

STATE OF MICHIGAN SKIN, SCUBA, and SURFACE-SUPPLY
DIVING FATALITY STATISTICS, 1965-1978

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INTRODUCTION

Diving related accidents in the State of Michigan are monitored by the University of Michigan's Underwater Technology Laboratory and Medical Center and the Michigan State Police. This paper is a compilation of all recorded skin/scuba diving fatalities for the period of 1965-1978. Recreational diving fatalities are treated separately from commercial accidents. From this information an attempt has been made to identify some factors common to these fatalities. This information should be useful to the diving community in identifying factors which can create a potentially fatal situation. Such an analysis involves some degree of logical speculation after the data have been collected.

Data for this report were obtained from accident reports on file with the Michigan State Police. These reports are kept on microfilm in non-indexed files, among an average of six or seven hundred water accident reports per year. Applicable reports were retrieved by scanning all water accident reports on file for each year. The Michigan State Police provided invaluable help in both the retrieval and the release of the necessary information.

The information supplied by some of the original reports is sketchy at best, especially in earlier cases. An attempt has been made to limit unnecessary speculation where factual information is not known.

The format of this report is similar to a report published by the University of Rhode Island.¹ This was done to allow comparison of accidents in Michigan to those nationwide.

MICHIGAN SKIN/SCUBA DIVING FATALITY TOTALS, 1965-1978

Table 1 summarizes fatal diving accidents in Michigan for the years 1965-1978. One fatality occurred during 1967 for which the original report was not located. Female divers account for only one death out of 48 reported during this period. Four of the fatalities are considered professional or semi-professional and are treated separately in this report. During the period 1959-1965, twenty skin/scuba diving fatalities were recorded in the State of Michigan.

A breakdown by month of recreational skin/scuba diving fatalities (Table 2) shows that, as expected, the highest toll occurred during the summer months, with 52 percent occurring during July and August, when water temperatures are at their warmest. Four deaths involved ice cover at the time of the accident.

TABLE 1
 SUMMARY OF DIVING FATALITIES, YEARLY, 1965-1978

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Scuba Diving, Recreational	3	0	**	4	2	1	3	4*	4	3	2	4	3	3
Scuba Diving, Professional and Semi-professional	0	0	0	0	0	0	0	0	1	1	0	0	0	1
Surface-Supplied, Professional and Semi-professional	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Skin Diving	1	1	**	0	0	0	2	0	0	0	1	1	0	0
TOTAL	4	1	(1)**	4	2	1	5	5	5	4	3	5	3	4

* One fatality was a female. All others are male.

** Original report missing.

TABLE 2

DISTRIBUTION OF RECREATIONAL SKIN/SCUBA FATALITIES,
BY MONTH, 1965-1978

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
January	1													
February														
March														
April							2	1	1	1	2			
May								1	1					1
June				1			2	1			1	1	1	1
July	1	1		2	1	1	2	1			1	1	1	
August	1			1	1		1	1	1	1	1	1	1	1
September	1										2			
October														
November														
December														
Unknown														(1)*

*Report missing

SECTION I

RECREATIONAL FATALITIES

Environmental Aspects

Although divers in Michigan are within a short distance of the Great Lakes, 60 percent of all fatalities occurred in inland lakes in the state (Table 3). Fourteen percent of all deaths occurred in quarries and rivers, with Great Lakes-related fatalities comprising 26 percent of the total. This may be related to the fact that most of the deaths occurred following a shore-based entry, rather than from a boat (Table 6). The distribution of sport skin/scuba diving deaths with regard to "accident depth" is summarized in Table 4. In those cases where the actual depth of the dive was not known, the depth given is that at which the body was recovered. It is worthwhile to note that 55 percent of all deaths occurred in 20 feet of water or less, and 80 percent occurred at depths of less than 40 feet. "Deep dives" (dives to 60 feet or greater) accounted for the remaining 20 percent of the total. Once again, this may be related to the fact that most accidents occurred following a shore-based entry into an inland lake where deep water is uncommon (Tables 3 and 6).

The information in Table 5 indicates that adverse weather conditions, such as rough water or strong current, were present in 30 percent of all cases. Sixty percent of the accidents occurred in calm water, and four fatalities involved partial ice cover. In each of these last four cases, the divers entered open water and proceeded under the ice sheet without the use of safety lines. In one case, both divers became lost under the ice while attempting a compass run to an ice-covered point 75 feet from open water, resulting in a double fatality. In both of the remaining cases, a buddy team of three entered open water and proceeded under the ice cover. They became separated, and two of the three divers chipped a hole in the ice to effect a safe exit. Further detail is available in the case history portion of this report.

The data given in Table 6 indicate that, in 86 percent of the fatal diving accidents during this period, the divers entered the water from the shore. Of those entering from the shore, only 17 percent actually used a float or buoy of some sort in the water. Fatalities while diving from a boat account for the remaining 14 percent of the total. As previously mentioned, this distribution may correlate with the fact that most fatal accidents occurred on inland lakes, where a boat ride to the dive site is often unnecessary. There does not appear to be an obvious correlation between boat diving and deep water deaths, as four fatalities of six from boats occurred in 40 feet of water or less. The remaining two fatalities account for approximately 30 percent of the total deep water deaths (60 feet or greater).

TABLE 3

LOCATION OF RECREATIONAL SKIN/SCUBA FATALITIES, 1965-1978

LOCATION	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Great Lakes	1					1			2	2	1	2	2	
Lake, Pond	2	1		4	2		4	3	2	1	1	2	1	1
River	1						1					1		
Quarry, Pit								1						1
Swimming Pool											1			1
Unknown														

(1)*

* Report missing.

TABLE 4

DEPTH OF FATAL SCUBA DIVE OR DEPTH AT WHICH BODY WAS RECOVERED,
RECREATIONAL, 1965-1978

DEPTH (feet)	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
0-10	1						3		1	1	2	2	2	
11-20	1	1		2			2	2			1	1	1	
21-40	1			2	2				2			1		2
41-60										1				1
61-100								2				1		
100-130	1					1								
Unknown			(1)*											

* Report missing.

TABLE 5

ENVIRONMENTAL CONDITIONS AT TIME OF ACCIDENT, RECREATIONAL SCUBA, 1965-1978

<u>CONDITION</u>	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Moderate (1-3 ft) Waves				2					1	2	1		1	2
Heavy (over 3 ft) Waves														
Current, Undertow, River	2						1							
Ice on Surface	1							2				1		
Calm	1	1		2	2	1	3	2	3	1	2	4	2	1
Other/ unknown			(1)*				1							

* Report missing.

TABLE 6
POINT OF ENTRY, RECREATIONAL DIVING FATALITIES, 1965-1978

<u>POINT OF ENTRY</u>	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Shore, Beach Pier	3	1		2	1		4	4	3	3	2	2	3	2
Shore with Float									1		1	3		1
Private Boat	1			2	1	1	1							
Unknown			(1)*											

* Report missing.

Training, Medical, and Rescue Aspects

Approximately 75 percent of the sport scuba victims fall into the 16-25 year age range, with one fatality younger than 16 years (See Table 7). A report published by the University of Rhode Island¹ indicates that divers over age 35 have a sharply increased risk of heart attack. Autopsies were not performed on those victims in this age group, and heart attack cannot be conclusively implicated in any of the four cases where the victim was over 35. "Possible heart attack" was listed on the original report for one case, and the victim in another was known to suffer from emphysema. The cause of death for one younger victim, age 29, was listed as coronary arterial atherosclerosis (by autopsy). This same victim had a history of fainting spells due to high blood pressure.

Table 8 gives the experience with scuba for the fatalities under study. Twenty-six percent of the victims were on either their first scuba dive or their first dive in unconfined water. Forty-two percent of all victims had five total dives or less, and persons with more than one year of diving experience account for 18 percent of the total. Actual experience of the victim is not known in almost one-fourth (23 percent) of all cases.

Tables 9 and 10 summarize the buddy status and buddy activity of sport skin/scuba fatalities. In 28 percent of all deaths, the victim was diving alone. However, in 47 percent of the remaining cases, where the victim was diving with at least one buddy, the divers lost track of each other, usually underwater. In such a situation, the buddy is not present to offer assistance in an emergency and the victim could be considered essentially to be "diving alone." Thus, in 75 percent of all cases, the victim had no one nearby to offer assistance. Maintaining buddy contact would appear to be a primary safety consideration.

Equipment Aspects

Table 11 summarizes the performance of personal flotation devices (P.F.D.'s) in the cases under study. In 48 percent of all fatal accidents, no flotation device was worn. In 64 percent of those remaining cases where a vest was worn, it was not used. In one of these latter cases, the vest was found to have an empty CO₂ inflation mechanism.

In one case, it appears that a free-flowing regulator at depth created an emergency situation. In the other incidents, it appears that either failure to use a piece of equipment (such as a vest or float) or improper use of equipment is a more relevant consideration. For example, in 83 percent of those cases where the divers entered from shore, no float was used. One victim, diving with no wet suit or vest, wore 18 1/2 pounds on his weight belt. Another victim wore 35 1/2 pounds on a "seat belt." In only four fatalities was the weight belt actually ditched. In one case, the belt was released by the victim's buddy. In another case, a double fatality, the divers were found under ice with weight belts removed. One unsuccessful attempt to ditch weights by a victim's buddy was also noted. Finally, one victim went diving without wearing fins.

TABLE 7

AGE DISTRIBUTION OF RECREATIONAL SKIN/SCUBA FATALITIES, 1965-1978

Years	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
10-15							1							
16 20	2			1	2		2	2	1	2	2	4	2	
21-25	1			2			2	2*	1	1			1	
26-30	1			1					1			1		3
31 35														
36 40		1				1			1					
41-45											1			
Unknown														

* One fatality was a female diver.

** Report missing.

TABLE 8

EXPERIENCE WITH SCUBA FOR RECREATIONAL FATALITIES
1965-1978 (SKIN DIVING NOT INCLUDED)

EXPERIENCE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
First Dive with Scuba			2	1			2		1		1	1		
First Dive in Open Water						1					1			
Early Open Water Dive								1	2				1	2
Some Experience								3		1		1		1
Considerable Experience									1	1		1	1	
Very Experienced										1		1	1	
Unknown	3		(1)*	2	1	1			1			1		

(Definitions: "Early" implies second to fifth dive, "some experience" implies a year of casual diving, "considerable experience" implies more than a year, and "very experienced" identifies instructors, commercial divers, or those with established diving reputations.)

* Report missing.

TABLE 9

BUDDY STATUS OF RECREATIONAL SKIN/SCUBA
FATALITIES, 1965-1978

NUMBER WITH VICTIM	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Zero (Diving Alone)	2	1				1	3	1	1	1	1	1		
One Other				2	2		1	2	2	2		1	3	3
Two Others	2			2			1	1	1		1	2		
Several Others													1	1
Unknown														

(1)*

* Report missing.

TABLE 10

BUDDY ACTIVITY DURING RECREATIONAL SKIN/SCUBA FATALITIES, 1965-1978

<u>BUDDY ACTIVITY</u>	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Stayed with Victim				4*	2			1	1			1	1	1
Lost Victim Underwater	2					1			2	1	2	2	1	1
Attempting Buddy Breathing										1				
Left Water Ahead of Victim												1		
Lost Victim on Surface													1	1
No Buddy	2	1					3	1	1	1	1	1		
Unknown			(1)**				2	2						

* In each case rescuer became exhausted and had to leave victim.

** Report missing.

Equipment Aspects

Table 11 summarizes the performance of personal flotation devices (P.F.D.s) in the cases under study. In 48 percent of all fatal accidents, no flotation device was worn. In 64 percent of those remaining cases where a vest was worn, it was not used. In one of these latter cases, the vest was found to have an empty CO₂ cartridge, although the firing mechanism had not been pulled. Two fatalities used vests with no CO₂ inflation mechanism.

In one case, it appears that a free-flowing regulator at depth created an emergency situation. In the other incidents, it appears that either failure to use a piece of equipment (such as a vest or float) or improper use of equipment is a more relevant consideration. For example, in 83 percent of those cases where the divers entered from shore, no float was used. One victim, diving with no wet suit or vest, wore 18 1/2 pounds on his weight belt. Another victim wore 35 1/2 pounds on a "seat belt." In only four fatalities was the weight belt actually ditched. In one case, the belt was released by the victim's buddy. In another, a double fatality, the divers were found under ice with weight belts removed. One unsuccessful attempt to ditch weights by a victim's buddy was also noted. Finally, one victim went diving without wearing fins.

Probable Causes

In those cases where the victim was diving alone (in the absence of either a buddy or another witness), or where the victim became separated from his buddy before an emergency was apparent, the cause cannot be determined. There are ten such cases.

The majority of the incidents fall into the category of possible exhaustion, panic, or air embolism. This includes those cases where the victim appeared excited and/or panicky to his buddy, or to a witness on the surface, and those where the victim simply sank or lost consciousness on the the surface after a dive. Twenty-three fatalities fall into this category.

There are 11 accidents for which more information is available. One victim who passed out on the surface was known to suffer from emphysema. Another victim had a history of fainting spells due to high blood pressure, and the cause of death was found (by autopsy) to be coronary arterial antherosclerosis. One victim was recovered with substantial evidence of air embolism after unsuccessfully attempting a buddy breathing ascent. Two divers appear to have been severely overweighted. One victim was struck by a passing boat and suffered lacerations of the neck and spinal cord. Four victims became lost under ice cover and apparently drowned, and one victim was found inside a shipwreck after having apparently lost his way out.

Comparison to National Statistics

Table 12 compares the fatal accident statistics in Michigan to national totals in several key areas. For the most part, fatalities in Michigan tend to reflect the information gathered nationally. Accidents seem to occur at a deeper depth on a national basis. Perhaps this is because of ocean diving, where deeper water is often easily accessible. Once again, it is noted that the majority of fatalities occurred when the divers entered from the shore, both statewide and nationally. It appears that significantly more divers in Michigan are using a float of some sort, however.

Lack of prior experience is much more common in Michigan fatalities, and it is also seen that a much greater percentage of accidents involved a lone diver. On both a statewide and national basis, the frequency of buddy separation is distressingly high. Personal flotation devices are not worn in far too many cases, and, where they are worn, they are not used as they should be.

TABLE 12

COMPARISON OF MICHIGAN TO NATIONAL DIVING FATALITY STATISTICS

	MICHIGAN 1965-1978	NATIONAL ₁ 1970-1975	MICHIGAN ₂ 1959-1965
ACCIDENT DEPTH:			
1) Less than 25 ft	55%	25%	86%
2) Less than 50 ft	80%	50%	95%
ADVERSE WEATHER CONDITIONS			
	30%	25%	--
POINT OF ENTRY:			
1) Shore	86%	70%	--
2) With float	17%	2%	--
AGE DISTRIBUTIONS:			
16-25 Years	75%	50%	--
EXPERIENCE:			
First Time in Open Water	26%	12%	14%
BUDDY STATUS:			
1) Diving Alone	28%	10%	--
2) Buddies Became Separated	47%	67%	--
PERSONAL FLOTATION DEVICES:			
1) Not Worn	48%	65%	--
2) Worn, Not Used	64%	57%	--

Recommendations

There appear to be several areas where improvements can be made which would significantly reduce the number of diving-related fatalities both in the State of Michigan and on a national basis.

1. A float or buoy of some sort should be used in the water at all times. In many cases, divers became exhausted and could not return to shore. A float offers a place to rest, while permitting a diver to progress toward the shoreline (or boat).
2. The "Buddy System" as practiced by many divers proves to be effective in providing aid to a distressed diver. Buddies should maintain visual contact with each other at all times, and be close enough to offer immediate assistance.
3. Personal flotation devices (P.F.D.s) should be worn. In far too many cases, no emergency flotation was available to the victim. Divers should also be trained in the proper use of a flotation device, since in over half of the cases where one was worn, divers did not use it properly.
4. Divers should receive proper instruction. Many victims had received no formal training in the use of scuba equipment or were diving with a friend who was a certified diver but not a certified instructor. Specialty areas of diving, such as wreck diving procedures or ice diving, which involve major modifications in diving procedures, also require instruction by qualified individuals in order to be carried out safely and effectively.
5. Divers and instructors must pay more attention to proper weighting. Obvious overweighting and inadequate buoyancy compensation were probably contributing causes in several fatal accidents. An overweighted weight belt and over-dependence on a buoyancy compensation device are far too common in current instruction.
6. Divers must be taught basic rescue techniques. Too frequently the buddy was unable to effect a rescue or administer mouth-to-mouth artificial respiration in the water. Simple self-rescue (dropping weight belt/inflating vest) would have prevented a significant number of fatalities.
7. Divers and diving course students must be encouraged not to attempt to instruct non-diver friends in the use of scuba or to provide diving equipment for non-trained divers.
8. A number of accidents involved "three-person" buddy teams. The use of three-person diving teams must be carefully re-evaluated for Michigan diving conditions.

SECTION II

PROFESSIONAL AND SEMI-PROFESSIONAL FATALITIES

Skin/Scuba Diving Fatalities

Three of the four fatalities in this section involved the use of self-contained breathing apparatus, and one case involved the use of surface-supplied diving equipment.

All three scuba fatalities are classified as semi-professional. The victim in each case was self-employed, and diving was not his primary occupation.

In one case, the diver was working alone, under ice, installing a bubbler system in a marina. The area between and outside of the three docks was ice covered, with open water in the boat wells (due to the bubbler system). The victim, stating that he wanted to finish the job that day, entered the water wearing double tanks and a variable-volume dry suit. He left a friend on the dock as an observer, and used no safety line, as he feared getting tangled under the docks. The victim surfaced in one of the boat wells on the center dock and stated that he was going to one of the other docks to do some work. He was not seen again, and was recovered under the large ice sheet near the shore of the marina. His weight belt and backpack were still on, but the tanks, which had been wired to the backpack, were found 20 feet away. The regulator mouthpiece was floating above the empty tanks.

Another victim was diving alone in a river, recovering fishing lures, an activity he had pursued for three years. The victim would overweight himself with 24 pounds on his waist and a two pound weight on each ankle. The dive site was below a dam where the water was quite swift. The victim was very fatigued, and witnesses said that he moved closer to the dam than normal, and apparently got drawn against the rocks and lost control. He was seen floating downstream turning over three times as he went. The regulator was out of his mouth the last time he turned over. The victim was recovered with the outside portion of a minnow bucket attached to his chest and a rope from his waist tied to an inner tube and diving flag. The rope was tangled around his body.

In the last scuba case, the victim was diving alone in 18 feet of water trying to find out why fishing nets were getting fouled on the bottom. He had not been diving in five years, and the equipment had not been used for equally as long. The victim entered the water and never resurfaced. He was recovered two and one-half hours later.

Surface-Supplied Diving Fatalities

The victim was diving from a salvage ship and removing steel from a sunken ship at 120 feet. He wore a variable-volume dry suit and lightweight helmet. The victim had been down 26 minutes on his first dive of the day when he told the surface personnel that he could not get any air, and that a piece of steel had fallen onto his air hose. According to the accident reports, the standby diver was into the water within three minutes and two scuba divers were

in within ten minutes. The victim was brought to the surface, recompressed, and CPR was administered to no avail.

REFERENCES

- ¹University of Rhode Island. 1977. United States Underwater Fatality Statistics 1975. Report # URI-SSR-77-11.
- ²Denny, M. K. and Read, R. C. 1965. Scuba diving deaths in Michigan. JAMA 192(3): 220-223.

APPENDIX

Case Histories, Recreational Skin/Scuba Fatalities, 1965-1978

Brief case histories of selected diving fatalities in Michigan for the years 1965-1978 are presented in this appendix. These histories have been constructed from the information contained in the accident reports on file with the Michigan State Police. To the best of our knowledge, only facts from these reports have been included. Although there is some obvious speculation in the discussions in other sections of this report, none of the information contained in this appendix is an assumption. As such, where factual information was lacking, the histories are somewhat sketchy.

In all cases, the victim was wearing at least a mask and fins, unless specifically noted otherwise. Those reports filed after 1971 generally contain more information about the equipment involved than earlier reports.

- Case 1: The victim, a 20-year-old male, and two buddies entered open water, then proceeded under four inches of ice cover. No safety lines were used. When the victim signaled that he was on reserve air, they surfaced beneath the ice where two of them cut a hole and exited. The victim swam off in an unknown direction.
- Case 2: A 29-year-old male went snorkeling alone with a newly purchased mask and snorkel. He was paralyzed from the waist down, but an excellent swimmer according to his wife. An hour and fifteen minutes after he entered the water, his wife found him in four feet of water. She attempted artificial respiration with no result. The victim bled from the nose. An autopsy reported the cause of death as accidental drowning.
- Case 3: The victim, an 18-year-old male, became separated from his buddy while diving on a shipwreck. The victim's buddy surfaced, and the victim's father then donned a tank, and found the victim lying on the bottom. He was pronounced dead after 45 minutes of artificial respiration at a hospital.
- Case 4: The victim, a 22-year-old male, was experimenting alone with a home-made breathing device in 12 feet of water in a pond on a calm day. He was found with two eight-pound, home-made weights (cloth bags filled with nuts and bolts) attached to a belt on his waist. The tanks, military aviator oxygen tanks, were found floating about 20 feet offshore.
- Case 5: The victim, a 39-year-old male, was swimming alone after dark with a mask and fins. He was found the next day in 20 feet of water.
- Case 6: The victim, a 21-year-old male, and his buddy were swimming with scuba gear underwater toward shore from an anchored boat. The water was rough, and upon reaching shore, they noticed the boat drifting away. They started back underwater, but the victim's buddy had to surface due to regulator malfunction. He noticed the victim swimming underwater with no obvious problem. Upon reaching the boat, the

victim's buddy became sick and a third party entered the water to help him into the boat. The victim then surfaced, rolled onto his back, and waved to the boat. The third party again entered the water to aid the victim, but became exhausted on his way to shore and released the victim. The victim submerged in approximately 25 feet of water.

- Case 7: The victim, a 19-year-old male without previous diving experience, was diving with two friends nearby on a clear, calm day. The victim, wearing a single tank, eight pounds of weight around his waist, and without fins, was told to stay in shallow water. His buddies saw a large amount of air coming from deep in the lake, and attempted to help the victim, but they could not hold him. He was recovered from 15 feet of water.
- Case 8: The victim, a 30-year-old male, was swimming with one friend on the surface of the water with scuba equipment on. The water was calm, and the victim was using his snorkel. A witness on shore reported that it appeared as though the mouthpiece came off the snorkel, causing the victim to panic. His buddy was unable to save him.
- Case 9: The victim, a 25-year-old male, was scuba diving with two companions on a clear day, with water conditions calm to rough. The victim surfaced after ten minutes and tore off his mask. His buddy held him on the surface and attempted to swim to the boat, but became tired and had to release the victim. The victim was recovered in 22 feet of water.
- Case 10: The victim, a 20-year-old male, unfamiliar with diving equipment, was diving on a calm day with one friend. He had trouble with his equipment and began calling for help. His buddy made several attempts to pull the victim to safety, but the victim was panicky, and fought his buddy off. The victim submerged in about 30 feet of water where he was recovered.
- Case 11: The victim, a 19-year-old male, was diving with one companion on a calm day. His buddy tried to pull the victim from the water after the victim ran out of air and tried to jettison his equipment. He succeeded only in removing his tank and his buddy could not pull him to the surface. The victim was recovered in 30 feet of water.
- Case 12: The victim, a 40-year-old male, and one buddy, were diving on a shipwreck in 110 feet of water on a calm day from a small boat. Both divers began to return to the surface, but upon reaching the surface, the victim failed to appear. His buddy resubmerged, but did not have sufficient air to reach the wreck. The victim was located the next day by police divers, on the bottom about eight feet from the wreck, with his reserve lever on, and his tank empty.
- Case 13: The victim, a 24-year-old male with no previous diving experience, was diving in six feet of water. He wore a mask, fins, and a single tank with a regulator. He surfaced twice, removing his mask the first time, and removing the mouthpiece the second time. The victim was recovered with scuba gear off.

- Case 14: The victim, a 24-year-old male, was skin diving with a mask only from a small boat. There was one other passenger in the boat observing him. After being submerged about two minutes, he surfaced and called for help with his hand on his chest. He submerged and was not seen after that. The victim was recovered in ten feet of water.
- Case 15: The victim, a 16-year-old male with no previous diving experience, went diving with one friend. The water was calm and he wore mask, fins, a weight belt, and a set of double tanks. The victim panicked ("get these tanks off me"), removed the tanks, and attempted to swim to shore. He was recovered in 15 feet of water.
- Case 16: The victim, a ten-year-old male, was skin diving for golf balls in a dam backwater on a rainy day in calm water. When he failed to surface after five minutes, a search was started by two men on the scene who had scuba outfits. The victim was found in 20 feet of water. His snorkel was recovered at ten feet.
- Case 17: The victim, a 17-year-old male with no previous diving experience, joined two friends for diving. The water was calm, and the bottom of the lake covered with weeds. The divers were in 20 feet of water, with a flag, when a skier went overhead. The victim wearing only a mask, fins, and a tank/regulator, panicked, lost his mouthpiece, and attempted to get his buddy's mouthpiece. He surfaced, but was pulled under by his tank and not seen again. The victim was found with the regulator strapped to his chin, and the area around the mouth discolored. One fin was missing.
- Case 18: Two victims: Victim A, a 16-year-old male certified 2 years earlier, wore a full 1/4" wet suit, flotation vest with CO₂ cartridge, fins, a single tank/regulator, no depth gauge, watch or compass; Victim B, a 20-year-old male, a certified diver with about ten hours experience, wore a 1/4" wet suit, flotation vest, a 16-pound weight belt, single tank and two-hose regulator. Victim B also wore a depth gauge, compass, and watch. The two victims entered open water, and attempted a compass run to an ice-covered point 75 feet away without the use of safety lines. Both were recovered face up, beneath the ice. Victim B had his vest partially inflated, and had attempted to cut his way out of the ice. His reserve was down, and the tank empty. Victim A was found with his vest uninflated and with 100 psi remaining in his tank.
- Case 19: The victim, a 25-year-old female, was diving in 15 feet of water with two companions, on a calm day. She wore a wet suit top, a 15-pound weight belt, a compressed air vest with no bottle, and a tank/regulator. She was a certified diver with about 30 hours experience, and had made six or eight 12-foot dives previously on this same day. She followed her two companions who looked back every 20-30 seconds. When one buddy noticed her missing, he rose to the surface, followed her bubbles down and found her face down on the bottom, not breathing. Her buddy removed her tank, brought her to the surface, and applied CPR upon reaching shore.

- Case 20: The victim, a 24-year-old male with two previous dives, went diving alone while two friends were swimming nearby. He wore mask, fins, and tank/regulator. The victim started yelling for help, and submerged before the friends could reach the victim. He was found in 15 feet of water, and CPR was administered by two deputies on the scene. Earlier this same day, the victim had turned purple, and experienced back pain and shortness of breath.
- Case 21: The victim, a 23-year-old male, and one buddy were doing some photographic work at 105 feet on a clear, calm day. The victim, with five years' scuba experience, and 78 logged dives in the past 15 months, wore a full wet suit, 18-pound weight belt, flotation vest, and twin 72's and regulator. The divers decided to abort the dive because of poor visibility, and began to surface. At 90 feet, the victim's buddy saw the victim start dropping back down, and went after him. He had to stop to adjust his camera and equipment and lost sight of the victim. Unable to locate the victim, he surfaced, donned another tank, and searched again, but could not locate the victim in the poor visibility water. The victim was recovered later, lying on his back, regulator out of his mouth, purging air, tangled in the marker buoy line.
- Case 22: The victim, a 39-year-old male, was diving with one companion on a calm day. He wore a full wet suit, weight belt, flotation vest, and a single tank/regulator, and had been certified the previous month. As the divers descended, the victim blew some air into his buoyancy vest. When he replaced his regulator and pressed the purge, it began to free flow, and the divers surfaced. The victim tried to ditch his weight belt unsuccessfully, inflated his vest with the CO₂ mechanism, and passed out. The victim's buddy could not get behind him to release the weight belt, and took him ashore, where artificial respiration was applied. The victim was known to suffer from emphysema.
- Case 23: The victim, a 27-year-old male with no known diving experience, entered the water alone, wearing a four-pound weight belt and a single tank/regulator. He did not wear a wet suit or flotation vest. He was recovered 3 1/2 hours later having ditched his weight belt, and having attempted to ditch his tank, which contained 1500 psi.
- Case 24: The victim, a 20-year-old male with one previous scuba dive, was diving with two companions in 20 feet of water with one-foot waves. The trio became separated, and the two other divers surfaced. They saw the victim in waist deep water, assumed he was going ashore and resumed diving. Upon returning to shore they could not find the victim. He was recovered on the water's edge about 300 yards away. The victim wore a single tank/regulator, no wet suit or flotation device.
- Case 25: The victim, a 17-year-old male with 13 years diving experience (non-certified), went diving alone in ten feet of water. A friend was standing on shore. There was a slight current and the seas were

calm. The victim wore a full wet suit, a 21-pound weight belt, a flotation vest, and 42 cubic foot tank/regulator. After about 20 minutes, he surfaced, called for help, and sank. The body was not recovered until it washed ashore two months later.

- Case 26: The victim, a 22-year-old male, certified nine months earlier, was diving in 45 feet of water with one companion. The water was rough, and the victim wore a wet suit, weight belt, flotation vest with no CO₂ inflator, and single tank/regulator. The victim's buddy lost his mask, and the victim went to recover it. The victim surfaced, called for help and submerged, but his buddy, 25 feet away, was unable to assist. When the victim was recovered, the waist strap on his tank had been released, and his tank was empty. The divers carried a small float capable of supporting only the flag.
- Case 27: The victim, a 17-year-old male with two years' scuba experience, and certified one year earlier, was diving with a buddy in moderate seas. They had made a previous dive to 30 feet, and after a 4 hour surface interval, went out in a boat to dive on a shipwreck in 108 feet of water. The victim wore a wet suit, 18-pound weight belt, a flotation vest, and single tank/regulator. On the deck of the shipwreck at 90 feet, the victim indicated that he wanted to buddy breathe. The divers began to buddy breathe and ascend, but the buddy had to take the regulator away from the victim to get air. During this time, the buddy lost his mask, and became separated from the victim. The victim was recovered the next day in 108 feet of water, his mask filled with frothy blood. His vest was not inflated, and he still carried his weight belt.
- Case 28: The victim, an 18-year-old male, was swimming in 12 feet of water with a snorkel and swim fins. The water was calm. A witness on shore stated that the victim was having trouble with snorkel plugging, and suddenly became violent and called for help. A rescue attempt failed when the victim pulled the rescuer under, and forced him to release the victim.
- Case 29: The victim, a 42-year-old male, was making his open water checkout dive with four other students and the instructor. The victim wore a 3/16" wet suit, a flotation vest, and a single tank/regulator. He also wore a weight belt (seat belt) with 35 1/2 pounds of weight. The divers were swimming toward a buoy marker, and the victim's buddy surfaced to locate the marker. The victim's buddy went back down, saw the victim for the last time, and swam to the buoy. Another student was having problems at the buoy and, under the assistance of the instructor, all returned to shore. No one noticed that the victim was missing until they were all ashore. The victim was recovered several hours later, on his back (submerged) with his vest inflated. The vest had a slow leak. The victim had one brother who died from heart attack though his doctor did not recommend that the victim have an EKG.
- Case 30: The victim, a 19-year-old male with no previous scuba instruction, was diving with two companions in calm water. None of the divers were certified. The victim wore a wet suit, weight belt, and a

single tank/regulator. He did not wear a flotation device. The trio became separated. Two of the divers surfaced and did not know where the victim was. After 20 minutes, they located the victim in 4 to 5 feet of water, his mask removed and the regulator out of his mouth. An abrasion and small cut were observed over the victim's right eye. The victim was brought ashore and given artificial respiration with negative results.

- Case 31: The victim, a 29-year-old male with two years of certified diving experience, was diving in calm water with one companion. He wore a full wet suit, an eight pound weight belt, a military-type flotation vest, and a single tank/regulator. The victim's buddy became cold, and advised the victim he was going ashore. The victim, with his vest inflated, said he was going to float on the surface for awhile. When the first diver got ashore, he called to the victim, and got no response. He went to the victim, and found the victim's head completely below the surface. He ditched the victim's tank and weight belt, and gave artificial respiration. The victim had a past history of fainting spells due to high blood pressure. Autopsy concluded that cause of death was coronary arterial atherosclerosis.
- Case 32: The victim, a 20-year-old male with one year of scuba experience (not certified), was diving with two buddies in a partially ice-covered bay. The victim wore a full wet suit, weight belt, flotation device, and single tank/regulator. The divers entered in open water, but soon their tube float got caught on the edge of the ice, and they let the safety line loose. They ascended, easily breaking through the honeycombed ice. They descended again into eight feet of water, became separated, and low on air. Two of the divers found a crack, chipped an exit hole, ditched their equipment, and crawled out. They did not know where the victim was. The victim was located by police divers, face down within 20 feet of the hole, with his reserved tripped and tank empty. CPR gave negative results.
- Case 33: The victim, a 16-year-old male with no previous skin diving experience, was skin diving with an inexpensive chain-store brand of mask, fins, and snorkel, while a friend watched on shore. He had no flotation device. The victim surfaced, called out, and submerged. He surfaced again and resubmerged. The witness tried unsuccessfully to locate the victim with a rowboat. The victim was recovered 1 1/2 hours later from 14 feet of water.
- Case 34: The victim, a 17-year-old male with no previous diving experience, was diving in moderate water with two companions. One of them was a certified diver, the other had no experience with scuba. The victim wore a wet suit jacket, ten-pound weight belt, and single tank/regulator. The trio began diving from the swimming area and descended holding hands, with the certified diver between the two novices. At about 25 feet they hit cold water, and decided to surface, stopping briefly for a motorboat. At the surface the victim indicated that he was not "OK" and sank. At this point, he was missing one fin. Both others went to assist the victim, but one surfaced when the victim kicked his regulator from his mouth. The

second diver brought the victim to the surface with his own vest inflated, but the victim grabbed the vest, and it began to deflate. The victim's mouthpiece was not in place. Both rescuers were exhausted and had to leave the victim who submerged and did not resurface. The victim was recovered 30 minutes later, with 2000 psi in his tank. CPR was administered without result.

- Case 35: The victim, a 20-year-old male with five years of scuba experience, was diving with four others on an inclined shipwreck in calm water. The victim wore a full wet suit, weight belt, flotation vest, and single tank/regulator. Ascending along the deck at about 80 feet, they all stopped and checked their air supply. All had 900 psi except the victim, who had 1500 psi remaining. All continued their ascent, except the victim, who went into the engine room, and galley store room. He was not missed by the others until they were on the surface. The victim was found in the storeroom, against the ceiling with his vest inflated, and his tank empty.
- Case 36: The victim, an 18-year-old male with less than three hours scuba experience, was diving with one companion in seven feet of calm water. He wore a wet suit jacket, a 17-pound weight belt, and single tank/regulator. The victim began having trouble and spit out the mouthpiece. His buddy attempted to replace it several times, until he ran out of air and had to surface. The victim was recovered with 750 psi remaining in his tank. He had been instructed on how to release his weight belt, but did not release it.
- Case 37: The victim, a 19-year-old male with four years of certified scuba experience, was attempting to teach a female friend with no previous experience to scuba dive. He wore a single tank/regulator, and 18 1/2 pounds of weight (no wet suit or flotation device). The victim entered the water (one to three-foot waves) first, and told the friend to jump in. Upon entering, the friend became panicky, and swam to the surface where she removed her mask and kicked off her fins. The victim came to the surface, and with the aid of several others, helped her onto the pier. The victim resubmerged, indicating no problems. Several minutes later, one of the witnesses jumped into the water and recovered the victim, who was lying face down with only his swimsuit on. CPR was administered with no result. The victim had been using an early model lightweight aluminum tank with six pounds of weight on the backpack harness.
- Case 38: The victim, a 25-year-old male with nine years of scuba experience, was diving with one companion in 20 feet of calm water. He wore no wet suit, weight belt, or flotation device. Both divers were low on air and surfaced. As they swam toward shore, the victim's buddy thought the victim was right behind him. When he reached a sandbar, he could not see the victim, searched briefly, and then summoned help. The victim was recovered about 100 yards offshore, his scuba tank empty.
- Case 39: The victim, a 28-year-old male, was assisting a group under instruction in a river with a moderate current (5-6 mph). The victim had one year of diving experience. A flag was placed on the dock,

and the divers were instructed to swim slightly upstream and to return to the bank and shallow water before surfacing due to boat traffic on the river. During the dive the victim signaled that he was surfacing, and his buddy followed. At the surface, the victim was knocked to one side, and then his buddy noticed the victim motionless and bleeding. He took hold of the unconscious, breathing victim and called for help. A nearby boat assisted, and the victim was taken to the hospital, where he was pronounced dead. The boat which struck the victim was apparently unaware of the accident, as it did not stop. The victim's buddy stated that their ascent had been slow and controlled with no evidence of panic.

Case 40: The victim, a 28-year-old male who had used scuba once before, was diving with one buddy in 20-25 feet of water. He wore a single cylinder and regulator (four pounds of weight attached to the tank) and a flotation vest with a spent 16-gram CO₂ cartridge. The divers entered the water after each had had three or four beers, the last one approximately one hour before diving. After a few minutes, the victim's buddy signaled to return to shore, but the victim swam off. The victim surfaced about 80 feet from his buddy and uttered something. His buddy ditched his own scuba and swam to the victim, who sank before he could reach him. The victim was recovered the next day, wearing all of his equipment, with the mouthpiece at his side.

Case 41: The victim, a 28-year-old male, and his wife were on a checkout dive in a gravel pit. He wore a tank-mounted weight/buoyancy system with 13 pounds of weight. After swimming to a buoy with his wife and their instructor, the victim went down with the instructor, leaving his wife at the surface. After they returned to get her, all three descended together to complete her checkout. The instructor advised that the victim wanted to swim off on his own on two occasions. During the checkout the instructor had to assist the victim's wife, after which the victim was gone. The instructor returned the victim's wife to the surface and searched the immediate area. He then returned her to shore, and took her tank back to the buoy for a spare. He searched for half an hour, then ran a previously mentioned compass course from the buoy to shore. The victim was located in 40 feet of water, face up with the regulator out of his mouth. The instructor took the victim to shore, applying mouth to mouth resuscitation. CPR was started until the ambulance arrived. The victim was pronounced dead at the hospital, death due to drowning.



THE UNIVERSITY OF MICHIGAN

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