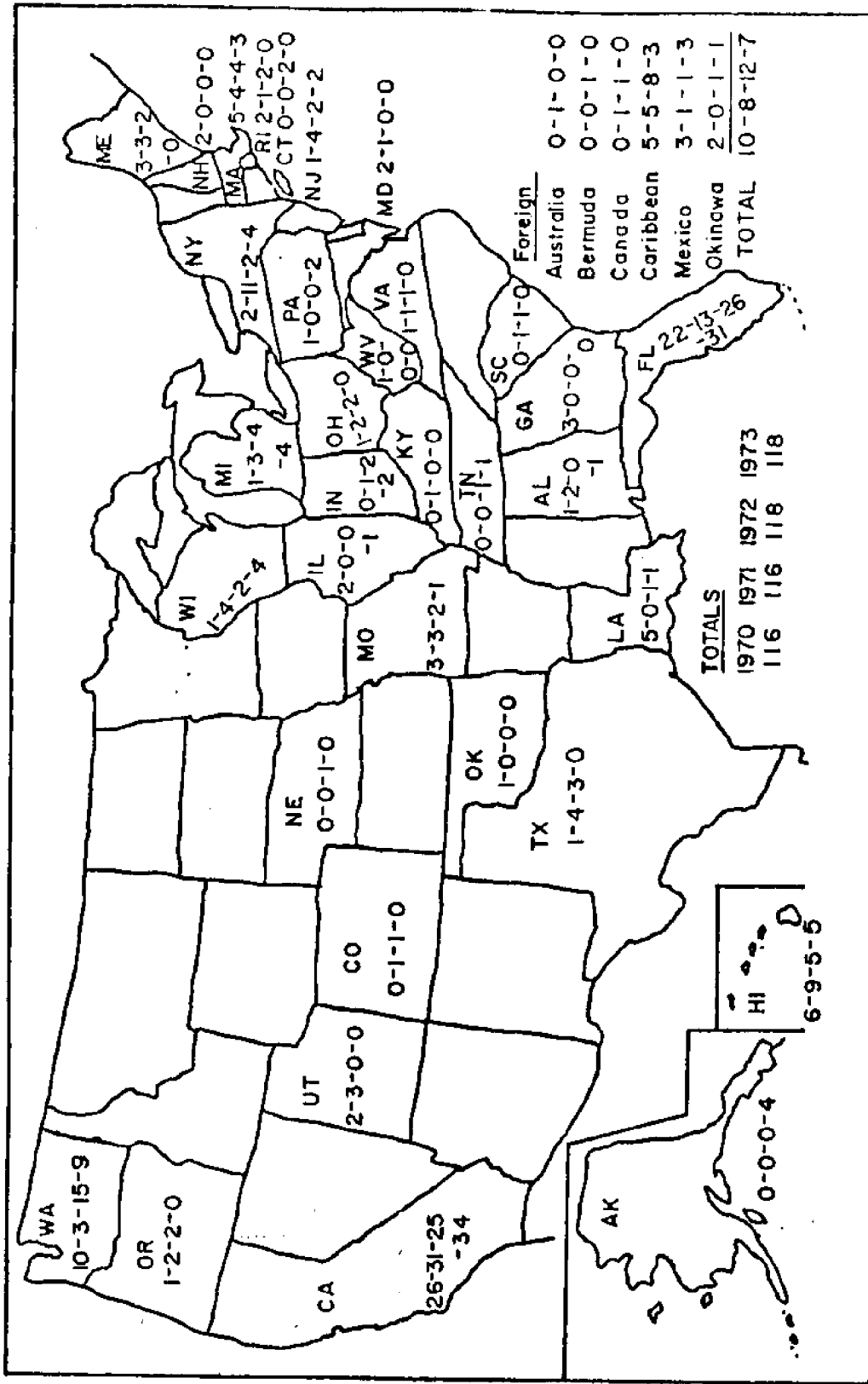


FIGURE 2.--NON-PROFESSIONAL SCUBA FATALITIES BY STATE AND FOREIGN AREA, 1970, 1971, 1972 AND 1973.

NOTE: FOUR PROFESSIONAL SCUBA FATALITIES WERE RECORDED: TWO IN FLORIDA, AND ONE EACH IN HAWAII AND CANADA. FIVE PROFESSIONAL FATALITIES OCCURRED WHILE USING SURFACE-SUPPLIED AIR; THREE IN NEW YORK AND ONE EACH IN TEXAS AND WASHINGTON. PROFESSIONAL FATALITIES ARE EXCLUDED FROM FIGURE 2.

Table 3.--Non-Professional Scuba Diving Fatalities by State and Foreign Area, 1970, 1971, 1972, and 1973

<u>Location</u>	<u>Fatalities</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
State:				
Alabama	1	2	0	1
Alaska	0	0	0	4
Arkansas	0	0	0	1
California	26	31	25	34
Colorado	0	1	1	0
Connecticut	0	0	2	0
Florida	22	13	26	31
Georgia	3	0	0	0
Hawaii	6	9	5	5
Illinois	2	0	0	1
Indiana	0	1	2	2
Kentucky	0	1	0	0
Louisiana	5	0	1	1
Maine	3	3	2	0
Maryland	2	1	0	0
Massachusetts	5	4	4	3
Michigan	1	3	4	4
Missouri	3	3	2	1
Nebraska	0	0	1	0
Nevada	0	0	0	1
New Hampshire	2	0	0	0
New Jersey	1	4	2	2
New York	2	11	2	4
Ohio	1	2	2	0
Oklahoma	1	0	0	0
Oregon	1	2	2	0
Pennsylvania	1	0	0	2
Rhode Island	2	1	2	0
South Carolina	0	1	1	0
Tennessee	0	0	1	1
Texas	1	4	3	0
Utah	2	3	0	0
Virginia	1	1	1	0
Washington	10	3	15	9
Wisconsin	1	4	2	4
West Virginia	1	0	0	0

Table 3.--Cont.

	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Foreign area:				
Australia	0	1	0	0
Bermuda	0	0	1	0
Canada	0	1	1	0
Caribbean area	5	5	8	3
Mexico	3	1	1	3
Okinawa	<u>2</u>	<u>0</u>	<u>1</u>	<u>1</u>
Total	116	116	118	118

Table 4.--Distribution of Fatal Non-Professional  
Scuba Accidents by Weekday, 1970, 1971,  
1972, and 1973

<u>Day</u>	<u>Accidents</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
	(percent)			
Monday	2	7	7	8
Tuesday	6	7	4	5
Wednesday	12	8	9	9
Thursday	6	4	9	6
Friday	10	9	5	9
Saturday	25	20	27	31
Sunday	39	45	39	33

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Table 5.--Distribution of Fatal Non-Professional Scuba  
Accidents by Month, 1970, 1971, 1972, and 1973

<u>Month</u>	<u>Accidents</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
	(percent)			
January	6	2	3	5
February	3	3	3	8
March	9	6	7	9
April	7	8	10	12
May	11	19	11	8
June	9	10	11	9
July	16	18	6	13
August	9	15	14	12
September	8	3	11	10
October	10	7	3	6
November	7	4	10	6
December	5	5	11	2

Table 6.--Location of Non-Professional Scuba  
Fatalities, 1970, 1971, 1972 and 1973

<u>Location</u>	<u>Fatalities</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Ocean, bay, sea	73	69	73	75
Minor lake, pond, slough	18	25	19	8
Cave	11	8	19	18
River	4	9	2	4
Quarry, pit, open mine	7	5	1	7
Great Lakes	1	0	3	5
Swimming pool	<u>2</u>	<u>0</u>	<u>1</u>	<u>1</u>
Total	116	116	118	118

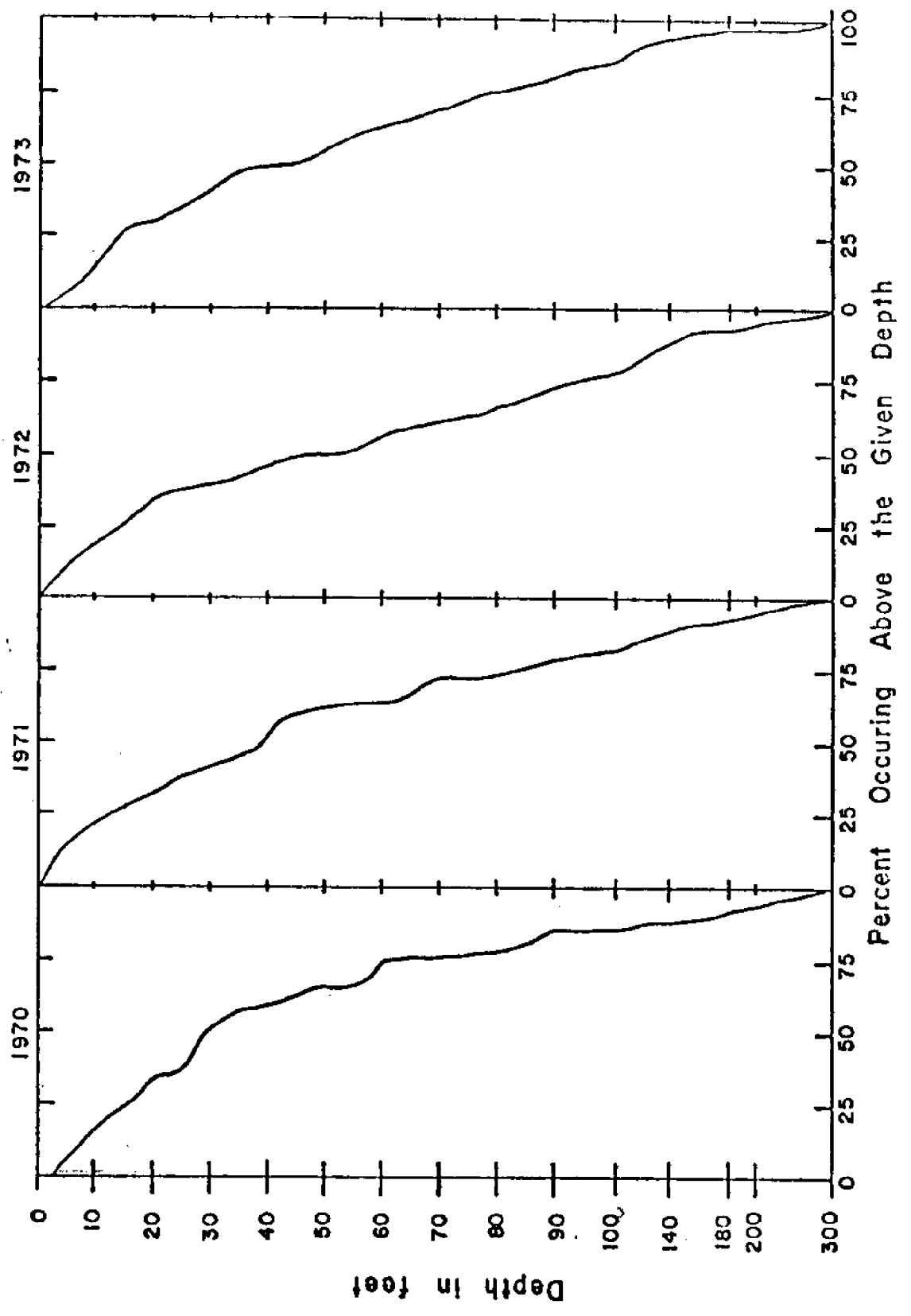
\*Does not include professional fatalities, 8 of which occurred in ocean water and one in the Great Lakes.

exercises at the deep end of the pool) or from a near-drowning event which injured his lungs with excessive fluid intake.

Figure 3 shows the cumulative distribution of accident depth for the four years. "Accident depth" is defined in this study as the depth to which the diver went on the fatal dive, regardless of where his final problem occurred. Where this is not known due to lack of eye witnesses, the depth at which the body was located is used. It should be understood that a substantial fraction of scuba deaths occur on the surface, usually immediately following a dive to whatever depth the diver or his group attempted. It is clearly important to establish this information since "shallow dives" (less than 40 feet, or deeper when the dive is brief) cannot have decompression sickness as the cause of difficulty. Further, dives less than 100 feet deep cannot be expected to produce narcotic symptoms in most divers, excepting those few individuals who are especially susceptible. As Figure 3 shows, the apparent trend of deeper accident depths suggested by 1970, 71, and 72 data is not echoed by these newest figures. It appears that in 1973, the region between 40 and 100 feet contributed a greater fraction of accidents (almost half) than in previous years, while the very deep dives contributed less casualties than in prior years. In reading the eye-witness narratives of these 1973 cases, there seem to be relatively few in which depth alone produced the fatalities. One coroner in a high risk area tended to list "nitrogen narcosis" as a contributory cause of death in several accidents, but of course, it is impossible to detect such a trauma in autopsy and the eye-witness accounts of these accidents (the only positive way of detecting a narcotic problem at depth) do not confirm these suppositions. Scuba diving to depths in excess of 120 feet was noted in 10 cases, (less than 10%). All of these occurred in the caves of Northern Florida.

In the several deep cave accidents, it is reasonable to suppose that narcosis contributed to the accident. However, an examination of these cases show that other factors (out of air, lost with no safety line, buddy separation) are also always present. The point is; deep diving of itself does not appear to be a serious environmental cause of scuba deaths. There are a number of cases each year, and several in 1973, where air exhaustion at 70 or 80 feet is more than enough to

# SCUBA ACCIDENT DEPTH 1970-1973



trigger a fatal occurrence. The impression left by much of the data is that it is the combination of the novice plus depths in the range 60 to 100 feet that is most likely to cause trouble.

A typical incident of this sort occurred in cold, northern water on a calm, clear Sunday. Two young men made their first, open-water dive with an instructional group in ocean water. The class and instructor left the area and the two men then made a dive in 80 feet and were missing for two days. When the bodies were recovered on the bottom, they were 30 feet apart and 100 yards from shore. Diver A had no air in his tank and no reserve on his tank. His mask was pulled down so that it covered his mouth and chin, but otherwise his tank, suit, and other gear were in place. Diver B had pulled his reserve and his tank was also empty, but otherwise his equipment was in place and normal. The region has no currents or tidal action so that it is difficult to escape the conclusion that these two beginners simply ran out of air at depth and could not achieve the surface and further that this was not a rescue situation. What would have been a routine dive for an expert became a deadly exercise for these young men on their second, open-water attempt.

Table 7 shows the number of cases which involved weather factors as possible contributors to the fatal event. Once again, as has been noted in the fatality statistics for 1965 (Webster, 1965) and for 1970 through 1972 (Schenck and McAniff, 1972) about one quarter of the scuba events (28 in 1973) appeared to involve weather problems. It is worth noting that all eleven of the cases in the "Heavy and Dangerous Surf" category are from California. In other words, one-third of the scuba deaths in California involved a dangerous weather situation, usually including shore entry with the always difficult problem of returning through increased surf from seaward. None of these 11 cases in 1973 involved instruction or early open water dives, and several involved divers of "moderate" or "considerable" experience. However, several had travelled some distance to dive and were not familiar with the special problems of the area. A typical example of this type of accident occurred in one of the deadliest inshore diving areas of California, the beaches of the Monterey peninsula. Two divers entered the surf line together with a one-man raft that was anchored beyond the line of breakers. Within ten minutes, the victim was in trouble,



having been struck by a large wave and separated from his buddy and the floating boat. The victim dropped his weight belt and inflated his buoyancy vest, but could not be reached from shore. The body washed in and was immediately given artificial respiration and heart massage by the local rescue squad, to no avail. Autopsy showed "drowning" as the cause plus "recent superficial laceration of scalp, left temporal parietal area". Significantly, this diver and his buddy drove to the Monterey area from a San Francisco suburb. A mortuary employee made the comment, "the undertow is terrific at that spot. Very few residents of the area try to swim there, they know the danger." Clearly, these divers entered a situation beyond their abilities and knowledge. The victim probably was incapacitated by striking rocks or the bottom while being tumbled in a large wave.

Table 7.--Fatal Non-Professional Scuba Cases  
Involving Weather and Sea Conditions,  
1972 and 1973

<u>Condition</u>	<u>1972</u>	<u>1973</u>
Moderate (2-ft or less) waves	11	6
Heavy (over 2-ft) waves	5	3
Heavy or dangerous surf	4	11
Current, undertow, river	4	7
Ice (loss of exit hole)	3	3

Each year brings two or three fatal accidents involving ice diving; almost always resulting from the loss of an exit location by the diver in trouble. In one of the two 1973 cases, the diver showed a lack of understanding of the physics of ice formation that cost him his life. Where he entered the water, the ice was so thin that it was easily broken from below. However, the sides of this quarry protected the far side of the water surface from the sun. When the diver attempted to surface here, he found the ice too thick to break. In tracing an escape route with two buddies, the victim apparently became lost and was not recovered for one hour. Interestingly, his tank had 1100 psi left at time of recovery, so that panic and possible claustrophobia must have played a part in this accident.

In the second ice event, the victim and buddy became separated under ice, and when the buddy came up, he heard the victim tapping on the ice obviously looking for an exit route. By the time the victim was found, he was tangled in brush beneath the ice and his tank was empty. This rescue, incidentally, involved many bystanders who had to break up and remove the ice cover to find the body, which was located by a metal detector. One of these ice victims was making his first dive when the accident occurred. He had purchased his gear the day before and it was reported by a witness that he had "several leg cramps while trying to don his wet suit".

#### 2.4 Work-Related Fatalities

About ten percent of the scuba accidents involved persons at work (Table 8). Both the college students were undergraduates obtaining marine specimens for their classes. In one case, the student and buddy were diving to obtain material for a large class of over 25 students on a field trip. When the student was lost in the water, no other student or faculty member were able to assist in the search as they had not been taught to dive.

Table 8.--Work-Related Non-Professional Scuba Diving Fatalities, 1972 and 1973

<u>Occupation</u>	<u>Deaths</u>	
	<u>1972</u>	<u>1973</u>
College student	4	2
"Part-time" commercial diver (college student)	1	1
Police Officer	1	2
Industrial employee	1	0
Oceanographic researcher	1	1
Underwater archeologist	1	0

Note: The work related scuba fatalities covered in Table 8 have been classified as "non-professional" since they are products of the sports scuba programs as opposed to commercially trained or full time professional divers. The latter are covered separately in the text.

One of the police officers died in a training accident while he was qualifying for a local police scuba team. In the second case involving an officer, the accident occurred during a search for a suspected drowning victim in a canal. The police scuba diver was apparently lost inside a syphon that lead off from the canal.

The oceanographic research diver was searching for a "lost" species of pipe fish in Mexico when he suffered a heart attack. He was 58 years old.

In addition to the work related scuba fatalities in Table 8 we acquired case data on some commercially trained, full time professional divers (3 fatalities in 1972 and 9 fatalities in 1973). It must be noted that the scope of this present effort is insufficient to do a thorough investigation of professional diving fatalities. Such investigations of professional diving fatalities are seriously complicated by insurance claims, legal actions and the wide geographical nature of their occurrence. This is, therefore, not to be construed as a comprehensive report on professional diving accidents.

The three professional diving fatalities reported in 1972 include one scuba fatality; a suit "blow-up" with rapid ascent from 280 feet and two fatalities while using surface supplied air.

In 1973, four of the professional diving fatalities involved scuba. The other five cases occurred on surface supplied air.

In Table 9 is given the "diving platform" in use when a fatal accident occurred. The bulk of the fatalities (about two-thirds) occurred while the victim was diving from shore. Six of the 13 fatalities occurring off charter boats occurred in Southern California, two were in New Jersey and Alaska, and the rest in Louisiana, Florida, and the Carribean. In two separate double fatalities, the accident descriptions suggest strongly that the deaths resulted from the private diving-boat dragging anchor offshore, leaving the divers stranded in the water miles from safety.

Mass dives from both charter and private vessels often involve the diver in a situation where his absence goes unnoticed for a considerable period of time. An example of

this occurred on a charter boat in 1973 where one-half-hour passed before the victim's "buddy" realized that the victim was gone and alerted the other divers on the boat and in the water. Recovery took another half hour insuring that this diver was beyond medical help. When found, he was tangled in kelp in only ten feet of water and his equipment showed that an attempt to ditch had been made. When fully equipped and suited, it is difficult to identify a particular diver underwater, especially if visibility is poor. Thus a buddy may become separated and find himself following other divers, thereby not realizing that his actual buddy is missing and in trouble.

Table 9.--Type of Diving Platform in Non-Professional Scuba Fatalities, 1973

<u>Platform</u>	<u>Skindiving</u>	<u>Scuba Diving</u>
Shore, beach or pier	20	74
Shore with surface float	0	3
Charter Boat	0	13
Private, recreational vessel	<u>4</u>	<u>25</u>
Total	24	115

Note: Eight of the professional fatalities occurred from a commercial dive boat or barge and one from shore.

Just prior to publication, additional data was obtained changing Table 7 by adding one case each to the "Current, undertow, river" category and the "Ice" category. Table 8 is also adjusted to include one additional case in the "Part-time commercial diver, college student category".

PART 3

THE SCUBA VICTIM:  
TRAINING, MEDICAL, AND RESCUE ASPECTS

3.1 Age Distributions

As Table 10 shows, the age distribution of scuba victims has not changed significantly during the four-year compilation. The age range of 16 through 30 years contains the bulk of the victims with the five year range, 21-25, containing the largest group, as in 1972. As in previous years, the age distribution of victims closely follows the age distribution of active divers.

Table 10.--Age Distribution of Non-Professional Scuba Diving Victims, 1970, 1971, 1972, and 1973

<u>Age</u>	<u>Victims</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
<u>Years</u>				
10-15	5 (1)	3 (1)	1	5 (1)
16-20	27 (1)	31 (3)	22 (1)	21 (1)
21-25	23 (1)	23 (1)	36 (6)	40 (2)
26-30	18 (3)	18 (1)	25 (2)	19 (1)
31-35	12	8	8	11
36-40	5	5	9 (1)	5
41-45	12 (1)	6	7 (1)	9
46-50	6 (1)	7 (1)	5 (1)	3
51-55	0	4	4	2
56-60	2	3	3	3 (1)
60-up	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>
Total	111 (8)	109 (7)	118 (12)	118 (6)

Note 1: Numbers in brackets refer to number of female divers in group.

2: The ages of the nine professional fatalities in 1972 ranged from 22 to 60.

### 3.2 Experience, Training, and Certification

The relative experience of scuba victims in 1973 was established in 85 cases, and is shown in Table 11. The very heartening decrease in first-dive events in both 1972 and even more markedly in 1973 may be the result of greater public understanding of the need for formal training in scuba diving plus more awareness at rental and sales outlets of the necessity of establishing a diver's qualification before giving him tanks and regulators. A classic example of how a total novice can become involved in a multiplicity of problems occurred during a California accident. The seas were described as "rough". The man had two buddies who he "barely knew" but whom he told he had dove before. The equipment was rented and the men had "two beers" before the fatal dive. Diving in 15 feet of water, with one man ashore, the buddies became separated and were "thrown around" by large waves. After a search of a few minutes, in which the man from shore joined, the body was found almost on the bottom. The buddy diver ditched his own and the victim's belt and got the body onto a rock that was awash. At this point, the lanyard on the victim's buoyant vest "pulled out" without inflation occurring. The two divers then manhandled the body ashore and administered artificial respiration to no avail. Later checking revealed that the victim had no certification and had never dove with air before. The autopsy listed "drowning" as primary cause of death, but the coroner discovered an overpressure injury in the lung, probably due to the victim holding his breath while attempting to deal with the heavy seas and the shallow-water surge. Here is a case that has most of the elements typical of novice accidents; eating and drinking just before diving, total lack of practice, casually-met buddies, a shallow-water embolism with life vest failure thrown in for good measure. Any one of these circumstances can be enough to kill a beginner; all together they tell a story of senseless and unnecessary loss.

Table 12 shows the number of scuba cases in which some sort of training activity was involved. Once again, the considerable reduction in this type of accident, compared with the previous three years, may be indicative of a greater awareness by instructors of the very dangerous character of the first-open-water-dive experience. Actually, the reduction in instructional fatalities is even more marked than appears in Table 12. At least four of the seven cases listed under "open water instruction, regular" involved divers of some

experience, and one involved a very skilled diver who suffered a heart attack in an advanced diving course. In other words, only three of these victims were true novices on their first, or very early dives.

Table 11.--Experience of Scuba Divers Lost in Fatal Accidents, 1970, 1971, 1972, and 1973

<u>Experience</u>	<u>Accidents</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
				<u>Percent</u>
First dive ever with scuba	12	14	6	3
First dive in open water	9	12	6	5
Early open water dive	15	19	21	31
Some experience	29	28	29	32
Considerable experience	21	20	32	23
Very experienced	14	7	6	6

Table 12.--Scuba Training Activities During a Fatal Accident, 1970, 1971, 1972, and 1973

<u>Activity</u>	<u>Accidents</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Open water instruction, regular	7	7	12	7
Open water instruction, friend	7	8	3	1
Died while instructing another, regular	2	0	1	0
Died while instructing a friend	1	0	0	2
Taking instruction in pool	<u>2</u>	<u>0</u>	<u>1</u>	<u>1</u>
Total	19	15	17	11

3.3 Diving Partners and their Activities

Once again, the number of fatal dives made by lone divers is only about ten percent of the total census (Table 13), showing that diving alone is not a serious problem in scuba fatal accidents.

Table 13.--Non-Professional Scuba Diving Partners During a Fatal Accident, 1970, 1971, 1972, and 1973

<u>Number with Victim</u>	<u>Accidents</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Zero (diving alone)	13	12	11	10
One other (buddy)	47	54	41	60
Two others	11	20	20	25
Three others	10	10	4	2
Several others	<u>19</u>	<u>17</u>	<u>33</u>	<u>14</u>
<b>Total</b>	100	113	99	111

In the 85 cases in which the buddy activity could be established (Table 14) well over half involved separation, usually underwater, but sometimes on the surface. One of the typical comments from the surviving buddy is a variation on "he was right behind me and seemed all right". Then, usually moments later, the man is lost and the search begins. When one includes the surface-loss cases, where two divers are coming in after a dive and the man behind suddenly sinks and is lost, it appears that a very large fraction, possibly as much as a third of the total scuba group, involves buddy separation. If a buddy shows the slightest suggestion of difficulty, confusion, or fatigue especially following a dive, the buddy should take a position behind his man and watch him continuously. This simple precaution might have saved a very substantial proportion of those divers who suffered disablement on the surface. In our opinion, a crucial standing rule in scuba buddy activity is that the more experienced man always follows the novice, where conditions or activity make a side-by-side configuration impractical.



Table 14.--Buddy Activity During Fatal  
Non-Professional Scuba Accident,  
1971, 1972, and 1973

<u>Activity*</u>	<u>Accidents</u>		
	<u>1971</u>	<u>1972</u>	<u>1973</u>
Buddy stayed with victim	25	27	22
Buddy lost victim underwater	24	25	38
Attempted buddy breathing	15	14	7
Buddy left water ahead of victim	9	4	4
Buddy lost victim on surface	<u>12</u>	<u>15</u>	<u>14</u>
Total	83	86	85

\*There is no overlap in categories.

Table 14 indicates the separation of buddies may be a primary contributor to scuba fatalities.

1973 was the worst year yet for multiple fatalities in scuba diving, with 23 of the victims involved in this sort of accident, (almost one-quarter of the scuba total, Table 15).

Table 15.--Multiple Non-Professional Scuba  
Fatalities, 1970, 1971, 1972, and 1973

<u>Multiple</u>	<u>Accident Cases</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Double	9	4	8	10
Triple	<u>1</u>	<u>0</u>	<u>2</u>	<u>1</u>
Total victims	21	8	22	23

Five of the double fatal events and the single triple death occurred in Florida caves, and one additional double death occurred in the ocean off Florida, due apparently to the dive boat dragging anchor and leaving the divers without a

way to get ashore. This accident occurred at night. In a double fatality off the California beaches, the surf was so rough that both divers in a buddy pair were killed attempting to return to shore through the heavy surf. This area off Carmel and the nearby Monterey County Coastline has been noted for its sudden heightening of surf which catches the unwary diver without warning. Local authorities have noted this as a very dangerous potential to visiting divers, the majority of whom come into the area from the San Francisco-Oakland area without knowledge of this environmental phenomena. A second California, double death in the Laguna area had a similar history. The two divers were overcome in rough waves and surf, one being immediately rescued by life guards but dying ten days later in the hospital from post-drowning symptoms. The buddy was not found for a day and it was discovered that he had knotted his weight belt, making ditching impossible. The diver rescued at the time of the accident did not recover sufficiently to make any statement and it was found that he had suffered a severe ear drum rupture. It is possible that this triggered this diver's problem and perhaps the problems of both men, since a burst drum may so seriously incapacitate a diver as to demand immediate rescue efforts on the buddy's part. However, such speculation remains only that. Double fatalities without the presence of witnesses are among the most complicated type of cases since it is usually impossible to distinguish between two separate events that coincidentally occur, or a chain of events set in motion by one diver and then involving the other.

This latter type of accident occurred when two Alaska divers on their first open water dive in 55 feet of water ran low on air. One began sharing with his buddy, but neither achieved the surface. As noted earlier, running out of air at moderate depths (i.e. 55 feet) is a minor problem for the expert diver. For the beginner it can become a desperate emergency. Early dives should not, in our opinion, involve dives in excess of 20 or 30 feet.

In Hawaii occurred a second double death involving the dragging of a dive-boat anchor offshore. Neither diver was ever found, although the boat came ashore eventually.

The final double event occurred in the state of Washington and again involved novice divers in moderately, deep water (80 feet) as discussed in Section 2.3.

### 3.4 Medical Aspects

Forty-nine autopsies were reported on the 1973 scuba fatal group. Table 16 shows the results.

Table 16.--Results of Autopsies,  
1970, 1971, 1972, and 1973

<u>Primary Complaint</u>	<u>Autopsies</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Asphyxiation or drowning	25	26	22	32
Lung overpressure	9	12	9	8
Injury to head (often plus "drowning")	5	2	2	0
Heart attack	5	1	3	6
Aspiration of stomach con- tents	3	1	2	1
Acute decompression sickness	0	0	1	1
Intestinal disorder	0	0	1	0

In our interpretation of these autopsy documents, we do not list the coroner's cause of death in the Table, where the autopsy discovered a true medical cause of the accident itself. For example, in a number of heart attack and embolism cases, drowning is listed as the "cause of death", but death was actually the result of the diver being incapacitated by a serious, but possible non-fatal medical problem. Once again, it is probable that the nine overpressure accidents represent only a portion of the true number. Some divers are not autopsied, and others fail to have the air damages detected.

The ages of the heart attack victims were; 39 (three), 40, 47, and 54. Such figures show the importance of medical examinations when middle-aged persons wish to engage in sports that may require a sudden, maximum physical effort.

If we were to project this sample to the entire scuba fatal group, assuming that this is a random and representative sample of the whole, then at least one-third of the fatal scuba group in 1973 suffered an incapacitating accident in the water (embolism, heart attack, or the inspiration of vomit). It is our opinion that instructors and divers should thus base their training and practice of accident management

on the assumption that they may have to deal with a diver unable to ditch his equipment, inflate his vest, or take any action whatever to save his own life. Divers may want to consider if their scuba system will float them when unconscious with their mouth well clear of waves. They should be certain that all straps and buckles are readily released by a buddy and that inflation lanyards or levers are visible and easily reached by their partner.

The single fatal bends case in 1973 involved four separate dives to depths of 125 feet involving four scuba tanks with no stops. Medical attendants at the chamber where the victim was unsuccessfully recompressed estimated on the basis of eye-witness accounts that the victim "owed 446 minutes of decompression time". The victim was accompanied by different divers on his various dives, so that the several buddies were not hurt.

### 3.5 Search and Rescue

In the majority of scuba cases, rescuers were aware of a problem within 15 minutes of the incident. As Table 17 shows, rescue often took hours or days, and nine divers were never found at all. If we assume that the chance of successful resuscitation drops sharply after five minutes of submergence without air, then in only about 20% of the scuba cases in 1973 was there much hope for medical intervention in the accident sequence.

There were 32 cases involving lost skin and scuba divers in which the Coast Guard participated either in a search or medivac capacity, and often in both. This compares with 34 such cases in 1972. Assistance by police, ambulance, rescue squad, and life guards was common in many of the cases. Resuscitation was attempted in virtually every case in which any hope of reviving the victim existed. A common problem in these situations is the delay in starting mouth-to-mouth breathing necessitated by getting the victim ashore or to a location where such activity can be accomplished.

Table 17.--Elapsed Time Between Start of Scuba  
Accident and Body Recovery, 1970, 1971,  
1972, and 1973

<u>Time Range</u>	<u>Recoveries</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Immediate, victim alive, died later	4	5	5	2
Immediate, victim dead	15	17	20	9
5 minutes or less	8	6	3	9
Over 5 to 10 minutes	4	1	5	6
Over 10 to 15 minutes	8	8	2	1
Over 15 to 60 minutes	11	14	9	11
Over 1 hour to 4 hours	10	13	14	25
Over 4 hours to 12 hours	9	8	7	10
Over 12 hours to 1 day	18	9	7	6
Over 1 day to 2 days	4	5	10	4
More than 2 days	6	7	8	10
Victim never found	6	11	7	10

## PART 4

## EQUIPMENT ASPECTS

4.1 Regulators and Air Supplies

There was no verified case of regulator malfunction or failure in 1973, although in less than 15 percent of the cases had a test been made after the accident. In two different cases the regulator was described as "leaky" but both accidents occurred in shallow water and there was no indication that the accident stemmed from this problem. In one case, a witness noted that the reserve lever on a single tank was jammed by the dust cap and could not be opened. This diving victim was reported to have refused his buddy's aid and "shot to the surface" from 46 feet of water, dying of an overpressure accident as a result. In a second case involving a regulator problem, a beginner on his first dive using rented equipment had mounted his regulator upside down which resulted in kinking of the hoses of a double-hose regulator. Since this victim never actually got below the surface, it is very possible that this difficulty triggered his accident.

In 20 cases investigators reported that air ranging in amounts from 200 psi to almost a full tank remained, although in the majority of investigations it is impossible to establish whether or not air remained.

4.2 Entanglements, Ditching

There were three California cases in which kelp entanglement was the primary accident cause. In one of the double cave accidents in Florida, involving skilled cave divers, the guide rope in the cave had been cut and it is supposed that this contributed to the loss of both divers. In another accident a diver became tangled in a buoy line at 90 feet. However, he had showed signs of distress before entanglement.

Two divers had knotted their weight belts so that ditching was impossible in an emergency. There were only eight cases in which ditching of tank and/or belt was reported in 1973, compared to 26 in 1972, 10 in 1971, and 26 in 1970. In one attempted ditch of a weight belt, the belt was prevented from falling free of the victim's legs by catching on a knife that

was mounted on the outside of the lower leg. This diver was found on the bottom out of air.

#### 4.3 Inflated Vests

The wearing of an inflatable vest or buoyancy-altering device was determined in thirty three scuba fatalities and one skin diver fatality. As Table 18 shows, the bulk of the cases involved a vest not used during the accident. While some of these 20 accidents probably involved a vest that failed when needed, the bulk of the cases clearly involve divers so incapacitated as to be unable to even operate a vest inflation device. Any vest that requires manual (lung) inflation or which has its method of inflation hidden or difficult to reach will simply not be used in many emergencies

Table 18.--Performance of Inflatable Vests,  
1970, 1971, 1972, 1973

<u>Situation</u>	<u>Cases</u>			
	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
Vest worn, not used, not checked	16	14	9	20
Vest worn, inflated during accident	6	9	15	10
Vest worn, not used, checked OK later	9	4	9	3
Vest worn, malfunction during accident	5	7	7	2
Vest worn, no cartridge	<u>2</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	38	34	40	35

#### 4.4 Other Equipment Problems

There were no fatal compressed-air tank explosions in 1973, nor was there any report of "bad" air causing an accident, although air is still being tested in only a handful of cases. The primary "equipment" problem in 1973, aside from the inflatable-vest failures, is the problem of losing one's

boat while diving offshore. Two double fatalities appear to have resulted from this failure of mooring tackle while divers were swimming off away from their boat. Persons diving several miles offshore should probably consider using two anchors when no one remains on the diving boat.



## PART 5

## SCUBA FATALITY CAUSES

5.1 Summation

As in past years, an attempt was made in all cases to define the "proximate starting cause" of the accident. Such a judgement is quite subjective and the ground rules for these choices are as follows: When a medical problem is detected in autopsy, or suspected from the victim's medical history or behavior in the water, this is always selected as the starting cause of the accident. We do not regard an over-pressure accident or heart attack as "contributory" or produced by some other emergency situation since a healthy or properly-trained diver would presumably not have suffered a similar event. The failure of a diver to take action to save his life, such as the dropping of gear or the inflation of a vest, is never regarded as the primary accident cause, although such problems may exacerbate an existing accident situation. Because so many of this group are incapacitated before they can take remedial action in their own behalf, it seems reasonable to always look on the cause of their becoming incapacitated as the true starting cause of the emergency. Weather and sea factors are selected as the starting cause when the narrative summaries of the accident and the described weather situation justifies this assumption. Most cave accidents are environmentally caused, that is, the diver drowns because he is in water having no free surface or easy escape, but a few of the accidents in caves can be more exactly defined as to starting cause. Those cases not included in this summary are usually the ones in which the victim is never found, in which no witnesses were present and the body gave no clues, or those few accidents that happen outside the U.S. where details are either lacking or, confused. Table 19 gives the summary causes for 1973.

The category "possible exhaustion, embolism, or panic" is a catch-all category but the accidents included in this group do form a rather distinct population. These are most often divers who have completed a dive and fail either on the surface or during the return from depth to the surface. This failure may manifest itself in relatively violent action; such as grappling at the buddy's regulator, "shooting to the

Table 19.--Proximate Starting Causes of  
Non-Professional Scuba Fatalities, 1973

<u>Estimated Cause</u>	<u>Cases</u>
(A) <u>Medical and injury causes</u>	
Diagnosed air embolism	7
Diagnosed heart attack	5
Possible exhaustion, embolism, or panic	23
Possible heart attack	3
Possible stroke or seizure	2
Possible nitrogen narcosis at great depth	2
Victim stated he was exhausted	1
Acute decompression sickness	1
Head injury with possible unconsciousness	3
Inhaled stomach contents	1
Partial drowning, lung injury resulting	1
Inhaled water while snorkeling	1
Total medical causes	47
(B) <u>Environmental Causes</u>	
Lost or out of air in cave	15
Out of air at depth	4
Diving in dangerous waves or surf	10
Tangled in kelp	3
Lost in underwater syphon	1
Carried away by strong current	2
Lost under ice	3
Frightened by shark	1
Cut by boat propeller	1
Total environmental causes	40
(C) <u>Equipment causes</u>	
Anchor of dive boat dragged stranding diver	4
Regulator improperly mounted, kinking hose	1
Total equipment causes	5
(D) <u>Other causes</u>	
Diver attempting to rescue buddy	2
Proximate cause not determined	24
TOTAL	94

surface" or shouting and waving arms. Much more common, however, is a partial loss of consciousness or ability to deal with the situation. Most typically, the victim lags behind, seems confused or vague and then suddenly slips underwater, often to be lost for considerable period of time. This occurrence appears often in the data. Several of these cases have been autopsied and no sign of embolism or heart attack have been found. Panic, at least as commonly observed and involving hyperactive behavior, does not seem to be an explanation for these many cases. It is the passivity of the victim, his total inability to look after himself, and his apparent willingness to sink below the surface that appears again and again in case narratives by buddy divers and other witnesses.

Such an accident is not limited to novice divers, although these divers are more likely to suffer this problem at once, that is, before they have even attempted to get underwater. Since such victims invariably drown, it is impossible to discover from the autopsy how much inhaled water may have contributed to the diver's failure. However, in the normal course of events, inhaling water is usually expected to produce spluttering, shouts of help, and arm waving. We have no explanation for these cases. In a previous report (Kindwall, et.al., 1971) mention was made of "diver's vertigo", a mild form of nausea detected in some navy divers and appearing most frequently on the ascent after a dive. It seems hard to believe that such a cause could kill, but it is important to realize that we are dealing with perhaps ten or fifteen cases, which is a very small group out of the estimated half-million serious scuba divers. (Schenck and McAniff, 1972(b), Jugel, 1973). It may be that certain emotional, physical and environmental stresses can interact to occasionally produce a vertigo effect that overwhelms the diver with faintness and nausea. In any case, divers should be aware of this problem and buddies should be immediately on their guard if, following a dive, a partner seems in any way listless or unresponsive. If suspicious, immediately get behind your man and watch him every second all the way in. Any diver who has suffered this type of accident and been saved should carefully write an account of his dive and physical sensations and transmit these to the authors of this report. It may be that relatively simple preventive measures can eliminate a major cause of diving fatalities, but the problem must first be understood.

## PART 6

## SUMMARY OF SKIN DIVING FATALITIES

6.1 Geographic, Environmental and Calendar Distribution of Skin Diving Fatalities

Table 20 shows the geographic location of skin diving fatal accidents in 1972 and 1973. California, Hawaii and Florida are the important locations of such accidents, as might be expected. Daily and monthly variations (Tables 21 and 22) reveal patterns similar to that for the scuba accidents; maximum activity on Saturday and Sunday and the bulk of the accidents occurring during the middle two quarters of the year.

Table 20.--Skin Diver Fatalities by State

<u>State</u>	<u>Fatalities</u>	
	<u>1972</u>	<u>1973</u>
California	8	7
Hawaii	3	5
Florida	1	5
Massachusetts	0	1
Maryland	0	1
Michigan	1	0
New York	1	0
North Carolina	2	0
Pennsylvania	0	1
Texas	0	1
Washington	0	2
Mexico	0	1

Most of the accidents occurred in the ocean (Table 23), and most of these ocean skin divers were working from a shore or beach with only four diving from a private boat.

Table 21.--Distribution of Skin Diver Fatalities  
by Weekday, 1972 and 1973

<u>Day</u>	<u>Fatalities</u>	
	<u>1972</u>	<u>1973</u>
Monday	1	1
Tuesday	1	0
Wednesday	0	1
Thursday	3	0
Friday	2	0
Saturday	4	11
Sunday	5	11

Table 22.--Distribution of Skin Diver Fatalities  
by Month, 1972 and 1973

<u>Month</u>	<u>Fatalities</u>	
	<u>1972</u>	<u>1973</u>
January	0	0
February	1	1
March	3	2
April	0	2
May	0	2
June	2	1
July	5	3
August	1	4
September	1	5
October	1	1
November	2	2
December	0	1

Table 23.--Location of Skin Diver Fatalities

<u>Area</u>	<u>Fatalities</u>	
	<u>1972</u>	<u>1973</u>
Ocean, bay, sea	14	20
Minor lake, pond, slough	2	1
River	0	3

## 6.2 Age Distribution and Other Data

Table 24 shows an age distribution for the 1973 skin diver fatality census that is quite similar in pattern to that for scuba diving fatalities, with over half the group in the 16-30 range.

Table 24.--Age Distribution of Skin Diving Victims, 1972 and 1973

<u>Age</u>	<u>Victims</u>	
	<u>1972</u>	<u>1973</u>
<u>Years</u>		
under 10	0	1
10-15	1	0
16-20	2	5
21-25	5	3
26-30	2	7
31-35	0	2
36-40	2	1
41-45	1	0
46-50	1	0
51-55	0	2
56-60	2	2
Over 60	0	1

Background data on these skin divers could only be obtained in six of the cases. In four of these, the divers had been certified for scuba for at least one year, on one case the diver was reported to have been skin diving and snorkeling for three years, while in one case, involving a shark attack, the diver was a national champion spear fisherman.

Buddy relationships were established in 19 of the cases as shown in Table 25. Skin divers, while fishing, do not normally practice the buddy system. As Table 25 shows, on only three cases was there a deliberate attempt to maintain a buddy pair situation.

Table 25.--Partners-Buddy Relationship of Skin Diving Victims, 1972 and 1973

Number in water	<u>1972</u>		<u>1973</u>	
	Victims	Buddy system used	Victims	Buddy system used
Diving alone	5	--	6	--
One other	3	2	7	2
Two others	1	--	3	--
Three others	2	1	1	--
Several others	5	1	2	1

In one of these, a college student in a scuba class was making a free dive to "recover a simulated scuba victim" and was watched by surface safety people. When he failed to surface he was recovered in "two minutes or less" but too late. This class had both a swimmer and a scuba diver as safety men over the free diver.

At least ten of these skin divers were lost for over half a day, three never being found at all.

The Scuba Safety Project obtained five autopsy documents relating to these cases. Drowning was listed in three as the only cause of death, a heart attack produced the fourth accident, while the fifth case, in addition to drowning, listed "acute pentobarbital intoxication", as a possible cause of the accident. It was impossible to determine why this diver had drugged himself before diving, and drowning, alone.

### 6.3 Causes of Skin Diving Accidents

Determining the proximate starting cause of a skin diving fatal event is more difficult than is usually the case with a similar accident involving scuba diving. The victim is more often by himself, and the final trouble usually closely simulates a simple drowning occurrence.

A reasonable estimate of the starting cause could be made in eleven of the twenty-four skin diving cases, as follows: Two of the victims suffered head injuries, one on an ice

chunk during an ice-diving expedition. In the other head injury case, heavy weather and steep waves seems to have produced the trauma in rocky water. A diagnosed heart attack (victim 51 years of age) caused a third accident, while a possible heart attack was listed by a coroner (no autopsy, victim 69 years old) in a fourth case, based on the fact that victim had had a heart seizure "a few days earlier". One diver was overwhelmed by large waves which blew up in his southern California swimming location "in minutes" according to eye witnesses. A second weather-related fatality involved a swimmer who surfaced and was swept away in a strong rip current.

Table 26.--Elapsed Time Between Accident Onset and Recovery of Skin Diving Victim, 1972 and 1973

<u>Time</u>	<u>Victims</u>	
	<u>1972</u>	<u>1973</u>
Alive - died ashore	0	1
5 minutes or less	2	4
10 to 15 minutes	5	2
15 minutes to 1 hour	1	4
1 to 4 hours	1	0
4 to 12 hours	0	0
Over 12 hours to one day	2	5
Two days or more	0	2
Not recovered	2	3
Unknown	3	3

There were two deaths caused by propellers in 1973, one involving a young scuba diver (noted in Table 19) who surfaced under an anchored boat which had started its engines, while the other was a skin diver who was struck in the head by the propeller of a moving boat. No diver's flag was used in this latter case and the local enforcement authorities noted that such a flag should be used in this area. Both these boat accidents occurred in Florida.

One skin diver was noted to be exhausted before he was lost, another one was reported to have been drinking "heavily"



before entering the water, and a third was, as noted before, under heavy pentobarbital sedation.

The single case of a fatal shark attack in 1973 took place in Mexico and involved a very well-known sports diver. The diver cried for help about a hundred yards from the stern of his anchored boat. The boat slipped its anchor and recovered the diver within two minutes or so, but the femoral artery had been severed and he never regained consciousness. Local experts (in the San Diego area) examined the wound and recovered what were reported to be parts of two teeth from "a great white shark". They estimated from these teeth fragments that the fish was perhaps 8 to 10 feet long and weighed perhaps 800 pounds. The diver was in full wet suit, carried a spear gun, and had no fins. Descriptions of the wound indicate that the fish made a single pass at the diver, mangling one leg. Witnesses noted that there had been skin and scuba diving in this area before, that it was a rather "sterile" region, but that sometime seals were found in the region and the shark might have attacked the diver thinking he was a seal. This is an extraordinary occurrence. In the files of the Scuba Safety Project, now including well over one thousand U.S. fatal diving accidents, there is only one other case in which a shark attack was verified by witnesses. In a very small number of other cases, a diving victim has been recovered with fish-imposed injuries, but in none of these cases is it possible to prove that the bites came before the victim died from some other cause. Our files do contain a number of accounts of fish attacks with non-fatal consequences, but many of these are of dubious credibility.

# UNDERWATER ACCIDENT REPORT

Forward report to:

NATIONAL UNDERWATER ACCIDENT DATA CENTER

P.O. Box 68 — Kingston, R. I. 02881

VICTIM INFORMATION	Name of Victim: Last First Middle Address: State	Victim's Sex Age Hgt. Wgt. Marital Status: M S D W UNK Occupation Employer
	Location of Accident (use landmarks, distance from prominent terrain features. Attach Chart or Map if available) State	CIRCLE LOCATION (By Code Number) 1. Ocean, Bay, Sea 4. River 2. Minor Lake, Pond, Slough 5. Major Lake, Pond 3. Quarry, Pit, Open Mine 6. Swimming Pool 3A. Cave 7. Great Lakes
TIME AND PLACE OF ACCIDENT	Date and Time of Accident Day Mo. Yr. Use 24-Hr. Clock Date and Time of Death Date and Time of Recovery Death Occurred in Water? (Yes or No)	Autopsy Performed: (Yes or No) Cause of Death: Medical Examiner Name Address Phone

**CODE FOR NON-FATAL INCIDENT**  
Circle one only (A, B, C, or D) which best describes seriousness of incident. Important: Report all "incidents", however minor. Describe in detail on page 4. Include equipment factors.

- A. Incapacitating injury rendering person unable to perform normal activities as walking or diving or to leave scene without assistance.
- B. Nonincapacitating evident injury as loss of blood, abrasions, lump on head, etc.

- C. Possible injury indicated by complaining of pain, blackout, limping, nausea, etc.
- D. Incident with no apparent injury, (near miss, etc.)

DESCRIPTION OF DIVES AND ACTIVITIES	Description of all dives within previous 12 hours including accident dive. Depth Time Down Surface Interval	At time of incident, Activities engaged in: Recreational Commercial Under instruction Instructing Cave diving Spear fishing Photography Night diving	At time of incident, Buddy record: Diving alone Diving with buddy Buddy distance Diving with more than one Distance to next nearest diver
	Type of Diving: (Explain if Necessary) Scuba Skin Other Unknown Others in accident (Yes or No) Separate report filed (Yes or No)	Vessels Involved (Yes or No) U.S. Coast Guard aid sought (Yes or No) (Give Details in "Description of Accident", Name, Captain, Address, Phone, etc.)	

WITNESSES	Name Address Phone Function/Role
	Reported by: Name Address City Phone
	Other Contacts: Name Address City Phone

ENVIRONMENTAL  
CONDITIONS

Sea: Calm      Moderate      Rough      Weather: Clear    Cloudy    Fog    Snow    Rain

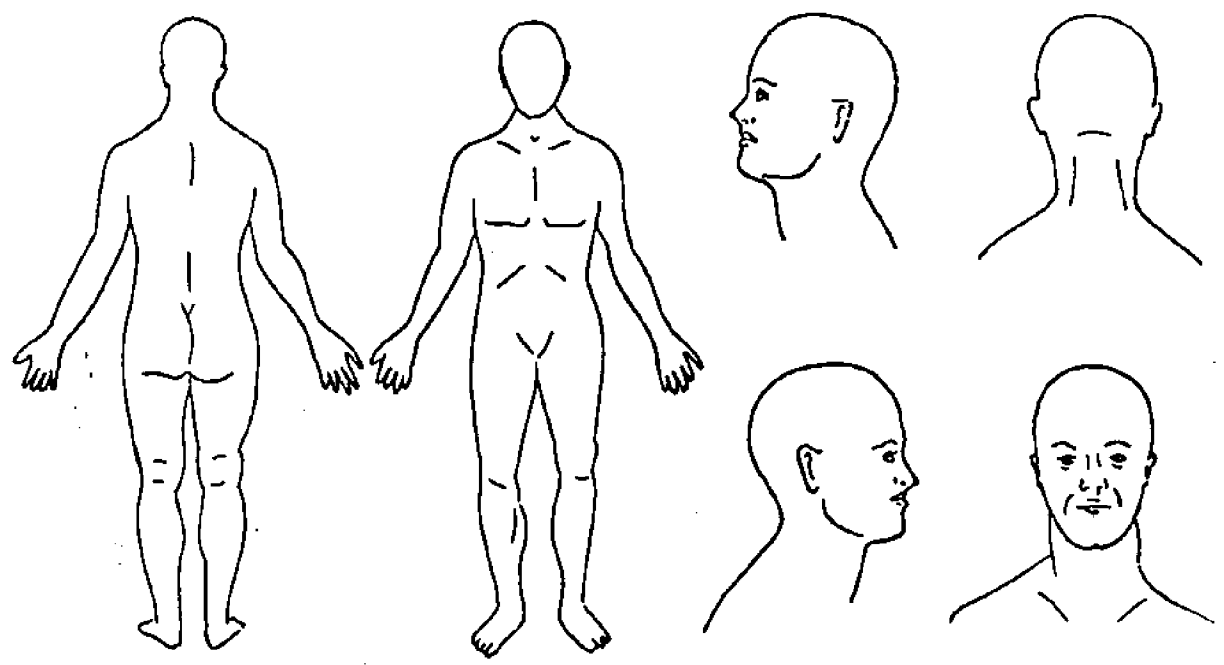
Current: Slight    Moderate    Strong    Direction      Thunderstorm    Tornado, Hurricane    Other

Wave Height:      Water Depth:      Type Bottom:      Wind Force      Direction

Water Temperature: (°F)      Air Temperature: (°F)

VISIBLE  
INJURIES

Illustrate all visible injuries (cuts, abrasions, fractures, etc.)



EXPERIENCE  
DATA

Swimming Experience: Years ..... *Courses and Agency*

Skindiving Experience: Years ..... (1) ..... Certification Date

Scuba Experience: Years ..... (2) ..... -DO-

..... (3) ..... -DO-

HUMAN  
FACTORS

Hours of sleep in past 24 hours .....

Time of last meal ..... What and how much? .....

Time of last alcoholic drink ..... What and how much? .....

Any known physical ailments, disability or impairment? .....

43  
EQUIPMENT DATA

NOTE: Equipment Brand, Type and Serial Number data need be included only if malfunction or failure was contributory to the incident.

Equipment Data Date and Time of Inspection	Brand, Type	Present Before Diving (Yes or No)	Present at Time of Recovery (Yes or No)	Condition	Equipment	Brand, Type, Serial No.	Present Before Diving (Yes or No)	Present at Time of Recovery (Yes or No)	Condition
Diving Suit					Knife (Posit.)				
Hood					Air Iron				
Boots or Socks					Flashlight				
Gloves or Mitts					Depth Gauge				
Mask					Scuba Gas				
Snorkel					Compass				
Fins					Regulator				
Weight Belt (lbs.)					Tank				
Buckle					Reserve				
Flotation Device					Watch				
Other Equipment									

Flotation Device: Used .....  
(Yes or No)

Tested after event? .....  
(Yes or No)

Regulator Tested? .....  
(Yes or No)

Results .....

Tank: Air Left ..... MFG. .... Date .....  
(PSIG)

Last Hydro-Test Date .....

Last Visual Inspection Date .....

Internal Condition: Clean .....

Slight Corrosion .....

Extensive Corrosion .....

By: .....  
NAME ADDRESS PHONE

Special Comments on Equipment .....

Equipment Inspected by: .....  
NAME ADDRESS PHONE

Equipment: Released to/or Held by: .....  
NAME ADDRESS PHONE



## PART 7

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